Panasonic Toughbook Flex

Market, Product, and Competition Analysis

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The Toughbook Flex: Prospects and Potential

Summary and Conclusions of a nine-month study by an independent, multi-discipline Opinion Leaders Committee

"An organization's ability to learn, and translate that learning into action rapidly, is the ultimate competitive business advantage."

-- Jack Welch, CEO, General Electric

Learning. Not an often-heard word within the Fortune 1000. Not in The Information Age. Today, the operative term is “knowledge” and Corporate America’s attempt to cope with it has spawned a billion-dollar industry known as Knowledge Management.

What exactly is knowledge? This report is being input to a personal computer stuffed with six hard drives holding over 260 gigabytes of data. A broadband Internet connection provides almost instant access to more stored information than existed in the combined collections of every library on earth one century ago.

Is all this knowledge? No. It is merely information. Essentially useless digital debris to anyone without the ability to pull related chunks out of the morass and assemble them into something meaningful. Essentially useless, in other words, to anyone without the “ability to learn.”

Over the hundreds of thousands of years of our evolution we’ve become quite good at learning. Maybe too good. In the past half-century mankind’s ability to turn information into knowledge and use that knowledge to create machines that can filter and manipulate ever more information into infinitely more knowledge has changed the paradigm of every aspect of life. Especially business and industrial life.

Throughout the corporate world companies inventory their data warehouses, drill into their data mines and explore their data archives 24 hours a day, 365 days a year. Billions and billions of computer “man hours” are devoted to combing information for knowledge. Knowledge that can be used to speed up a process here, cut a cost there, enhance a sales opportunity somewhere else.

Business organizations—like the people who manage and staff them—have gotten rather good at learning, at converting information into knowledge.

"Translating that learning into action rapidly," however, is another matter. To gain any competitive advantage, let alone an "ultimate" one, the latest "weapons" from the knowledge factories have to be rapidly and effectively delivered to those expected to wield them.

The proposed Flex wireless display system helps solve one of the most basic roadblocks to "translating learning into action rapidly" by disseminating knowledge to field force and other workers left out of the learning loop by existing computer technology.

It is a system designed to bring the same knowledge to these users that is available to colleagues able to access corporate intranets, private wireless networks, and the Internet from notebook or desktop computers.

If there is one marketing point about this system that should be stressed from the outset it is this: The Flex is not a supercharged PDA, a 25^{th} century pager, a Handheld Portable Computer endowed with wireless connectivity. The Flex is a *computer*. A full-featured, high-powered, state-of-the-art computer capable of running the same software and performing the same "miracles" we've all come to expect from our desktops and laptops. Capable of doing all these things in places where it has never been possible to do them before.

To help the Panasonic Personal Computer Company evaluate opportunities for the Flex system, an Opinion Leader Committee composed of expert analysts, researchers and media executives was formed under the direction of Jeffrey Ayers, Senior Partner at Dentsu Communications and Marketing Group.

The Committee members, identified in Appendix A, were charged with researching markets where the Flex might find substantial acceptance, identifying hardware and software requirements specific to those markets, and evaluating the Flex relative to current solutions.

In addition to the Opinion Leader Committee research, Technology Business Research, Inc. conducted a marketing survey in which 157 corporate executives and IT managers were queried to determine their level of interest in a Flex-type mobile computer system and the specific features and functions they considered most/least important in the configuration of such a device. A complete report on the TBR survey is included as Appendix III of this document.

Both the Opinion Leader Committee's conclusions and TBR's findings indicate that a substantial number of volume computer buyers in vertical industries see the need for an ultra-portable, highly mobile, Windows-compatible computing device that is fully integrated into their wireless networks and can be deployed under adverse conditions.

As would be expected from a product with extreme potential for increasing productivity, job performance and cost containment on “blue-collar” assignments, concerns about durability and ease of operation and training were common.

Looking at the horizon directly in front of the Flex, the Committee was particularly impressed by the vast number of routine, yet time-and-resource-consuming tasks that have been completely bypassed by the computer revolution. Almost every industry surveyed still has vast numbers of field employees writing things down on pieces of paper…millions of pieces of paper which then have to be organized and entered into databases by other armies of employees.

In the Committee’s opinion any major task still performed using pencils and forms (referred to as “checklist” or “clipboard” applications in this report) is ready to fall before the Flex revolution. The Committee also believes the ratio of units sold to number of employees will be unusually high in “checklist” areas because the Flex will be entering a computer-less workplace. Buyers will thus be able to place large immediate orders instead of ordering piecemeal as existing notebooks or pentabs reach the end of their budgeted lifecycles.

A major factor in promoting the conversion of paper-age departments into computer-age ones would be offering the Flex as a turnkey solution.

Example: Insurance companies have some of the most sophisticated and technologically advanced computer systems in the world.

Expecting the highly capable professionals running those systems to configure the Flex for use by insurance adjusters, however, would almost certainly generate sales resistance. Not because they couldn’t do it, but because the adjusters have never used computers in the field and would require training, impacting IT department schedules and budgets.

For this reason, many IT managers in similar situations can be expected to take a position along the lines of “You deliver it to us pre-configured, with an application that replicates standard industry forms and is compatible with our servers, and we’ll fine tune it and deploy it.”

Though the example given is a situation unique to users migrating directly from analog to digital ink, the Committee feels that offering the Flex as a turnkey solution is almost a marketing imperative in other areas as well.

Offering it pre-configured, with appropriate applications and complete with the internal modules and external peripherals necessary for the targeted task would empower companies to deploy it and enjoy an almost immediate return on their investment.

A construction company, for instance, wouldn't have to negotiate separately with Panasonic, wireless providers, application developers, GPS-receiver makers, laser rangefinder vendors, etc. It could, rather, order thousands of systems knowing that Panasonic would design them, build them, install on-site prototypes and ensure the whole system—from the perimeter boundary sensors to the display-screens next to the bulldozer operators—works before shipping the first complement to Kuwait.

The turnkey approach offers customers the reassurance inherent in having one phone call to make regardless of what goes wrong.

It gives competitors without the resources or will to escape their hardware-vendor-only cage a very hard road to trek when trying to sell Flex alternatives.

Interestingly, one market segment PPCC is already well entrenched in—law enforcement—offers a fine example of a technologically challenged field force in need of a seamless solution. Motorcycle, ATV and bicycle-mounted police officers in otherwise computer-literate departments are still working solely with paper, pencil and radio…as are the majority of parole officers, prison guards and social service field investigators.

The Committee feels that law-enforcement department decision makers would be highly receptive to new technology that would computer-enable these officers. Given this, and the Toughbook notebook line's broad acceptance in the public-service community, the Committee recommends this market be considered as the initial launching pad for the Flex.

Also on the subject of law enforcement, the Committee believes that one of the Flex's most crucial features, its ability to be operated as either a standalone system or in conjunction with a Toughbook notebook, will speed the adoption of the Flex for a host of other public-safety applications.

Today, officers riding motorcycles are computer-handicapped compared to those in cars. Tomorrow, when the motorcycle patrolmen are using the Flex, officers in the cars will be the ones at a "competitive" disadvantage, exposing themselves to increased danger by having to turn away from a suspect and return to their patrol car to access their computer. Using the wireless-screen component of the Flex as an extension of the vehicle-mounted Toughbook would eliminate that risk.

(Technologically, of course, the wireless display-screen will presumably be compatible with all notebooks supporting the proper PC Card protocol. For purposes of this report we present it as being used only with its own CPU module or a Toughbook. We further believe that a strong effort to cross-sell the Flex and the Toughbook incorporating favorable pricing and/or option incentives should be considered.)

Other markets in which the Flex should be able to offer immediate “competitive advantages” include construction, utility, inspection and quality control, and customer service. Areas which we feel will return major dividends after a more lengthy (three-to-five-year) period of development include healthcare, defense, and education.

Though several members dissented, the majority of the Committee believes that the wireless display system has the potential to eventually become the biggest-selling model in the Toughbook line.

While the Toughbook notebooks have no viable competitors in the ruggedized notebook field, not every notebook application requires a high-performance, fully ruggedized, eight-pound computer. And competition (i.e. price-cutting) for volume orders of lighter, “disposable” notebooks for white-collar “road warriors” has been historically fierce and is getting worse.

The Flex, as of now, has no viable competition. No other portable computer of any kind offers its unique combination of communication, performance and ergonomic capabilities.

The size and weight of its display/input/output panel separates it from bloated pen tablets.

Its current-generation technology and lack of cables separates it from so-called wearables.

Its performance and connectivity place it on a mountaintop far above any CE or Palm device.

The manufacturing capacity of its builder allows for quality control and delivery schedule standards higher than possible for any competitor bound to a Taiwan-based OEM vendor.

Every new product has a potential downside, of course, and the Flex is no exception. In our opinion the biggest danger the Flex faces is failing to operate within the expectancy parameters of both end-users and system managers.

Though mobile computing and communication technology is still in its infancy, many people—IT managers as well as end-users—consider it a mature industry. They are conditioned to expect a certain level of performance from their Wintel portables. When they input something they expect an immediate response.

A certain degree of tradeoff of instantaneous action in exchange for the Flex's unique ability to go virtually anywhere and do almost anything is expected, but perceptibly sluggish screen response and communication dropouts between the screen and the CPU module will not long be tolerated.

Industry is always—and rightfully so—conservative about introducing new technologies into more or less smoothly running companies.

IT managers grumble about the acquisition of what they consider "oddball" computers in exactly the same manner as truck mechanics faced with the addition of a Volvo cab-over to their fleet of Peterbilt hood units. End-users get nervous at the thought of training sessions.

Being Windows-based, touchscreen-operated and compatible with the most popular wireless protocols for enterprise communications, the Flex should be an easier sell—particularly to IT professionals—than a more radical device using an uncommon operating system and unproven input/output technology.

Despite the above mitigation, devising and implementing marketing programs for the Flex is going to require a very different mindset than that used in creating sales strategies for Toughbook notebooks.

The Toughbook persona has always been that of the legendary "better mousetrap." More durable, faster, brighter and offering more responsive technical support than its competitors.

The Flex, however, is *not* a better mousetrap. It is not a *mousetrap* of any kind. It stands alone in a category of computer and communications products that is Panasonic's to define.

And because it stands alone, the question from potential buyers is *not* going to be "Why do I need better notebooks?" It *is* going to be "Why do I need this product at all?"

The way in which the Flex marketing program answers that question and the extent to which the system meets or exceeds the promises inherent in that answer will to a large degree determine the success or failure of this potentially breakthrough product.

System Hardware

Members of the Opinion Leader Committee were asked to research and recommend enabling technologies for use by the wireless display system. This initially entailed some discussion of the differences between "computing" devices and "communications" devices. The general consensus was that while computing devices can perform all the functions of communications devices, the latter can mimic few of the functions of true computing devices.

System Hardware: Display Technology; Usage Patterns

It is the unanimous opinion of the Committee that the majority of Flex usage will take place outdoors for the following reasons:

-- The wireless display system is uniquely suited to provide onsite data acquisition and retrieval for users in law enforcement, construction, GIS, transportation, military and related fields A substantial majority of the jobsites in these areas are located in open-air, uncovered environments.

-- The wireless display system will frequently be used as a peripheral to extend the benefits of vehicle-mounted Toughbooks to places where using a traditional notebook would be problematical and/or counterproductive. The majority of these locations will also be in outdoor venues.

-- Even in circumstances where the display units are primarily used indoors, there will be numerous occasions when they will be accessed in outdoor locations or by persons transitioning from indoors to outdoors and vice versa.

For example, configured as a wireless data-access network on a corporate campus, it is anticipated that the majority of usage will take place indoors. However, the system will also be used by people traveling between buildings, eating lunch outdoors, etc. Given that it is now illegal—or against corporate policy—to smoke in virtually all U.S. office buildings, it can reasonably be expected that the displays will even be used when employees are standing around outside on a "smoke break."

System Hardware: Display Technology; Screen Type

In view of the usage patterns discussed above, it is suggested that all versions of the wireless display be fitted with transflective screens to maximize brightness and minimize glare when used outdoors in direct sunlight.

We also feel that the transflective screen's mode of operation—balancing ambient light and backlight to achieve optimum brightness in all environments—will provide a comfortable, seamless transition for people moving between indoors and outdoors, bright offices and dim corridors, etc. While it is not absolutely necessary for a mobile display-screen to provide a constant level of perceived illumination in differing environments, use of Panasonic's Sunbright technology to achieve that standard would be a productive selling point, particularly in comparison to competitors' displays.

System Hardware: Display Technology; Screen Size

Given the almost limitless applications for a light, compact and rugged wireless computing system usable anywhere from inside an aircraft engine to a freeway median strip, both transport and software requirements argue against adopting a one-screen-size-fits-all strategy for the Flex.

Some users will be wearing the display as they move between tasks, others will be transporting it on motorcycles or bicycles, still others will have it strapped to the handlebars of an RV or forklift or mounted to a quick-release bracket on the dashboard of a car,

On the application side, the system can be expected to be used for everything from generating electronic forms to displaying maps and circuit diagrams, from serving as a sketch pad to displaying videos detailing parts assembly or maintenance procedures.

For these reasons, we recommend the Flex initially be offered in at least two sizes—approximately 8 and 6 inches measured diagonally.

System Hardware: Display Technology; Screen Rotation

It would be highly advantageous to incorporate technology to rotate the screen image 90 degrees in much the same manner as the CF-37 Rotation Tool rotates the image 180 degrees.

The ability to use the display vertically would not only make it easier to fill out forms and complete checklists, it would also enable electronic simulations of tasks previously performed on paper—such as completing an onsite police incident report—to visually retain the same familiar form and shape users are accustomed to.

System Hardware: Ruggedization

Even more, perhaps, than Toughbooks--which are sometimes used strictly indoors or in-vehicle--the wearable display system is going to be exposed to moisture, dirt, dust and extreme weather conditions.

Of the unit's two components, the screen is likely to be under considerably more stress than the module. As a keyboardless device, it will be handled, pushed, prodded and jabbed more than Toughbook touchscreens and as an open (verus clamshell) device it will frequently be fully exposed to the elements even when not in actual use.

On the module side of the equation, the system's technologically advanced wireless capability does make it possible for the actual computer to be left behind in a vehicle, office, workshop or other secure enclosed area as long as the screen is within transmission range. Given the average worker's disinclination to carry anything he doesn't have to, it is a reasonable assumption that the system's remote capability will be utilized whenever feasible. Also, the module's carrying system can be structured to provide some protection from rain and dust.

For this reason, we feel that while the module must offer roughly the same level of ruggedization as the CF-27, the display-screen requires a level of ruggedization approximating that of the CF-28, particularly in the area of splash and moisture resistance.

System Hardware: Pointing Device

The configuration and performance of the pointing device will be a significant influence on end-users' overall satisfaction with the system.

While it can be argued that a tablet-type touchscreen display obviates, to a large degree, the need for a separate pointing device and "mouse" buttons, the Committee believes that this theory will not prove true in practice for several reasons:

-- Dragging items from one edge of the screen to another is easier with a self-contained pointing device that doesn't require large movements and repositioning of the user's hand and arm.

-- In many applications, a number of icons in many applications will be too small or close together for accurate tapping or double-tapping with a finger—particularly a gloved finger. Users engaged in tasks not requiring the continuous use of a stylus may resent both the physical and mental interruption caused by picking up the stylus, tapping something, and then putting the stylus back in its holder.

-- Using a pointing device with properly positioned mouse buttons enables almost simultaneous dragging and clicking. One finger drags the cursor and another, usually the thumb, stays poised to click the mouse button the instant the cursor is over the correct icon. Placing mouse buttons directly under the touchscreen would provide this capability when the cursor is being dragged to the bottom center of the screen, but would not when the user was moving the cursor near the top or edge.

The Committee examined several types of pointing devices and reached the following conclusions:

-- Users must be able to use the pointing device with one hand while holding the display-screen with the other.

-- Any pointing device selected for the Flex has to be fully sealed against dust, dirt and moisture.

-- While a pressure-sensitive pad can be sealed under a plastic membrane to achieve the proper degree of protection from the elements, pointing devices (and keyboards) that don't provide mechanical feedback have repeatedly proven unpopular with users.

-- Pressure-sensitive pointing sticks have proven considerably more popular than round pressure pads but are much more difficult to seal. Though the device can be isolated to eliminate the possibility of it allowing water, dust, etc. to enter the inner case, it would be difficult to keep the external mechanics from being fouled by dirt, mud and other debris. Use of a flexible boot around the "stick" would eliminate this problem, but could negatively affect the device's responsiveness.

Also, pointing sticks are traditionally embedded in the keyboard, giving right- and left-handed users equal access. It is not known what user response to a "stick" mounted beside or under the screen would be.

-- Trackballs, such as the optical unit used in some Toughbooks, are excellent pointing devices, delivering almost as much convenience as a true mouse despite being in a fixed location. Unfortunately, trackballs tend to get sticky or hard to move smoothly when coated with even a minimum amount of particulate matter and a large enough ball for precision operation would probably require the screen case be thicker than otherwise necessary.

-- For the past several years, touchpads have been the pointing device of choice for most notebook manufacturers, including Panasonic. They and their related buttons are relatively easy to seal, the majority of notebook computer users are familiar with them and comfortable using them, and touchpads can, if desired by the manufacturer, provide a surface for capturing signatures and performing numerous special functions.

Integrating a touchpad into the Flex, however, poses real-estate problems. Whether mounted beside the screen (not a recommended location because of the left-hander/right-hander issue) or in its traditional space under the screen, a touchpad and its related buttons take up a lot of space. Having to allow an extra two-inch boundary below the screen just to accommodate the pointing device detracts from the designers' ability to make the display as lightweight and streamlined as possible.

-- Looking to new technology for a new solution to the touchpad dilemma, the Committee recommends that development and testing of a "virtual touchpad" be considered.

Such a device could be invoked in numerous ways—pushing a dedicated button in the "mouse button" cluster, tapping an icon, or simultaneously pushing both mousebuttons. Upon invocation, the "touchpad" would appear at the bottom center of the screen right above mouse buttons mounted in the case.

The virtual pad would be roughly the same size as mechanical pads, with the boundaries clearly marked by something like double yellow lines. User tests would determine the best position for the lower boundary. Logic suggests the edge of the screen case should form that boundary, but tests might show that the preferable location is a bit above the case edge. (Technologically it is probably easy to configure it so users can drag it anywhere on the screen, but that might not be desirable from the point of view of marketing the device as an out-of-the-box turnkey solution.)

In operation, the virtual touchpad would perform exactly like a detached keyboard. The pad should be *translucent* so items under it can be seen clearly seen, but not completely *transparent* which could make it harder for some users to keep within its boundaries. Ideally, the degree of transparency would automatically change according to the type of program in use, becoming more transparent when the touchpad is floating over a page of type in Word, for example, than over a blank desktop with perhaps one icon underneath it.

Developing the technology to support this ideal, however, may not be cost-effective. An almost as good—in some cases, a better—approach would be to make the degree of transparency user-defined. Simply sliding a finger up the line marking either edge of the pad could raise or lower the amount of light from the screen that passes through the touchpad.

It is also important that the cursor retain its functionality when dragged into the virtual touchpad box, so it can be used to move and open icons located in that area.

Closing the virtual touchpad could be accomplished by the same means used to open it, though it could also be configured to automatically close with the program in use.

System Hardware: Wireless Communications

Support for as many popular wireless protocols as possible is going to be a key factor in marketing the Flex. Panasonic has a highly successful track record in wirelessly interfacing portable computers with corporate networks and the Committee favors adopting the same type of modular system used in the CF-27 and 28 for the Flex module.

It should also be noted that with many companies and public agencies of all sizes moving from private networks to encrypted communications over public networks, the ability to provide a robust connection to the Internet is a key consideration. While wireless DSL service is still in its infancy, we believe development of an internal module to provide this option to Flex users should be pursued as soon as there are some clear indications as to which wireless DSL providers will survive and which will fail.

Regarding communication between the wireless display and the computer module or companion portable computer, the Committee recommends that the system be engineered to allow for adjacent, non-conflicting use of as many Flex systems as is technological feasible and cost effective.

System Hardware: Operating Platform

Several members of the Committee suggested that the Flex could be successfully based on enhanced versions of PDA platforms like Windows CE, Palm OS and similar handheld devices. The majority of the Committee strongly recommends use of the Microsoft Windows OS—preferably with support for Win 98, NT 4.0 and 2000--for the following reasons:

-- The inherent inability of the CE and Palm operating systems to support the complex, computationally intensive applications required by the industries and public agencies identified in the Applications section of this report. Other CE and Palm drawbacks include:

-- Inability to support large-size, high-output multimedia displays.

-- Inability to access industry-standard mass storage devices.

-- Inability to run potential users' current applications and the related cost of licensing dedicated applications for them.

-- Inability to support advanced wireless protocols.

-- The amount of extra stress on IT departments forced to deploy, upgrade and maintain one operating system and set of applications for remote usage and another for notebook and workstation use. While the extra IT work is minimal when simply providing PDAs with embedded applications to salesmen and executives, configuring hundreds of Palm-type pseudo computers for law-enforcement officers or construction-site superintendents would be such a complex process that IT department costs—overtime payments to existing staff or new hires—are virtually certain to rise while productivity declines.

-- Deployment of devices with a new operating system and applications would create an unnecessary user learning curve and could require implementation of a costly retraining program.

System Hardware: CPU

Several alternatives to advanced Intel Pentium-series, central-processing units were examined for possible cost-saving, power-saving, heat management and performance benefits. The Committee concluded, however, that the Toughbook line is correctly perceived as a bastion of quality design, superior assembly and premium components in a portable computer world increasingly filled with blandly designed, third-party-built notebooks assembled from the cheapest components available when the unit came down the assembly line.

Given the Toughbook's image as the *de facto* standard in ruggedized computing, we feel any deviation from that standard would be inappropriate.

System Hardware: Mass Storage Device

Two Committee members suggested the use of solid-state memory devices in place of hard drives to increase durability, decrease power usage and enhance access speed. The majority disagreed, opining that:

-- Panasonic hard drives and shock resistance technology has rendered the issue of hard drive reliability a moot point. Based on standardized testing, user reports and service records, there is no reason to believe that current solid-state devices and their mounting systems would prove any more durable than Toughbook hard drives.

This conclusion was reinforced by the personal experience of the author, who has performed numerous published Toughbook evaluations over the past five years. Despite such extreme torture-testing as repeatedly slam-dunking the CF-34—with its case open—ten feet onto a hardwood basketball court and repeatedly dropping the CF-27 five feet to a concrete floor in the middle of a boot sequence, there were no instances of hard drive failure or diminished hard drive performance.

-- No current solid-state memory device provides the storage capacity—5GB at a minimum—needed to store the amount of data and program files required for proper execution of many wireless display tasks.

-- Solid-state memory devices are not cost-effective and there is no reason to believe that, given current technology, such a device dense enough to provide 5GB of storage would have appreciably faster read/write times than a high-performance hard drive.

System Hardware: Input/Output Devices

In addition to the touchscreen discussed above, the Committee unanimously agreed that provision should exist to upload, transfer and print data from the system computer module under circumstances where no wireless server connection is available. It is felt this can be satisfactorily accomplished by the inclusion of a USB port for connection to a CD-ROM or other external storage device, digital camera, external wired modem and standalone printer.

-- The Committee also recommends the inclusion of a serial port for input of data from various types of probes and sensors used in many of the target applications.

-- Since many users in outdoor environments may be wearing gloves it is also suggested that a tethered stylus be supplied.

-- Addition of an Ethernet port for connection to non-wireless-enabled servers may be of benefit to some potential purchasers.

-- Additional audio and visual I/O devices for consideration in future product revisions are covered in the Future Technology section.

System Hardware: Operation Via Stylus

For many reasons, especially the difficulty of precisely operating a touchscreen with heavily gloved hands, the Committee favors attaching a stylus to each Flex unit.

The stylus should be a passive unit requiring no power source, with an easily accessed mounting point and an unobtrusive tether connecting it to the display unit. The tether should be detachable at both ends for easy replacement of broken styluses and to accommodate users who wish to work without the umbilical cord connected.

System Hardware: Security

If feasible and consistent with case-integrity goals, a removable hard drive should be considered. If this is not possible, it is recommended that a high degree of software security be available at the system administrator's option. This should include an embedded application prohibiting access to a hard drive removed from a Flex and interfaced to another computer or a data-recovery system.

System Hardware: Power Supply

Though new battery technologies promising longer life, lighter weight, less heat and the ability to be molded to fit any space have been somewhere just a wee bit over the rainbow for a number of years, the fact is that the lithium-ion power cell is still the only viable power source for a device of this type. (Toshiba's recent announcement that they will be shipping Lithium-polymer batteries as thin as 1mm by the end of the year, if true, may change this situation dramatically.)

Recommendations on power supply include:

-- Minimum four-hour continuous runtime.

-- Easy connection to vehicle power system for recharging both the module and the screen between job sites.

-- User-configurable, proprietary power-saving system with one very aggressive option.

-- Instant-return hibernation mode that operates independently of Windows and does not require rebooting two out of every three times it is used.

-- Removable hot-swappable batteries

-- AC power adapter/charger with dual output for simultaneous, high-speed recharging of both screen and module.

System Software

Due to the compatibility required between CPUs and operating systems, detailed discussion of OS variables is included in the Systems Hardware section.

Also, in preparing this section, the Committee assumed the Flex would ship with all standard Windows utilities.

Re: software, the real issue with the Flex is which applications facilitating the use of a touchscreen panel in lieu of a keyboard should be bundled with the hardware, which should be offered as options, and which should be embedded into individual programs rather than implemented at the system level.

Numerous categories of enabling applications were examined. To best position the Flex as an out-of-box solution instead of an inert piece of hardware, the Committee unanimously agreed that the types of software detailed below should be available to Flex users directly from Panasonic as either standard equipment or a pre-installed option.

System Software: Signature Capture

An advanced signature-capture utility that authenticates and stores signatures in compliance with E-Sign Act requirements should be part of the Flex's basic package. From a foreman ordering 10,000 cubic yards of concrete to a customer signing off on a service order to a police officer filing a report, the necessity for e-signatures that will be accepted in civil and criminal actions is almost absolute.

Among the many such tools recently introduced, Communication Intelligence Computer Corp's Sign-It contains a number of qualities that rate it substantially above most similar Windows-based utilities.

Based on biometric authentication technology instead of more common static authentication protocols, Sign-It analyzes signatures using much the same methods as those used by human handwriting experts. Sign-It is compatible with a broad range of programs and will protect all kinds of documents--from expense reports to 400-page contracts.

The program also provides hardened security over both public and private networks through the use of three task-optimized protocols: Secure Hash Algorithm (SHA-1) , DES and Triple DES encryption and PKI (Public Key Interface) infrastructure.

System Software: Virtual Keyboard & Keypad

The Committee believes the primary use of virtual keyboards will be limited to performing specific tasks within specialized applications and that virtual keyboards and keypads will be integrated into those applications. Among other benefits, this would allow program developers to use any number of specialized keyboards whose form and functions would vary with the nature of the data requiring input.

Despite this, it is recommended that a standard QWERTY-type, on-screen keyboard be included as a standard utility for entering brief notes, e-mail and other tasks requiring limited text input.

Though it is anticipated that tools for performing major financial, mechanical and/or scientific calculations will be embedded in relevant applications, inclusion of a simple ten-key virtual calculator is recommended.

An attractive alternative would be a non-QWERTY keyboard and number pad designed for rapid one-finger text entry. An excellent example is Textware Solutions dynamically resizeable Fitaly keyboard, which is pictured below.

System Software: Display Rotation Tool

This utility is discussed under “Display-screen” in the System Hardware section.

System Software: Fingerprint recognition

Integration of software enabling the scanning and digitalizing of thumbprints would be a highly valuable feature on Flex systems intended for the law-enforcement market and a positive feature on all Flex units if integrated into the system’s internal security system.

Note: In early 2001, Compaq Computer announced the release of several notebook models with integrated thumbprint authentication.

System Software: Network Server to Flex Accelerator

In the absence of truly high-speed wireless transmission between enterprise intranet-server hosts and clients, any application that could speed access times and limit the amount of data actually broadcast would have the dual benefit of improving user productivity and cutting transmission costs.

Based on the concept of transmitting only changed blocks of information when exchanging files between client and host, several solutions have recently been introduced. Of these, the most advanced seems to be iOra, Inc.'s Epsilon, which has a unique ability to reuse contact blocks without needing to duplicate them.

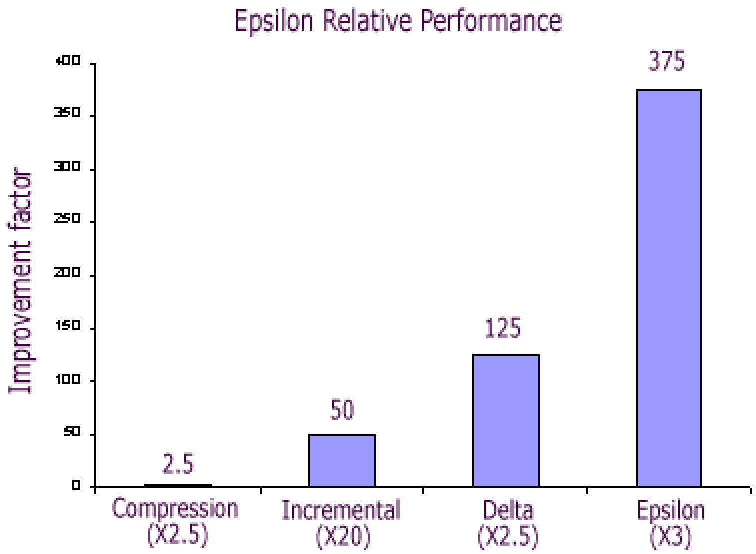
For example, five 84-page, video-game repair manuals need to be distributed to client Flex units. Of the 84 pages in each manual, 60 pages are the same—generic information and testing protocols for video games—24 pages are specific to a particular game.

With other technologies, all five presentations would be downloaded to the Flex clients. With the Epsilon technology the common content is downloaded in one file and the different content is downloaded in five separate files. In this example, what would be a 420-page download becomes a 180-page download.

From the end-user perspective, the system is transparent. His file list will show one file for each video game (PacMan, Demon Age, etc.). Invoking any of these will automatically merge the common pages with the game-specific pages and open them as a single unified file.

As illustrated by the chart below, iOra claims Epsilon technology offers up to 150-percent improvement over previous transmission protocols.

The bad news regarding Epsilon is that the technology is not available as an add-on or extension of current file-transport programs, it is only available as an integrated part of iOra's Mobile Intranet Suite.



While an entire host-client communication system isn't an appropriate application to offer as part of the Flex's standard configuration, the advantages of the Epsilon technology may be sufficient to justify approaching iOra about a possible joint-marketing effort.

System: Attachment Points

To a large degree the manner in which the twin components of the system will be "mounted" to the user will be dictated by the application. Considering the vast number of potential tasks the Flex may be called upon to perform and the fact that some will require the user to carry both components, while some will require only the display-screen, the Committee concluded that there is no one-size-fits-all approach to this issue.

There are two major areas that must be considered in designing a carrying system for the Flex machine mounting and on-body carriage.

System: Attachment Points; Machine Mounts

-- Mounting solutions for both the screen and the module involving non-standard equipment should almost always be developed in conjunction with a third party, either the vendor of the equipment or an aftermarket specialist. A good example of this is the current joint venture with Kawasaki to develop a mounting system for use with police motorcycles.

-- Quick-release mounting capability, either directly or via some kind of holder, should be engineered into the final release. The vast majority of the Flex's work will be done out-of-vehicle and, in many cases (such as emergency services), would require the user to access the Flex and exit the vehicle in as close to one rapid movement as possible.

It could be argued that the best way to accomplish this would be to have the user wear the unit continuously, rather than taking it off while in transit. We feel, however, that this would be undesirable for several reasons:

-- Vehicle mounts could contain integrated power connectors to charge the Flex batteries while in transit.

-- In many dispatch (including EMS and search-and-rescue) operations it will be necessary for the user to be able to view the screen while also watching the road.

-- The availability of a vehicle mount provides users with an option. They can wear the unit from one site to the next or mount it in its holder and enjoy greater comfort and the security of knowing that the batteries will be in good working condition upon arrival at the next job.

System: Attachment Points; On-body

Form must follow function in this area. The needs of a police officer using a display-screen next to a suspect's car are vastly different than those of a telco technician using both Flex components to test a line.

Also, the optimum type of carry case for a given application will depend to a great degree on the finished size and weight of the product. A small, light module could be carried in a shoulder bag or clipped to a regular belt. A larger, heavier one would probably require its own support straps. The most common observations made by Committee members include:

-- In almost all cases, the screen will be either held in the user's hand or placed next to him on the job site while in use. We feel there is no appreciable need for a screen-mounting solution that presupposes it will be used simultaneously with being worn.

-- Many users employing the Flex screen as an extension of a vehicle-mounted Toughbook or with the Flex module in a vehicle or other off-body site, will have more need of a temporary *storage* case than a full *carrying* case.

Example, a motorcycle policeman pulls over a speeding driver, gets off his motorcycle, grabs his Flex screen from its quick-release mount and approaches the suspect's vehicle carrying the Flex in one hand. Getting the suspect's paperwork, he inserts it in a clip above the screen, enters the data and awaits the results.

At this point he needs someplace to quickly and easily "dump" the display, get out a ticket book and write a speeding ticket. If his query came back positive—say, the suspect is wanted on suspicion of armed robbery—he needs to get rid of the display, draw his gun and prepare to make an arrest extremely rapidly, always bearing in mind that the suspect might also reach for a gun.

In no case does the officer need a precision-fitted carrying case that requires concentration and dexterity to use and has potentially obtrusive fasteners. For this application, a holster or pouch worn on the officer's Sam Browne belt is both sufficient and desirable.

Note: In order to fit on the belt, it might be useful to offer such a holster with additional exterior pockets to hold some of the other items (cans of Mace, etc.) typically worn by police officers.

-- Not having to route connecting cables between electronic modules provides a tremendous degree of freedom in locating those components on the body. To the fullest extent possible, the wireless philosophy behind the Flex technology should be applied to the on-body carrying system(s). Doing away with the electronic cables but retaining the maze of mounting straps, buckles, and adjusters typically used to mount on-body computers only solves part of the problem.

Note: In many industrial, inspection, construction and similar applications, a single Flex is likely to be used by more than one person. Particularly in situations where the system is handed off to a new user at the end of a shift, it would be highly desirable to provide a carrying system that requires minimal “fitting” adjustments.

-- The chest-mounted screen system envisioned in early prototype presentations is not recommended. The rigging would be difficult to get into, the straps would have to be readjusted, and the screen would be difficult to use while bending over to work on tasks such as diagnosing a misfiring engine or assembling an electronic component.

Competition

Note: The Committee as a whole not being charged with researching the history and business models of potential wireless-display-system competitors, the opinions in this section are solely those of the report's author.

Put simply, at this moment the Toughbook Flex wireless system has no direct competition. No current—or publicly announced future—product converges the unique features of the Flex with Matsushita's unparalleled ability to design and manufacture precision electronics and Panasonic Personal Computer Company' proven expertise at nurturing vertical markets.

There are many computing devices capable of competing with the Flex in running applications. None that I know of have the Flex's unique combination of current-generation motherboard and chipset technology, user-friendly form factor, superior display system, wireless connectivity options and ruggedized design.

In reality, all computers compete with all other computers to a greater or lesser degree. The mainframe supporting dumb terminals competes with standalone workstations. Laptops compete with desktops for footprint space in corporate and home offices. Handheld Portable Computers compete with laptops on the road, and PDAs, Smart Phones and portable Internet appliances compete with both the laptops and handhelds.

Focusing on the Flex, it could be argued that its major competitors include palm-type devices, notebook computers and pen tablets. In my opinion, these arguments are specious for reasons set forth below (and, in the case of PDAs, in the hardware section).

Technologically, the only true competitors for the Flex are so-called wearable computers. In the *marketing* arena, the most likely competitor—based upon its strong position in a number of industries where the Flex could be expected to make major inroads—is Symbol Technologies.

Competition: Symbol Technologies

There are a number of reasons to consider some of Symbol's offerings major competitors to the Flex. The company is both extremely aggressive and highly focused. This intense, precisely targeted aggression has enabled it to develop new products for existing markets and leverage its core technologies and strategic relationships to open new markets with rapidity.

From its beginnings as a maker of barcode scanning equipment, Symbol has become a major supplier of traditional and wireless inventory and product-control systems and hardware to many of the largest wholesale and retail vendors in the country.

In addition to offering competition to the Flex in Symbol's areas of traditional strength, Symbol has, of late, been moving into some industries high on the list of potential Flex markets—several of them also existing Toughbook markets.

-- Law Enforcement: In late February, Symbol entered into an agreement to market Aether Systems' wireless data products and services on Symbol's wide-area, network-capable, handheld computing devices. Aether is the parent company of Cerulean Technology, an industry leader in law-enforcement software frequently run on Toughbooks and currently being ported for use on the Flex.

Partnering with EDS, Symbol is developing a wireless system to provide networked access throughout the British penal system. If the $300 million project is successful, it is reasonable to assume that EDS and Symbol will attempt to market it in the U.S. One significant aspect of the program is that the hardware will be full-function Windows PCs. Most of Symbol's applications run on proprietary single-purpose terminals or customized palm-type devices.

-- Transportation: Symbol's e-Mobile Delivery 3.2 application integrates electronic signature proof-of-delivery, real-time wireless transmission of delivery information, and Global Positioning System (GPS) vehicle-tracking capabilities.

-- Healthcare: In conjunction with Sybase, Palm and Certicom, Symbol is developing applications designed to "mobilize healthcare" via its wireless network and handheld data terminals.

It is recommended Panasonic move as rapidly as prudent to deploy the Flex in markets where Symbol is showing an interest but is not yet well-established.

Competition: Wearable Computers

If there is a high-tech parallel to the "blind leading the blind" the wearable computer market is it. From one of the most technologically and financially endowed corporations on earth to a resource-thin enterprise whose directors have publicly beseeched someone, anyone, to take it over, vendors of wearable systems are wandering in a marketing desert, seemingly incapable of navigating to the life-saving waters of sales and profitability despite their products' allegedly compatibility with GPS applications.

Now over a decade old, the wearable computer "industry" remains an abject failure bereft of managerial focus and marketing "horse sense" and betrayed by its gurus. It is an industry trapped in laboratories where commercial realities are trampled by futuristic visions of computers embedded in shoes, powered by executives pacing their offices, and communicating with wristwatch-size I/O devices and sunglass-mounted display-screens via the user's nervous system.

Despite a substantial and rapidly growing demand for wearable-type computers from both the industry and public sector, there is not one commercially available wearable that comes close to meeting those demands. (See Appendix II: TBR Market Research Report.)

Competition: Wearable Computers, Xybernaut

People find me peculiar. They think it's odd that I spend most of my waking hours wearing eight or nine Internet-connected computers sewn into my clothing and that I wear opaque wrap-around glasses day and night, inside and outdoors. They find it odd that to sustain wireless communications during my travels, I will climb to the hotel roof to rig my room with an antenna and Internet connection.

-- Professor. Steve Mann
Technology Review May/June 1999

Though he wasn't officially added to the company's board of advisors until the year 2000, Xybernaut can, in one sense, be called the wearable house that Steve Mann built.

If there is such a thing as a brand name in the wearable field, it is Xybernaut, holder of the unenviable record of having the highest ratio of press releases to unit sales in the history of the computer industry.

Since its founding, Xybernaut has obscured the fact that it has neither marketing nor manufacturing capability behind a blizzard of releases touting everything from patent filings to "strategic alliances" that turn out, upon inspection, to be nothing but an announcement that some software company or another has acknowledged that their product (usually an application that will run on any Wintel machine) will work on a Xybernaut Mobile Assistant.

Given the nature and timing of Xybernaut's press releases, its sponsorship of numerous showcase "conferences" and its relentless pursuit of media coverage and photo opportunities—and the threadbare relationship of all those initiatives to the company's actual performance and marketing efforts—it could be postulated that Xybernaut's directors, at least at this point in time, are concerned more with the value and liquidity of the company's stock than with selling computers.

[Author's note: The above was written in late February, 2001. On March 16, two days before this report went to press, Xybernaut issued a press release in which Chief Executive Edward Newman claimed that Xybernaut and IBM were in advanced discussions aimed at "combining the patent position and know how obtained by Xybernaut in the wearable PC arena with IBM's resources." In the wake of the announcement Xybernaut's share price more than doubled to $4.16, sliding back to $3.56 after IBM's official response: We talk to many companies.]

Design-wise, Xybernaut has suffered from a slavish devotion to the philosophy of Dr. Mann, currently at the University of Toronto and previously at MIT. For a quarter-century, Mann has been the chief advocate of what could be called the "Cyborg Cult."

In this cult's vision of on-body computer technology, the appearance of the apparatus and its ability to dominate the persona of its user is almost as important as the equipment's technical specifications and performance. Mann, himself, has been particularly vocal on this aspect of his research, repeatedly endorsing so-called "cyborg-ware" as the fashion statement of the future.

(While it is not germane to this discussion, it is interesting that the "Cyborg Cult" preaches a philosophy diametrically opposed to the classic science-fiction definition of a "cyborg" as a robotic device designed to be visually indistinguishable from a human.)

To be a commercially viable, solutions-based industrial product, any computer—wearable or otherwise—has to subjugate form to function. Examination of the illustration above, used by Xybernaut to promote its flagship product, the Mobile Assistant IV, clearly shows that the cyborg model subjugates function to form.

The following example taken from a 3/2001 Xybernaut press release illustrates the point:

"British Airways check-in agents based in Terminal 4 donned cyber-style equipment designed to terminate queues by enabling them to rove the terminals to carry out on the spot check-ins…the computer comprises a keyboard worn on the check-in agents forearm, a head mounted mini display comparable to a 15 inch full-screen and a battery worn on a belt…the trial is taking place over three days…"

The test certainly makes a good press release and it is reasonable to assume that Xybernaut press agents had to do nothing more than dial a few phone numbers to get British television and print-media news coverage.

It is equally reasonable to assume that check-in agent productivity was negatively affected by the time-consuming process of getting in and out of the device (putting on the full Mobile Assistant regalia can require the efforts of two people.) And that the job performance of the agents in the last several hours of their shifts was substantially compromised by the growing discomfort of being strapped into a human equivalent of the harness and reins worn by cart-pulling horses.

It is also reasonable to assume that after a short initial period of tolerant curiosity, passengers would begin to resent having to deal with de-humanized "service representatives" who could not possibly maintain the kind of eye contact necessary for satisfactory in-person customer relationships.

Compare this to a Flex experience. An attractively dressed agent, still fresh and efficient in the sixth hour of his or her shift, enters a passenger's information into a two-pound wireless display-screen with a few taps, gets a confirmation, looks the passenger in the eye, smiles, and says "You're all set, have a nice flight."

Cyborg proponents would argue that their approach provides advanced functions such as heads-up display output, voice recognition input, and head-mounted camera capability. Like anything else in technology, those features come at a price.

Use of a heads-up display, for example, precludes use of a touchscreen, limiting typical Xybernaut users' data input to non-voice-enabled applications to an inconvenient, hard-to-operate mini-keyboard strapped to their forearm. Yet, as discussed in the Future Tech section, all these functions and more can be implemented using non-cyborg-styled user-friendly devices.

Note 1: Xybernaut recently announced a new top-of-the-line model, the Mobile Assistant IV TC. Key differences between it and the Mobile Assistant IV are a CPU upgrade (Pentium MMX 233 to Pentium III 400), a larger standard hard drive (12GB), optional 6.4-inch and 8.4-inch SVGA “all-light” touchscreen displays and an internal battery that will power the unit for up to 1.5 hours. Obtaining longer runtime would still require the use of the separate battery pack used on the Mobile Assistant IV.

It should be emphasized that the MA IV TC is, as of this writing, not shipping and no shipping date has been announced. Technological details, such as the nature of the “all-light” display panels, are also not available.

Unless used with a docking station, neither Xybernaut model is capable of wireless communications beyond what is available through a PC Card interface.

Note 2: Another recent Xybernaut press release announced the formation of Xybernaut Development Corporation (XDC) to address “critical corporate development activities” and focus “on the critical aspects needed to establish wearable computing as the next paradigm of computing and communications.” This follows an earlier announcement that Xybernaut would enter the software market and develop applications that could be used on a variety of Wintel portable computers.

Note 3: After an aborted attempt to induce Sony to enlist as their OEM manufacturer, Xybernaut, in early 2000, announced that it had signed an OEM and technology sharing agreement with IBM. While there is no reason to doubt such a contract exists, it is significant that no mention of an IBM connection was made in conjunction with the MA IV TC announcement.

In May 2000, Xybernaut Chief Technology Officer Michael Jenkins told the author that the company’s agreement with IBM would enable them to include a removable MicroDrive to augment the hard drive on their next model. The MA IV TC does not incorporate a MicroDrive.

Note 4: Xybernaut frequently extols the value of its “intellectual property” using belligerant phrases such as “any company that wants to build a wearable computer has to go through us” and claiming over 100 “core patents” in wearable technology. In actual fact, the U.S. Patent Office has registered considerably fewer patents (some of which have been duplicated in other countries) to Xybernaut, though others may be held individually by Xybernaut executives or engineers or controlled by license agreements.

In any case, Xybernaut's claims have not affected the ability of ViA, Inc. to develop and market a wearable computer, nor has Xybernaut ever challenged ViA's legal right to do so.

Competition: Wearable Computers, ViA

Of all the companies which are currently marketing or have announced wearable computers, ViA, Inc. comes closest to offering a Flex-like product by emphasizing touchscreen input, output and display technology over a head-mounted I/O and display (though they do offer a heads-up display option).

Though not visible on the *Entertainment Tonight/Gadget Magazine/Robb Report* radar, ViA is, in my opinion, a more serious Flex competitor than Xybernaut and the only manufacturer of a computer similar to the Flex in concept and practicality—as illustrated by ViA's choice of flexipc.com as one of its domain names.

ViA is also the only wearable computer company which mirrors many of the competitors Panasonic faced in entering the ruggedized notebook arena—competitors whose lack of funding restricted their ability to refresh outdated models and widely market the systems they did have.

Given the nature of the customers ViA has attracted and the tasks they are using the systems for, it could be argued that the ViA II offers proof-of-concept for the Flex.

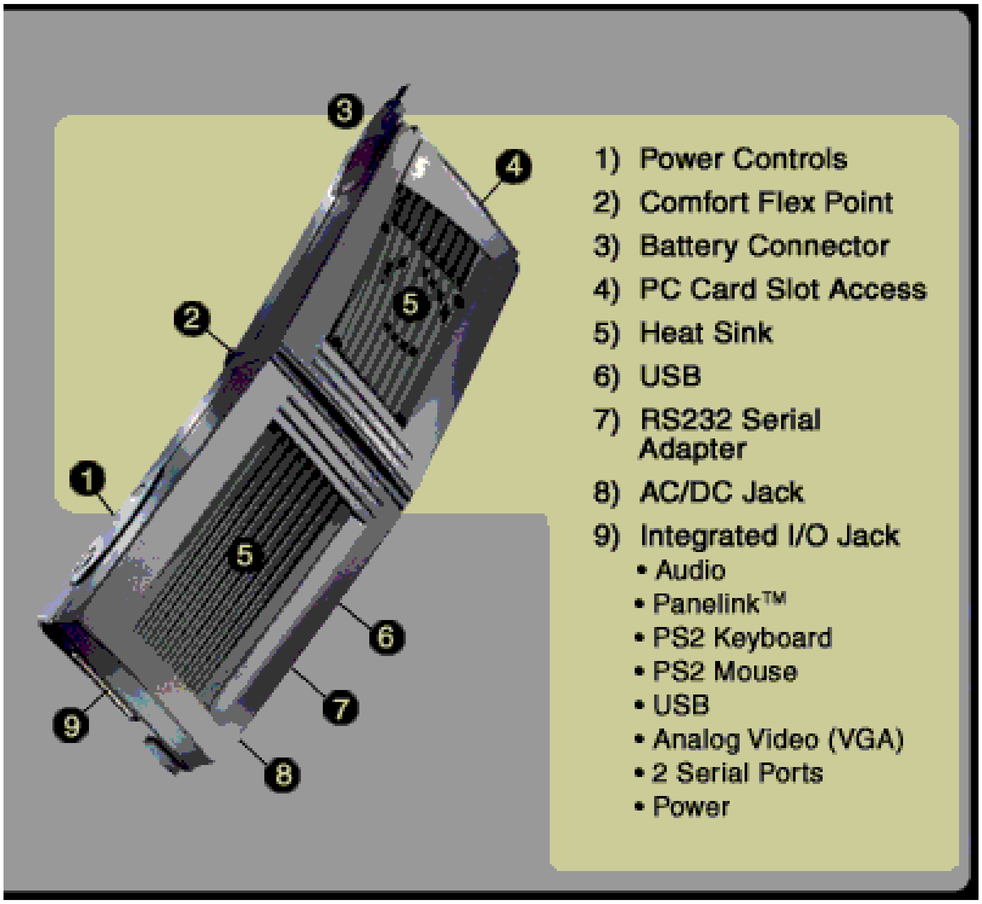
Not having the resources to maintain a program of continuous technological improvement or a major marketing campaign, ViA nevertheless has managed to sell a reasonable number of units in the type of vertical markets envisioned for the Flex. ViA's customers include Ford, General Motors, Northwest Airlines and the Department of Defense.

(DOD has also served as a developmental and beta test partner for ViA, whose President and CEO, W. Edward McConaghay, graduated from the U.S. Military Academy at West Point. Also, major defense contractor General Dynamics serves as ViA's worldwide marketing agent for military applications.)

ViA II wearables are currently being used for aircraft inspection, agricultural data-gathering, surveying, construction site preparation, (using the AGTEK software described in the Applications: Construction section), ship building and home inspection applications.

ViA II's are also being used as Portable Agent Workstations by Northwest Airlines, performing on a regular basis the same task that Xybernaut Mobile

Assistant IV's did in the three-day British Airways demonstration described above.



The ViA II module is intended to be worn on the back of the user's belt.

The differences between Northwest's Portable Agency Workstation initiative and the Xybernaut/BEA test are enormous. In the former case, the initiative began with the airline. Northwest designed the application and selected ViA as the hardware provider after considering and rejecting solutions from, among others, Fujitsu and WalkAbout.

Using Welch-Allyn barcode readers and Comtec Information System's Cameo2 portable printers, ViA provided a system meeting Northwest's specifications for ease-of-operation, light weight, highly readable display and durability.

As deployed, the system provides a close approximation of what was described earlier as a "Flex experience." Except that it is a Flex experience limited by a *166MHz Cyrix-based* computer module that has to be belt-worn and *hard-wired* to its display system and has no wireless network capability beyond what is available via a PC Card.

It is not at all hard to envision how much better the Northwest program would be if it were run on a Flex-based wireless LAN system with Pentium III power and the ability to automatically update the flight check-in server so gate agents were working with the same data as the roving "portable agents."

Change that scenario to a Flex-enabled multipoint wireless distribution system in which the "portable agents" only have to carry the display-screen and the airline gets even more productivity—probably at a lower cost.

The more computationally intensive the task, the more users would benefit from the Flex's advanced technology. Contractors using ViA systems to survey a new freeway corridor, for example, would experience much greater productivity gains than an airline running what is basically a pure data-management application.

Note 1: Several weeks prior to Comdex 2000, ViA announced that the Defense Advanced Research Projects Agency was financing development of an updated ViA wearable based on a 700MHz Transmeta Crusoe CPU.

Backpack-styled prototypes running a 600MHz Crusoe chip were field-tested by U.S. Army Military Police and ViA claimed the finished product would be released near the end of Q1 2001. Results from the Army tests have not been published and nothing further about this product has been released by ViA.

DARPA is the central research-and-development organization in the Defense Department. Its mission is self-described as the pursuit of "research and technology where risk and payoff are both very high and where success may provide dramatic advances for traditional military roles and missions and dual-use applications." It has previously funded other research projects—including one to develop low-cost cooling systems for computer electronics—in which ViA had a major interest. A search of the public DARPA database turned up nothing on the ViA Crusoe program, but that could be because the project is still ongoing and has yet to be reported on.

Note 2: ViA claims to hold a patent for a "wireless communication feature for use in wearable computers." I have been unable to locate any information describing the nature of this "feature" and either verifying or refuting this claim. Direct inquiries from a magazine journalist to ViA have resulted in "I don't know anything about it" responses from marketing and PR executives.

Note 3: ViA has announced and is shipping a hard-wired 8.4-inch SVGA "Sun Readable Display" touchscreen that is about ½-inch deep and weighs about 15 ounces. The display, which is claimed to be rugged, dust, and water-resistant is similar to the Panasonic Sunbright display in that it reflects ambient light back through the pixels. The ViA SRD does not, apparently, have the light-balancing capability of the Sunbright screen as its backlight is either full on or full off.

Note 4: ViA, Inc. is not related to Taiwan chipmaker Via Technologies, which is embroiled in various legal battles with Intel. (Via Technologies does, however, provide chipsets used in the ViA II.)

Competition: Wearable Computers, IBM

IBM is the first company in the United States—and quite possibly the world—to run television commercials for wearable computers. Strangely, IBM does not now and may not ever offer wearable computers for sale. Or it may release five different models by the time this report is printed.

There may be some entity—perhaps the computer that defeated chess Grandmaster Garry Kasparov—within IBM that can explain the motives behind its long flirtation with wearable computers and reveal its future plans for this market. With all due regard to analysts who spend their entire work lives following IBM, I don't think anyone outside Big Blue can do more than guess. I will therefore limit my assessment of IBM's potential to seriously compete with the Flex to the presentation of a few salient facts.

-- IBM has both the engineering and financial resources to do anything its top executives will it to do. A successful product cannot, however, be "willed" into existence and IBM has occasionally squandered immense chunks of assets trying to turn flawed visions into marketable commodities (i.e. OS2).

That said, it would be foolish to ever underestimate IBM's ability to substantially impact the wearable computer market if it chooses to do so.

-- As of March 2001, IBM acknowledges having produced about 100 handmade wearable computing prototypes of the type pictured above. The prototypes are based on a Pentium 233MMX CPU and it is believed, but not confirmed, that some of the units have a 680MB hard drive and others a 340MB MicroDrive. All have 64MB of RAM, a monocular heads-up display and utilize IBM's ViaVoice speech-recognition technology.

-- Except for improvements to the display-screen and other peripherals, the prototypes are basically unchanged from what IBM originally revealed in 1998.

-- In late 1999 IBM declared their wearable would "not compromise on PC applications" and said users would be able to "walk around with this thing attached to a wireless network, browse the Web, talk to it, do voice navigation, e-mail and all that stuff." They also announced that they planned to deploy wearable prototypes in specialized vertical markets, such as stock trading, manufacturing and healthcare.

IBM prototype demonstrates that "cyborg" styling is not necessary to produce a wearable computer with a heads-up display. Big Blue has not, however, managed to eliminate the mass of connecting cables that impede wearables in real-world situations.

-- In June 2000 a design engineer at IBM's Almaden Research Center made the dubious assertion that IBM had a monopoly on the software necessary to enable wearable computers to recognize and output enhanced audio and visual objects.

-- IBM's wearable prototypes have been tested on a power-generator assembly line operated by a General Electric subsidiary and in an unnamed university hospital where it was used for data collection by doctors doing their rounds. (See Healthcare Applications section.) Both tests are believed to have taken place outside the continental USA, possibly in Australia.

-- IBM has a horrendous record in all areas of portable computing. Despite being a best seller and having the non-ruggedized segment of the notebook industry's best brand name, its ThinkPad line of notebooks has posted losses recently exceeding $1 billion per year. An early attempt to manufacture laptops in its own purpose-built, automated factory failed, as did an effort to

OEM a handheld computer based upon a separate display-screen/computer module and mini-keyboard. In both cases, excessive component failure rates were major contributors to the eventual termination of the programs.

In the late 1990s, IBM, despite being an early entrant in the one-piece, handheld computer market, was overpowered by more sophisticated products from Toshiba and other companies. As the ‘90s drew to close, IBM introduced its underwhelming entrant in the PDA sweepstakes: the WorkPad, a monochrome Palm clone.

-- IBM has made little or no attempt to enter the ruggedized portable computer market. Most prospective corporate and public-agency volume buyers of wearable computers stress ruggedization and durability as key factors in their buying decisions. (See Appendix III: TBR Market Research Report.)

-- Based on its advertising, IBM seems to believe there will be a large market for wearables among white-collar corporate executives. Whether or not a wearable really offers a traveling sales executive anything that a four-pound, wireless-enabled sub-notebook doesn’t is questionable.

-- Any attempted analysis of IBM’s wearable strategy must include an assessment of Big Blue’s OEM and technology-sharing relationship with Xybernaut. Other than instigating and announcing the IBM/Xybernaut/Bell South test (see Applications: Utility; Telephone Company), IBM has been far more reticent than Xybernaut about this relationship, but that could be a deliberate attempt to keep the value Xybernaut shares depressed while Big Blue considers making a buyout.

Competition: Notebook Computers

Any Wintel notebook—given similar I/O, connectivity and processing capabilities—should in theory be able to run the same applications as the Flex. But a notebook’s ability to add two and two and get the same answer as the Flex in no way renders it interchangeable with the Flex.

The Flex is designed to go places notebooks can’t go and provide full computer functionality in situations where working with keyboards and clamshell cases 20 inches deep when open is impractical if not impossible.

Furthermore, excluding Panasonic’s own Toughbooks, few, if any, notebooks combine state-of-the-art computing and connectivity technology with the degree of ruggedization planned for the Flex. The most fully ruggedized Toughbooks, the CF-27 and 28, are nine-pound portables. The Flex wireless display, used with its module detached from the user or as a Toughbook extension, should weigh-in at under three.

Competition: Pen Tablets

It is undeniably true that in a number of markets the Flex will be fighting pentabs from both major vendors like Fujitsu and smaller makers such as WalkAbout and Intermec.

Unlike current wearables, some existing pen tablets are far from being technological weaklings. The Walk-About Hammerhead HH3, for example, is fully ruggedized, uses a 400MHz Pentium III CPU, is Windows 95, 98 and 2000 compatible, comes standard with a 10GB hard drive, offers several display-screen options, and features both a sealed PC Card slot and a sealed “flex” space” that can be used by integrated wireless or GPS modules.

Despite their technological prowess, pen tablets have largely been successful only as single-purpose devices for limited applications. One reason for this is the genre’s legacy of running proprietary operating systems and applications; most pentab manufacturers joined the Windows revolution late, after other generalized portable-computing solutions were well-established.

More importantly, pen tablets are inherently victims of their own form factor with increased capability generally being matched by increased weight and bulk—all of which has to balanced in one hand while the unit is being used.

The sophisticated, durable HH3 is an excellent example. Cramming everything from the hard drive to the expansion slots to the “flex” module space to the CPU and heat sinks into the screen case has resulted in a unit that weighs about 4 ½ pounds and is as wide (over 11 inches) and as deep (1 ½ inches) as the average laptop.

Given the slow development of such items as high-density, solid-state memory devices, tiny CPUs requiring no heat-shielding or ducting, and ultra-miniaturized communications modules, it is doubtful that a technological solution to the pentab form-factor dilemma will be available within the next several years.

Even if such a solution did suddenly become technically feasible, it is highly unlikely that it could be implemented into a commercial device and brought to market at an acceptable price point.

While pentabs will remain viable—and even, in some limited environments, thrive—for the foreseeable future, it is clear that their golden days as “best of breed” data collection and storage devices for on-site field-force workers are over.

Applications: Aeronautical & Automotive

Most current-generation wearable computers were initially deployed in the aerospace industry, primarily by airframe manufacturers to help inspect and service planes after test flights and by airlines issuing the computers to maintenance technicians working in space-restricted zones such as the area behind the impellers in a jet engine.

Though most units currently used for maintenance applications feature heads-up, rather than flat-panel displays, strong arguments can be made that the Flex system incorporates user-friendly technology that more than offsets any perceived benefit of the heads-up display device. There are, in addition, a number of other airline-related applications that while well-suited for the Flex, are incompatible with heads-up display-based wearables.

Note: Deployment of the Flex, as noted below in the Design section, would be equally beneficial in many other industries using sophisticated assembly procedures. The Committee decided to include the findings in this section because the aerospace and automotive industries have, to this point, been the major purchasers of traditional wearables for these applications.

Applications: Aeronautical and Automotive Design

Since the beginning of the development cycle leading to the creation of the Boeing 777, computers have become the most critical tool in the design and fabrication of new airliners. With the 777, Boeing proved that it is possible—and cost effective—to design a state-of-the-art passenger airplane without a single mockup, scale model or blueprint. The entire project was done—right down to calculating the amount, shape and cutouts of the galley carpet—by teams of engineers stationed throughout America and Europe, working collaboratively on ganged mainframes.

Though car makers still use mockups, models and drawings to test styling concepts, the mechanical development of many new models is performed largely as described above.

While mainframe computers can remotely program milling machines to make parts and control assembly-line robots welding groups of components together, the bulk of the final construction is still done manually.

In aircraft, plumbing and electrical systems have to be linked together, seats must be installed, gauges and control surfaces connected and parts of the outer skin have to be riveted to the wings and fuselage. The same processes, on a reduced scale, take place in building a car. Everything from installing the radio and hooking up the air conditioning vents to fitting the carpet has to be done by hand.

With Flex systems workers and inspectors would have immediate access to detailed diagrams of the exact area they were working on. Clearances, torque settings, angles, and other specifications would no longer be subject to memory errors, confusion reading from paper documents, or loss of productivity by a worker being forced to leave his worksite and refer to a workstation monitor mounted overhead or on a bench.

Instead, the worker would have the Flex display setting right next to him. Clearances and other requirements would appear in exactly the right location on the diagram of the subsystem. As each process was completed, the worker would click that area and the specifications would be deleted from the screen, giving him a view that included only the tasks remaining.

Another scenario, one in which assembly steps have to be done in a certain order, would have the steps appear sequentially on the screen. When the worker tapped the “complete” button for one step, the next would appear.

A major auxiliary benefit of the above systems is that exact records of the order and timing of tasks would be automatically filed on the appropriate server. In the case of individual workers, the advantages of precise, automatic record keeping are obvious.

If a component assembled by a given worker consistently fails more QC tests than the company average, a quick scan of his records may show that he is performing one procedure unusually slowly, indicated that he is having trouble with that step and needs retraining. Or he might be slow in several areas and is rushing through the others to keep up with productivity quotas.

Group analysis of the same data would also produce tangible benefits. Identification of a procedure that is being done consistently slower than expected could trigger a time-and-cost-saving redesign of that “bottleneck.” If the majority of workers seem to be finishing most tasks ahead of schedule, an increase in production-line speed might be justified.

Note: Automobiles being mass produced, use of the procedures just des-cribed would be limited to critical production points, most of them probably involving the assembly of complicated components off the main assembly line. Use of the Flex for training or retraining assembly workers in all areas, including non-Flex-enhanced assembly-line procedures, should shorten the learning curve and reduce training costs.

Applications: Aeronautical and Automotive; Aircraft Maintenance

One of the very first tasks for which wearable computers were commercially used was jet-engine inspection and maintenance; mission-critical work that must be performed with strict adherence to mechanical procedures and record-keeping requirements established by the FAA and the engine maker. From there, inspection of certain airframe components was added to the wearable “to-do” list.

While the engines themselves are often large enough to stand in, their curved surfaces and restricted clearances make grappling with a notebook computer difficult. Airframes, filled with hard-to-access areas and crawl spaces, are equally non-notebook-friendly.

Current wearables do eliminate many of the notebook’s drawbacks, but their wire harnesses and bulky, badly integrated components create problems of their own by negatively impacting workers’ mobility and range of motion.

Using the wireless wearable display system, inspection and maintenance workers would not be required to carry anything to the actual work site except their tools and the thin, lightweight display-screen. The computer module could be placed anywhere convenient, allowing the worker to navigate tight passages and crawl spaces unencumbered by restrictive and uncomfortable body-mounted computer modules and battery packs, and unimpeded by easily snagged and disconnected cables.

Applications: Aeronautical and Automotive; Automobile Maintenance

In the two decades since Volkswagen introduced the first cars with an output terminal allowing mechanics to plug-in a piece of test equipment and access such critical information as voltage, vacuum and fuel-flow rates, computer diagnostics has become the *de facto* method of testing automobile performance in every area from horsepower production to exhaust emissions.

The hardware used has become extremely sophisticated, with high-powered computers integrating test results with a database containing performance criteria for virtually every make and model of car sold in America over the past 15 years. In addition to being sophisticated, this hardware is large, bulky and requires numerous sensors to be connected to various components in the car.

In a private presentation at the Society of Automotive Engineers 2001 World Congress and Exposition, researchers from German automotive electrical component supplier Robert Bosch, Inc. and Carnegie Mellon University displayed a prototype of a wearable, portable system that could perform many of the same tasks as today’s garage-bound diagnostic computers.

Key to the system was a data-gathering module that could be clipped to several points in any typical internal-combustion engine. (Integrated modules in next-generation vehicles would make it possible to run the tests without even lifting the vehicle's hood.) Using a wireless protocol, the module transferred raw data to a pocket-sized mini-computer where it was analyzed and the results transferred to a hard-wired display device.

Seemingly an application perfectly tailored to the Flex, the Bosch system would probably be initially deployed to service writers at new car dealerships for several reasons:

-- The service writer/customer interface point is perhaps the most inefficient stage in the entire process of accepting a car for repair, repairing it, and delivering the repaired car to the customer.

Legislation in almost all states requires that auto repair centers provide a detailed estimate of charges when cars are dropped off for repairs and that any substantial upward change in that estimate be approved by the customer before repairs are begun.

A car dealer may have ten or more mechanics supported by three or four service writers. Early in the morning, dozens of customers wanting service begin to arrive. The service writers, not mechanics themselves and having no access to diagnostic equipment, listen to a description of the problem and fill out a service order containing an estimate.

When scheduled maintenance or obvious problems are involved, this system works fine. The service writer knows the price on 60,000-mile tuneups, brake jobs, and wheel alignments on all the makes and models serviced at the dealership.

When something is really wrong, the system collapses. A typical service order will instruct the mechanic to "check out engine misfire." The estimate will be a pure guess. Too low a guess and the customer will have to be contacted after the mechanic checks out the car and finds the problem; too high a guess and the customer will drive off in a huff and go to an independent garage. The customer might even be mad enough to buy his next new car at another dealership. Usually the service writer low-balls the estimate.

Given a normal workload, the correct estimate will probably not be ready for at least several hours. More often than not, the customer can't be reached on the first call—and the service writer has lots of call to make. By the time the customer is reached and an approval granted, it may be almost closing time. Parts not in stock can't be ordered until the next day. Unfinished work piles up, productivity goes down. The worst nightmare of any shop manager—having to turn new business away and ask customers to come back another day—becomes reality.

Running the Bosch, or an equivalent application, on a Flex, the service writer walks up to the first car waiting to be checked in. Within five or six minutes the system has been hooked up to the car and the tests performed. The application software has defined the problem and calculated the estimate, based on actual parts cost and labor charges derived from the car maker's time-allotted-for-procedure chart and the dealer's hourly charges.

The service writer defines the problem, explains the estimate and has the customer electronically sign the work order. The mechanic verifies the diagnosis, performs the repair, and the service writer informs the customer the car is ready for pickup.

Applications Aeronautical: Customer Service Representatives

There's an old cliché that goes "they also serve who stand and wait." Perfect illustrations are the airline workers who stand around boarding gates waiting for planes to arrive full of passengers wondering where to go next.

Within moments after a flight has landed these agents are surrounded by people demanding information—gate assignments and times of connecting flights, commuter-flight-connection information, where to get checked baggage, and more.

Studying this area, the Committee found that these critical customer-service jobs are still largely performed by entry-level employees equipped with a clipboard and a radio. We believe this to be a potentially fertile market for the Flex, because:

-- Gate assignments are constantly changing. Most last-minute changes are transmitted by radio to the service reps; many are not heard correctly; others are quickly forgotten. The Flex-based system would automatically update, in real time, all gate changes. A simple, automated non-specific radio call (Attention: Check Gate Changes) would alert reps to check the Flex screen, where recent changes would be highlighted, before giving out gate numbers from memory.

Tapping any flight number would invoke a simple diagram of how to get from the arrival to the departure gate. Generally, showing the diagram to a traveler should be faster than the current point-and-explain method of directing people from Gate 84, Concourse B, to Gate 52, Concourse D.

-- On-time arrivals and departures have become an endangered species in the U.S. A person arriving 45 minutes late has no idea whether he has to sprint for a connection because it is leaving on time or can take time for dinner, drinks and shopping because the connection will be departing two hours late. Flex-enabled attendants would have access to the very latest arrival and departure information direct from the airline operations server. In many cases this information would be much fresher than that listed on airport arrival and departure screens, which often show flights as leaving “on time” even though they are still at the gate 45 minutes after their scheduled departure.

-- Baggage carousel assignments also change frequently, often just as the plane is landing. Being sent to the wrong baggage carousel in a large metropolitan airport can cause delays—crucial delays in the case of business travelers due at meetings—of up to an hour while the traveler waits for hundreds of bags to appear, discovers that his isn’t among them, hunts down a baggage handler, is told that the baggage return area for his flight is somewhere else, goes to the new location, finds his bags have been hauled to the baggage room because he wasn’t there to claim them on time, and eventually locates someone to unlock the baggage room.

Providing real time updates of baggage flow to Flex-equipped customer service reps meeting planes would eliminate the vast majority of these problems.

Note: Northwest Airlines is currently using a wearable computer-based system to speed up the passenger check-in process. More information on their system is contained in the Competition section under ViA.

Applications: Checklists and Forms

For numerous technological, productivity and legal reasons, the Committee unanimously believes that the wireless display system will become a solution of choice for many procedures that involve filling out forms and completing checklists. We further believe that the system's utility in performing these tasks will be consistent in all public service and industry jobs requiring the creation and filing of such documents.

Implications of the E-Sign Act

The U.S. Electronic Signatures in Global and National Commerce Act, which took effect in October of 2000, gives virtually all digitally stored documents the same legal status as paper documents. The implications of this law in regard to the use of electronically generated forms and checklists are substantial.

Under the E-Sign Act, forms and checklists can be created electronically, automatically filed and distributed and, finally, put into long-term digital storage without ever having to be rendered on paper. The efficiencies in both employee productivity and space utilization created by this Act are obvious.

The advantages of electronic generation and storage of such documents in the event they eventually have to be recalled for use in regulatory hearings or lawsuits are also substantial. Though paper records can be indexed and cross-indexed in many ways—with the indexes stored electronically, if desired—an employee still has to find them, separate the needed documents from the irrelevant ones in each file, create a log of those removed and, in most cases, copy those being provided to outside sources.

Using an electronic storage model, the original documents never leave the virtual file cabinet. And they can be instantly sorted and re-ordered in an almost infinite number of ways. Regardless of what folders the files are stored in—or what servers they are stored on—retrieving, for example, maintenance records on a single aircraft with a lengthy service history and accessing maintenance records on all airplanes of a specific type in service during the year 2001 become equally simple tasks.

After retrieval, requested documents can be electronically forwarded or automatically printed for delivery in physical form.

The E-Sign Act does require that digital documents be electronically authenticated to be legally valid so companies availing themselves of its benefits will have to use a security certificate application on their system.

Applications: Checklists and Forms; General Benefits

-- Automatic filing and distribution of completed documents increases efficiency.

-- Forms and checklists can be quickly, inexpensively and simultaneously updated on all end-user systems via network download.

-- Visual alert if items are not completed.

-- Visual alert if items requiring numeric input are above or below specified tolerances.or operating ranges.

-- Automatic help screens for troubleshooting out-of-specified-range problems identified by checklist application.

-- Automatic triggering of lockout device if worker attempts to operate equipment before successfully completing form.

Applications: Construction

According to the United States Department of Labor, the construction industry is a $845 billion-a-year behemoth employing over 6.3 million workers. The number of potential uses for the Flex in this industry is incalculable.

From the original surveying of the construction site, through the architectural design process, the building phase, the outfitting of the structure and the landscaping of the site, the potential size of the Flex market is limited only by the imagination of application developers and the types of peripherals—on board and remote GPS receivers, laser measurement devices, remote stress sensors, cameras—compatible with the system.

Going beyond business or residential structures into the area of road construction, tunnel and bridge building, mining, pipe and conduit mapping, installing cable systems and building or expanding transit systems, the vast potential for a multi-function, high-powered, daylight-readable, wireless computer and communications system in the construction industry becomes even more obvious.

It is the committee's belief that the likely return from establishing the Flex as the dominant "wearable" system in the construction industry could reach over $100 million annually within three years. Reaching this goal will require a clearly focused, well-funded effort to identify target segments of the industry, partnering with appropriate vendors (specialized sensor manufacturers and software developers) to create turnkey solutions, and release of a wireless-display-system variant optimized for construction applications.

Note: Many of the applications listed in the Inspection, Utility and GIS sections also have relevance to the construction industry. Example: Using a Flex to inventory existing underground cable runs may be considered a utility application; using a Flex to obtain survey and positioning data for installing a new cable network could be considered a construction application.

Applications: Construction, On-Site Project Management

Keeping track of daily work assignments, raw materials delivery, inspections, worker productivity, material used, and dozens of other details can leave a foreman stranded behind a desk in a construction shack when he should out on the property.

With the Flex system, he can enter this data on the fly as it takes place in front of him at the work area. Chances are, he won't even have to tote the computer module with him, opting instead to leave it locked in the "shack" or a vehicle.

Note: Several Committee members recommended pursuing a working relationship with Meridian Project Systems, makers of the Prolog series of Windows-based construction-management applications. They noted that Meridian already makes “pocket” versions of its flagship product, Prolog Manager 6, for the Windows CE and Palm operating systems.

As expected, those applications have severe limitations. Only a handful of Prolog’s basic functions are supported and the handheld units have to be physically interfaced with a workstation running Prolog 6. Under these circumstances, it is felt Meridian might welcome the chance to work with a company that could provide a robust, wireless-enabled remote system capable of running its full programs.

Applications: Construction; Site Preparation

As noted elsewhere, the potential value of the wireless display system for collecting and manipulating Geographic Information Services data using GPS and other positioning systems is consistently high across many industries.

AGTEK graphic

One segment of the construction industry where a dirt, dust, mud resistant portable system with a highly readable daylight screen should be extremely welcome is site preparation.

Such a system would provide operators of heavy equipment a three-dimensional topographical view of their actual position, their position relative to curb lines and other markers and their implement’s angle of attack. Ideally the system would also provide a function allowing engineering drawings showing the shape, location and depth of complex forms—like excavations for custom-shaped swimming pools—to be compared to the work in progress and used as a guide by the machine operator.

A number of companies make applications specifically for these functions.

One of the most common is Graphic Grade GPS by AGTEK Construction Computer Products. AGTEK currently vends this program using Compaq as an OEM vendor for notebook computers intended to be mounted on bulldozers, earth scrapers, graders and other pieces of heavy equipment.

Given Compaq's long history of producing what are arguably the most fragile portable computers in the industry, the ease with which even the most sealed keyboards can get clogged and sticky in muddy conditions, and the inherent simplicity of touchscreen activated controls, the Committee feels that an overture to AGTEK may prove fruitful.

Applications: Construction; Machine Automation

A much more sophisticated version of a site preparation application, the term "machine automation" is actually a misnomer. A more accurate name would be "operator guidance." A typical machine automation system would be based on a RTK (Real-Time Kinematic) GPS system consisting of a base station transmitting to remote receivers outputting to a computer mounted on the machine to be "controlled."

When used, for example, on a large earth-moving project, data from the remote GPS receivers—which could be internal or external units connected to the machine's dash-mounted Flex module—would be converted to digital terrain maps (DTM) that could be rotated and viewed from any angle via touchscreen input. Differences in values between the actual work done to that point and the design specifications would be displayed on the screen, as would statistics on elevations, slope angles and similar data.

The dynamically updated DTMs would free the earthmover operator from having to perform calculations, reference blueprints, or follow grid markers. To complete the job he would only have to maneuver his machine to follow the map and instructions as they were updated in real time.

In addition to allowing contractors to save money by using relatively inexperienced heavy-machine operators, the benefits of Machine Automation include elimination of the need to set grade stakes and other markers, accuracy under five centimeters, and automatic databasing of work comp-leted. Dual-purpose Machine Automation systems can also be used to perform site inspections by reloading stored DTMs and design files.

Of the Machine Automation vendors currently shipping product, the Committee believes Leica Geosystems may be the best prospect for a strategic partner. Leica's Dozer 2000 system is designed to run on Wintel touchscreen portables and there could be an opportunity for a cross-marketing as well as technological relationship.

Applications: Emergency Services; Medical

The demand for a lightweight, easy-to-maneuver, wireless alternative to—or extension of—a vehicle-mounted laptop is growing throughout the public-safety field. From daily situations like those facing Emergency Medical Teams and police and firemen at an accident site to major disaster relief—such as post-earthquake—deployment of a wireless display system could save lives, increase response-team efficiency and cut agency information-management costs substantially.

Emergency Services: EMS

Currently, most emergency medical service communications between ambulance crews and hospitals is done by radio. While this system works well for reporting estimated time of arrival at the emergency room, condition of the patient and details about the injury or illness, it is inadequate and inefficient for a number of reasons—including the inability to collect and share data in real time, lack of usefulness in generating reports, and inability to maintain a time-line history of the incident.

A wireless display system would provide the following advantages:

-- Ability to collect, store and automatically transmit patient vital signs. (Would require USB or serial interface to monitoring sensors.)

-- A continuous and uniform data stream on patient condition to everyone in the care chain from the ambulance crew to the trauma-center surgeons.

-- Ability to provide EMTs with treatment guidelines for specific conditions such as burns, stroke, chest injury, etc.

-- Generation of electronic incident reports and automatic distribution of them to appropriate departments (billing, insurance, pharmacy, etc.) and state and local agencies.

In researching this area, the Committee discovered one dedicated Windows-based EMS application designed for display-panel use, SafetyPADbase, by Open Incorporated. This program, which is currently in limited use with ViA II systems, enables many of the functions listed above and is compatible with either touchscreen or voice input.

Note: In 2000, the Norfolk, Virginia, Fire and Paramedic Service began a pilot program to convert rescue units from a pen-and-paper to an electronic reporting system.

At inception the old paper reporting methods and the new electronic record-management system were concurrently maintained by field units. After several months of experimentation and review, the old system began to be phased out. Department heads now predict that they will eventually be able to convert to a 100 percent-paperless environment at headquarters and in the field.

Applications: Emergency Services; Fire Fighting

It is the committee's belief that the primary usage for the Flex among city fire departments will be as a companion product to vehicle-mounted Toughbooks.

Fire captains and chiefs need a durable, reliable, easy-to-operate means to maintain access to their databases and information channels while conferring with subordinates at the fire site and visually inspecting fire lines, breaks, adjacent buildings, etc. A ruggedized, wireless display system with an ultra-bright screen is a product well tailored to meet those needs.

Emergency Services: Forest and Grass Fires

Though not a very large market, a majority of the Committee felt that attempting to supply wireless display systems for use by designated teams of experts who travel from all parts of the United States to handle these types of conflagrations would be advisable for several reasons.

-- Because of the nature of these disasters—which frequently threaten hundreds of homes and tens of thousands of acres—and the bravery of the crews fighting them, often parachuted into areas surrounded by out-of-control fires—forest and grass fires are very high-profile emergency situations which get intense media coverage. Use of the Flex to help subdue these blazes would be a powerful promotional tool in marketing the product to other public-safety agencies and industries dealing with potentially hazardous situations.

Also, the wireless display system has several unique capabilities that could make it a very effective tool in fighting wildfires and helping ensure the safety of the firefighters on the scene.

-- Most firefighters in these situations come from specially trained quick-response teams and live hundreds—or thousands—of miles from the fire location. Their lack of familiarity with the terrain and topographical features of the area ablaze adds immeasurably to the risks already present in such a hazardous occupation. Using wireless display systems loaded with maps indicating fire trails, elevations, water sources, etc. would greatly add to their ability to plan effective escape strategies. Using the wireless display system with an integrated or external GPS receiver would significantly enhance the beneficial effects of the mapping application.

-- Aerial photographs downloaded to the wireless displays in real-time would substantially aid crew chiefs and fire captains in making decisions about strategic matters such as where to ignite backfires, attempt to create firebreaks, and reallocate their resources.

Applications: Emergency Services; Major Disasters

The committee's research identified a strong need in the public-safety and transportation arenas for a portable display solution that could feed into communications systems controlling evacuations, outlying traffic, and emergency services after hurricanes, earthquakes, tornados and environmental disasters.

-- Investigators equipped with wireless displays loaded with area maps could pinpoint the location of trapped victims, blocked roads, downed power lines, damaged bridges, unstable buildings, and other hazards and transmit them to the disaster-control center. The disaster site and nature of the problem in each part of it would be displayed on matching maps on desktop workstations or wall displays and on the wireless display screen of rescue workers routed to the location.

-- Using a small camera connected to the module's USB port, detailed digital images of disaster scenes could be transmitted back to the disaster-control center where specialists could study them and relay specific instructions for dealing with situations unfamiliar to the emergency workers on the scene. The images themselves could be marked up and returned showing such specific information as points where rescuers could dig under a collapsed wall with minimal chance that it would fall further and take down a still-standing wall in proximity to it.

Applications: Emergency Services; Roadside Assistance and Toxic Spills

Emergency Services: Roadside Assistance

When dealing with people trapped in crushed vehicles, drivers stricken with heart attacks or other disabling medical conditions, motorcyclists with head injuries and similar incidents, the first respondent on the scene—be he a policeman, fireman, or other emergency worker—might encounter a situation that lies outside his specific area of training. An on-drive database could quickly and clearly provide step-by-step guidance in handling most predictable situations—including graphical depictions of various car models and the location of stress and support members resistant to cutting by such tools as the “jaws of life.”

In conjunction with a camera, the wireless displays could “broadcast” images (via a central server) enabling more experienced personnel using in-vehicle Toughbooks to counsel the initial respondents while they are in the process of extracting victims and stabilizing them until trained EMT’s arrive.

Emergency Services: Hazardous Material Spills

Because using a computer within the protective “space suits” worn by Hazmat specialists would require a heads-up display and voice input, the Committee does not see any significant market for the current generation Flex in this area.

There are, however, certain hazardous material *handling* applications well suited to the Flex system’s capabilities. They are noted in the Applications: Industry section.

Applications: Geographical Information Services

Geographical Information Services have been described as "high-tech equivalents of a map."

Call that a major understatement…particularly since May 1, 2000, when the Selective-Availability System the Department of Defense was using to purposely introduce errors into civilian-channel Global Positioning System satellite receiver signals was deactivated.

Since that time the precision of civilian GPS receivers has improved approximately 500 percent. Systems that had located positions within 200 feet are now accurate down to 40 feet. And that improvement rate is based on a consumer-grade standalone GPS receiver being used in the simplest possible manner. Other, more advanced GIS applications featuring enhanced GPS and/or laser sensors can pinpoint locations within a few inches.

GIS operations are, generally, tools used to facilitate specific tasks--mapping a new highway, targeting a missile launch, inventorying county assets, surveying for a new subdivision, transmitting location coordinates to search and rescue teams, etc. For this reason, other references to GIS systems will appear throughout this document.

Major users of GIS-enhanced applications include municipalities, utility companies, ecological consultants, transportation companies, mining operators, argri-business, real estate developers, disaster-relief agencies, and the military.

In addition, many companies and organizations which have previously hired outside contractors for GIS functions are now using their own field workers for such tasks as inventorying geographical assets, collecting climatic data, surveying and designing pipeline and conduit systems, linking maps, data and digital images, and a myriad of other tasks.

Currently, the bulk of these applications are performed by special-function, ruggedized pen tablets using input data from both traditional computer devices such as touchscreens and cameras, and specialized devices, such as GPS receivers, heat and motion sensors, laser sensors, depth sounders, weather-recording instruments, seismic-action recorders, etc.

While some of the computing devices used in these applications utilize the input data in real time and a few are able to automatically update central servers via a wireless protocol, many are simply data-recording devices that have to be taken off site and downloaded into a workstation before the collected data can be utilized.

The Committee considers GIS applications a key arena for the Flex for a number of reasons:

-- Many of the computing decives currently in use are technologically obsolete, suffer from limited functionality, are not fully ruggedized, or lack advanced communications capability.

-- The size and scope of the GIS market is growing exponentially with the majority of positive market sectors for the wireless display system—utility, construction, law enforcement, municipal government, EMS, military—beginning to implement GIS programs for an expanded number of tasks.

-- Virtually all of the most popular GIS-based applications, many of which began life working under proprietary operating systems or DOS, have already been ported to Windows and many are pre-configured to run on touchscreen, non-keyboard devices.

-- As currently configured, the Flex will be compatible—either through its serial or USB port—-with most major GIS input devices, including laser arrays, multiple GPS receiver and relay systems, video input devices and similar peripherals.

-- The Flex is also compatible with such advanced GIS protocols as Differential GPS, Inverted Differential GPS, Carrier-Phase GPS, WAAS (Wide Area Augmentation) DGPS, and Ground-Penetrating Radar.

-- Given the high level of computing power inherent in the Flex, it should be able to run the intensive CAD and AutoCAD applications necessary for fulfillment of some GIS tasks more efficiently than even the best current hardware.

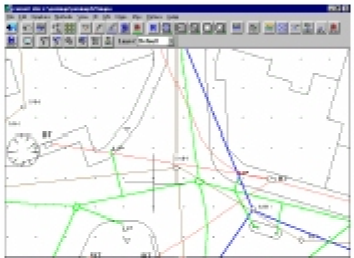
Applications: GIS; Software

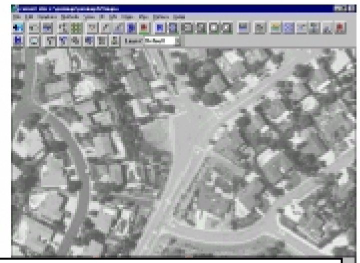
While many GIS applications are embedded in software packages covering multiple aspects of a project (such as fleet-tracking and trailer-utilization efficiency or construction-site preparation), standalone GIS programs in such venues as land and sea navigation, mapping, environmental monitoring systems, etc. are common.

Of the most prominent software-development companies in this area, Condor Earth—which currently offers the Toughbook CF-17/34 as a hardware option for purchasers of integrated GIS systems—would seem to be the most logical strategic partner for Panasonic.

-- Condor Earth's PenMap for Windows is a highly versatile Windows 95/98/NT/2000 field-data and collection application that combines surveying, CAD and GIS functionality. As befitting its name, it is designed for pen or touchscreen input and should be easily ported to the Flex.

PenMap supports over 70 different types of field sensors for complex jobs, but works equally well with data gathered via hand tools such as tape measures.





PenMap vector-based map **PenMap radar-based map**

Using PenMap, field technicians can view and edit two- and three-dimensional maps and data in real-time using one of over 20 different surveying techniques. Other features include the ability to link digital photographs to points, lines and polygons, line and polygon editing, and onscreen GPS and survey-instrument controls.

In conjunction with hardware from various vendors—including, as noted, Panasonic—PenMap is currently being used in construction, mining, defense, public utility, law enforcement, and other major industries.

Applications: Healthcare

The wireless display system has the potential to offer unique solutions in many areas of the healthcare industry. Some of these solutions, such as the Electronic Medical Records system described below, can be implemented now. Others, such as the use of virtual gloves in physical training and surgical procedures, will not be possible until the input and interface devices currently available for these applications are refined and miniaturized.

Mass acceptance of the system for any purpose, however, is very likely to be inhibited by major healthcare providers' tight budgets and traditional lethargy toward new technologies. That said, their need to invest in capital improvements to streamline and modernize their procedures in order to remain (or become) profitable—and the record-keeping demands of an ever more litigious society—should result in healthcare becoming a large and highly profitable market in four to five years.

Healthcare: Electronic Medical Records

Converting patient charting and other record-keeping tasks from paper-based to digital systems is a classic win-win situation: The patient gets better care; the healthcare provider has lower costs. Doctors and nurses gain access to relevant data in a fraction of the time its takes to locate it on loose-paper charts and mentally collate it.

EMRs can also be configured to fit specific tasks and automatically restructure themselves for others. For example, an electronic medical record viewed on a wireless display in a patient's hospital room could be customized to group medications in one section, blood-pressure results in an another and so on. Viewed on a billing department workstation, however, the same record would display patient events chronographically.

An EMR program running on a Flex would also greatly facilitate drug administration and monitoring. Instead of having to search for different drugs to find the last time each had been administered, a doctor would enter the name of one drug and a screen displaying data about that drug and all the other drugs the patient had been given would instantly appear.

Doctors would "write" prescriptions from an on-screen inventory list which would also show the potencies available for each drug and briefly recap the manufacturer's recommended daily does for common conditions. For more in-depth information, the electronic version of the *Physician's Desk Reference* would be available on the module's hard drive or the host server. When updates to the PDR are issued, all display systems in an institution would be simultaneously upgraded.

Drug availability would be automatically updated in real-time. Unlikely as it may seem, pharmacies in American hospitals, most of which use a just-in-time drug-ordering system to take advantage of weekly price fluctuations on generic drugs, are frequently out of stock on a number of common prescription medicines.

Typically, a prescription written by a doctor doing his “rounds” will go to the hospital pharmacy after rounds and then be delivered to the appropriate nursing station. If the item is not available, the prescribing doctor—who by then might be in surgery, in an office 20 miles away, or on the golf course—must be located and a replacement medication ordered. If the prescribing doctor can’t be found, a replacement drug must be ordered by another doctor who has been briefed on the case. Using an EMR application on the Flex, a real-time link to the pharmacy’s inventory-control system would update the inventory list as items went out of stock or were restocked. Out-of-stock drugs would appear in red on the list and the names of similar in-stock drugs provided.

A search of the patient’s complete server-stored medical history would be automatically initiated whenever a prescription was entered, and information alerts listing potential drug conflicts or previously unfavorable reactions to a drug would be issued as needed.

As with drug information, virtually all the data currently on patient charts could be enhanced—as well as accessed faster—through use of a Flex running an EMR application. As just one example, all blood-pressure readings taken since the patient entered the hospital could instantly be displayed, graphed and compared with pulse and respiration rates.

Doctors using this system at a patient’s bedside will have “under” their fingertips more timely and accurate patient information—and more ways to use it—than ever before. They will also be able to access and manipulate it so rapidly that the amount of time needed to complete each set of rounds will decrease to the point where staffing levels could be significantly reduced.

For large HMO and managed-healthcare facilities, such as the Kaiser-Permanente hospitals on the West Coast, those savings may more than recoup the capital expenditures on the system within the first year.

Easily implemented encryption technology would prevent unauthorized access to data on servers and one of a variety of security devices—from passwords to thumbprints—would prevent unauthorized users from tampering with the bedside units. A fully integrated EMR system with wireless display units as the bedside clients would also generate easily retrieved, authenticated, time-and-date-stamped documents for use in re-certification, regulatory or legal proceedings.

Applications: Insurance & Disaster Claims

No matter how many policies they sell, most insurance companies wouldn't be in the black if they didn't control costs. Speeding the flow of information from the field to the corporate networks is a key cost-control initiative throughout the industry.

The same imperative for fast, efficient data collection and processing exists for governmental agencies charged with providing direct aid and/or low-cost loans to disaster victims. In many cases their clients are homeless, have lost income-producing tools and supplies, and otherwise have problems that require rapid intervention.

Insurance & Disaster Claims: Insurance Adjusters

Of all the information—new policies, claim forms, settlement offers, etc.—that converge daily on a typical insurance company's data center, on-paper reports from adjusters in the field are almost always the most-time consuming to integrate.

With over 100,000 full-time and tens of thousands of part-time (outside contractors hired on an as-needed basis) insurance adjusters, the insurance industry could be a significant market for the Flex.

Benefits of implementing the wireless display system include more standardized reports, increased adjuster productivity, automatic filing of reports in on-server case folders, faster acceptance or rejection of claims, reduction in the number of employees needed to manually enter data, and automatic distribution of the report to relevant departments such as fraud-evaluation units.

Connecting a digital camera to the Flex module's USB port would further enhance productivity by eliminating the need to separately upload images and integrate them into the proper case file.

As this application involves migrating users directly from the pen-and-paper age into the wireless display system era, development of an application mimicking the insurance industry's current printed forms would be required.

Insurance & Disaster Claims: FEMA

The Federal Emergency Management Agency is charged with providing grants and low-interest loans to states, municipalities and individual victims of such natural disasters as floods, earthquakes, wildfires, tornadoes and hurricanes. Both major individual and family-assistance programs administered by FEMA, the Individual and Family Grant Program and the

Disaster Housing Program require that FEMA inspectors visit the claimants' homes (or home sites) and file a report before a claim can be approved for payment.

Typically, FEMA Disaster Assistance Employees (DAE) move into a location almost immediately after the President designates it a disaster area and remain on-site until all claims are processed. Depending on the nature of the disaster and the size of the area affected, this time period can range from a week or two to several months. A computerized reporting system that boosts DAE productivity levels would substantially cut administrative costs and enable faster claim payments by decreasing the amount of time FEMA employees spend in the field.

Applications: Law Enforcement; Patrol

In the year 2000 the Congress of the United States set aside $70 billion to support and enhance state and local public-safety agency services. Much of that money was eventually used to develop, upgrade and/or expand the technological resources available to police officers serving those agencies. Under the Bush administration, expected to be more conservative and law-and-order-oriented than its predecessor, it is reasonable to expect that the amount of federal funds available for annual discretionary spending on law enforcement will increase steadily over the next four years.

From "meter maids" writing parking tickets and policemen patrolling the streets to FBI agents and prison guards, the scope of what could be called the law-enforcement industry is vast and pervasive. Every level of government, from the White House to the smallest municipality, has its own local police force and is also served by law-enforcement agencies under control of other jurisdictions.

Among this plethora of investigative and policing agencies are county sheriff's departments, state police agencies, the FBI, the U.S. Marshal Service, agents of the Bureau of Alcohol, Tobacco and Firearms, and officers of the Immigration and Naturalization Service.

Numerous other public agencies have specific law-enforcement responsibilities. Examples of "policemen" employed by agencies whose primary mission is not law enforcement include social service investigators, transit police, and probation and parole officers. The State of California even has a law-enforcement agency whose sole purpose is to supply guards for the state's mental institutions.

Regardless of their function and jurisdiction, one task common to all these agencies is gathering data. And one common need is access to data, not just their own data, but *everyone's* data. Information from wants and warrants files, vehicle codes, penal codes, national and state crime-information centers; information including mug shots, police sketches and images and, possibly, fingerprint files. (Given speed limitations on fingerprint searches, real-time access may be limited to files containing thumb prints of a limited number of major suspects.)

Data that is continually updated as new reports and daily bulletins are added to the system. Data that can be obtained quickly and accurately by any officer, anytime, anywhere.

Almost amazingly, a significant percentage of the estimated 1,000,000 peace officers in the U.S. do *not* have direct access to virtually any of that data anywhere, or anytime, they are on patrol.

Serving over 1500 police agencies, Panasonic is the industry leader in providing ruggedized portable computers to the law-enforcement community. Given the Toughbook line's excellent reputation and high visibility in this area, the Committee believes the Flex will prove highly successful in many areas of law-enforcement technology, both as a standalone system and as a companion piece to vehicle-mounted Toughbooks.

That said, the Committee almost unanimously felt that the initial positioning of the Flex in the law-enforcement market be as an advanced appliance to computer-enable officers still relying on paper, pencils and radios to collect and access data.

Applications: Law Enforcement; Patrol, Two-Wheeled

Being a motorcycle patrolman is one of the most hazardous jobs in law enforcement. The estimated 40,000 motorcycle officers in the United States must undergo rigorous training—including, in many programs, practicing "dumping" (falling off) a motorcycle at high speed.

In addition to the qualities required of policemen patrolling by automobile, they must have superior reflexes, balance, peripheral vision and physical stamina. Patrolling a beat on a bicycle requires many of those same abilities, plus world-class cardio-pulmonary capacity. Many officers working out of cars do, however, have one ability not possessed by their two-wheeled colleagues: The ability to immediately access departmental and inter-agency crime information databases.

The earliest motorcycle patrolmen took to the country's then largely unpaved streets about 1905; the first bicycle patrols in approximately 1914. Motorcycle patrols have existed continuously since their first deployment. Bicycle patrols disappeared almost completely as production of radio-equipped police cars and motorcycles ramped up during the early 1930s, not to be revived until 1987 when the Seattle Police Department began using them to police gridlocked downtown streets.

Today a growing number of police agencies are instituting motorcycle and/or bicycle patrols for the first time. In addition to the approximately 40,000 motorcycle patrolmen, the nation's two-wheeled police forces include over 12,000 officers patrolling on bicycles.

Empowering the two-wheeled law-enforcement community with computer access equivalent to that enjoyed by officers in patrol cars will require special mounting devices (see Attachment Points section) and the use of software optimized for the Flex.

-- It is the Committee's understanding that Panasonic is already working with Kawasaki Motorcycle Company, the largest supplier of police motorcycles in the U.S., to develop motorcycle mounts for both Flex components.

-- The Committee recommends Cerulean Technologies be approached about customizing their PacketCluster suite of law-enforcement data-management software for the Flex. Cerulean is an industry leader in this field and PacketCluster is the application of choice for the majority of police agencies deploying Toughbooks.

-- The PoliceMobile Suite by Mobile Access Software is suggested as an alternative to PacketCluster if Cerulean's cooperation cannot be obtained or if it is found desirable to offer police agencies an option of two turnkey solutions.

Note: Bicycle-mounted Emergency Medical Service teams, often managed by local police or fire departments, are becoming increasingly common because of their ability to quickly reach victims in congested areas. The Committee recommends that the same Flex hardware developed to enable police bicycle patrols be integrated with appropriate software (see the EMS section) and marketed to two-wheeled EMS teams as a turnkey solution.

Applications: Law Enforcement; Patrol, Automotive

Most members of the Committee believe that the Flex will, in time, prove a popular "peripheral" for use in conjunction with Toughbook notebooks mounted in police cars, particularly in city and state traffic-patrol operations where officers typically work without a partner "riding shotgun."

The major basis for this belief are the hazards inherent in what many officers call "go-backs"—the process of having to return to and enter their vehicle to "run" identification documents given to them by the driver they have pulled over.

For solitary officers the go-back process inevitably involves several instances where they lose eye contact with occupants of the "client" vehicle, making it easier for one of the occupants to reach a firearm hidden in or under an article of clothing, a purse or the car seat itself.

Historically, it has also been true that a statistically significant (relative to all cases of "escape" attempts) number of drivers who obligingly stop their cars and hand their documents to a patrolman attempt to flee while the patrolman is returning to or sitting in his patrol car.

Whether they are motivated by the knowledge that there is a warrant out for their arrest or simply "under the influence," the end result is frequently a high-speed chase resulting in the injury or death of the suspect, officer, or innocent bystanders.

While there is no empirical evidence that such drivers are less apt to take flight if an armed officer is standing in close proximity to them, the relative infrequency with which that occurs indicates that such is the case.

-- It is recommended that some sort of fixed or removable clip or other device to hold items such as like drivers licenses, registration certificates and insurance cards be fitted above the screen of all Flex units intended for police patrol applications.

-- Implementation of a credit-card-reading device into the wireless display-screen itself would be of great value to agencies in states issuing driver's licenses with magnetic strips on the back and jurisdictions allowing minor traffic violators to post bail or pay fines on-site via a credit card.

Like the document clip, this feature would be of equal value to two-wheeled and four-wheeled patrolmen.

-- Credit-card-reading capability could help spur adoption of the display as a companion to patrol-car-mounted Toughbooks by eliminating one more reason an officer might have to return to his vehicle.

Applications: Law Enforcement, Patrol Duties, Off-Road

An increasing number of regional and national public-safety agencies—the U.S. Forest Service, state fish-and-game departments, local police departments in ski and water recreation areas, the National Park Ranger Service and others—are using substantial numbers of ATVs, dune buggies, snowmobiles, horses, and even Jet Skis for law enforcement—as well as search-and-rescue—purposes.

-- While not offering the potential for huge annual sales, this could be a good, dependable market for “off-the-shelf “ Flex units developed for law-enforcement work.

-- The likelihood that agencies purchasing systems for off-road law-enforcement uses would want them pre-configured for EMS and search-and-rescue GIS applications as well could lead to a higher-than-average sale price and profit margin on these units.

-- While a “universal” handlebar mount for the display-screen might work on a majority of the “vehicles” used in off-road missions, the computer module itself would probably have to either be worn by the user or be fitted with an expensive custom mount.

Since drivers or riders of these “vehicles” can exit by simply climbing out or stepping off them, it is not anticipated that wearing the module would impede mobility in any appreciable way.

Law Enforcement: Accident Investigation

Most advanced computer programs for use traffic at accident scenes combine data entry, GIS and data-mining functions. Since such programs are intended to be run on mobile computers and depend heavily on the positioning and rearranging of visual objects, many have been designed from their inception for touchscreen input.

Among these types of programs, Condor Earth's law-enforcement version of the PenMap application noted in the GIS section is one of the most highly developed.

Features include:

-- Support for over 40 different recording instruments including road wheels, GPS positioning systems, laser rangefinders and digital cameras.

-- Separate databasing of all geographical information related to an accident with a tag explaining how every measurement point or coordinate in the report was arrived at.

-- User-configurable drag-and-drop data-entry forms for positioning objects on a graphical representation of the accident scene.

-- The ability to record data onto existing background maps; i.e. a map of a frequent accident site stored on the computer hard drive or departmental server. By reducing the quantity of data the accident investigator has to enter, this feature increases productivity and accuracy.

Programs taking a somewhat simpler approach to accident investigation, such as VS Accident Investigator by Visual Statement, Inc., should also be able to run on the Flex with few, if any, modifications.

Capability-wise, the main difference between PenMap and Accident Investigator is that officers using the latter obtain their measurements from traditional manual tools rather than sensors plugged into the computer.

Officers enter measurements into the system via drop-down menus and Accident Investigator automatically generates a diagram of the accident site and calculates, among other things, the speed, momentum, acceleration and braking rate of the vehicles involved.

Other VS Accident Investigator features include:

-- A forms-based module for conducting guided interviews with participants and spectators.

-- A complete range of drag-and-drop diagramming tools.

-- A touchscreen-accessible vehicle specification database covering the years 1971 to 2000.

Note 1: Because it does not require any investment in electronic sensors or measurement devices, VS Accident Investigator may be better suited to small agencies with limited funds than PenMap.

Note 2: Presumably because Visual Statement is a Canadian company, Accident Investigator currently reports measurements only in metric or British Imperial units.

Applications: Law Enforcement; Forensics

Applications to aid crime-scene investigators are available from several vendors. The Committee believes that the most prominent use of the Flex in this environment would be as an enabling device for patrolmen arriving at a crime scene immediately after its discovery.

At its core, a typical “first-impression” forensic application would be of the checklist variety, a variation on the insurance company “super bill” used by the majority of U.S. doctors. A series of templates specific to a given type of law-enforcement situation (crime) would contain “checkboxes” for a multitude of crime-scene details, witness responses, evidence descriptions, etc.

Double-clicking on a box or touching a radio button would bring up a screen for the user to add handwritten notes or diagrams. The notes would remain attached to the specific check-box item they relate to, with the item changing color or in some other way visually indicating that a note is attached. General note pages relating to the entire form would also be available.

Note: As used here, the term “checkboxes” encompasses actual checkboxes, multiple-choice queries, and blanks intended to be manually filled (using onscreen handwriting technology or a virtual keyboard) with specific bits of information such as names, locations, etc.

Data from the form would be transmitted to the PD server in real time where it might be stored as raw data, forwarded as-is to appropriate departments on the network or re-formatted into report form.

As with all similar types of applications, a maximum amount of personalization should be written into the program. Individual departments have to be able to add questions, maps and other local data to the application and automatically update Flex units in the field, either selectively or in a batch.

Though it might appear that attempting to condense all the variables inherent in a criminal activity into checkboxes or multiple-choice questions would result in an unwieldy, hard-to-manage document, this has not proven true in similar data-gathering situations.

General fill-in-the-blanks and checkbox queries relating to time, place, nature of call, etc. would be uniform throughout the application suite, but the majority of questions would be specific to a particular type of crime: drug, robbery, assault, breaking-and-entry, homicide and so on.

The officer would select the nature of the crime from a menu and be presented with the appropriate questions. (Linkage should be provided to enable an officer at, for example, a murder scene in which drugs were found to automatically invoke a page of drug-related crime checkboxes and append it to the report.)

Deploying such a Flex-based system could generate extensive benefits. It would provide a detailed inventory of the crime scene taken in real time as the first officer on the scene is actually seeing it—a definite improvement over entering what he remembers into a car-mounted laptop or precinct-house desktop after additional officers have arrived and relieved him.

The tabulated inventory and (electronic) hand-written comments would reflect the crime scene, the condition of any victims or witnesses, etc. in a pristine state, before the arrival of ambulance crews, police photographers, detectives, press, fingerprint experts, et al.

The report derived from the program would often be more complete and accurate than reports generated by current methods because the officer would be continuously prompted for information in a non-invasive, non-threatening way. Also, information derived from the report would be available to all divisions within the department in real time. In many cases, a detective might even be able to review the data on his Toughbook while being driven to the crime scene.

Perhaps most important, officers testifying months or years after the fact would have a detailed, dated, time-stamped, and electronically signed "real-time" record to refer to during depositions and trials. The classic cross-examination question, "But how can you be sure that…" can now be answered, "Because I was looking directly at it while I entered it into my computer."

Suddenly the entire issue of what the officer may or may not have remembered when he got back to his car or precinct station and wrote his report becomes moot—exiling to oblivion one of the favorite tactics used by defense attorneys trying to discredit police officers.

Note: Depending on the communication range of the Flex deliverable, law-enforcement crime-scene investigations may be one area in which wireless display-screens will be used primarily as extensions of vehicle-mounted, full-sized Toughbooks.

Note: In designing (or modifying an existing) crime scene data-collection program for the Flex, care should be taken to ensure that the raw data entered in the application can be seamlessly integrated with at least one prominent fact-gathering and case-tracking program, such as Guidance Software's EnCase.

Law Enforcement: Special Weapons and Tactics

S.W.A.T. teams are comprised of an elite group of law-enforcement officers with specific training in team operations, use of specialized weapons and vehicles, and tactical planning.

The existence of S.W.A.T. teams, sometimes referred to as “riot squads” or “special forces,” is common in major metropolitan police forces, large county sheriff’s departments, state police agencies and some federal law-enforcement agencies. They are most commonly deployed in highly volatile situations involving substantial risk of injury or death to police officers, the general public and/or innocent bystanders.

Typical situations requiring S.W.A.T. team intervention include barricaded suspects, crimes involving hostages, high-risk search-and-entry operations, service of arrest warrants on gangs, and raids on establishments suspected of housing large quantities of illegal drugs and/or firearms.

S.W.A.T. teams have their own command and control structure and may be augmented by such specialists as hostage negotiators, bomb-disposal experts, and clinical psychologists on an as-needed basis. S.W.A.T. operations are often directed from a strategically located command post in constant contact with front-line commanders.

Emergency Medical Teams are almost always on the scene during S.W.A.T. operations and should, ideally, have real-time access to the operational data being distributed on the S.W.A.T. network.

Though the Committee believes that the full deployment of Flex systems for use by S.W.A.T. teams will not occur until release of a safety-helmet-compatible hands-free display option (see Future Technology section), there is still a viable market for the current system in this area.

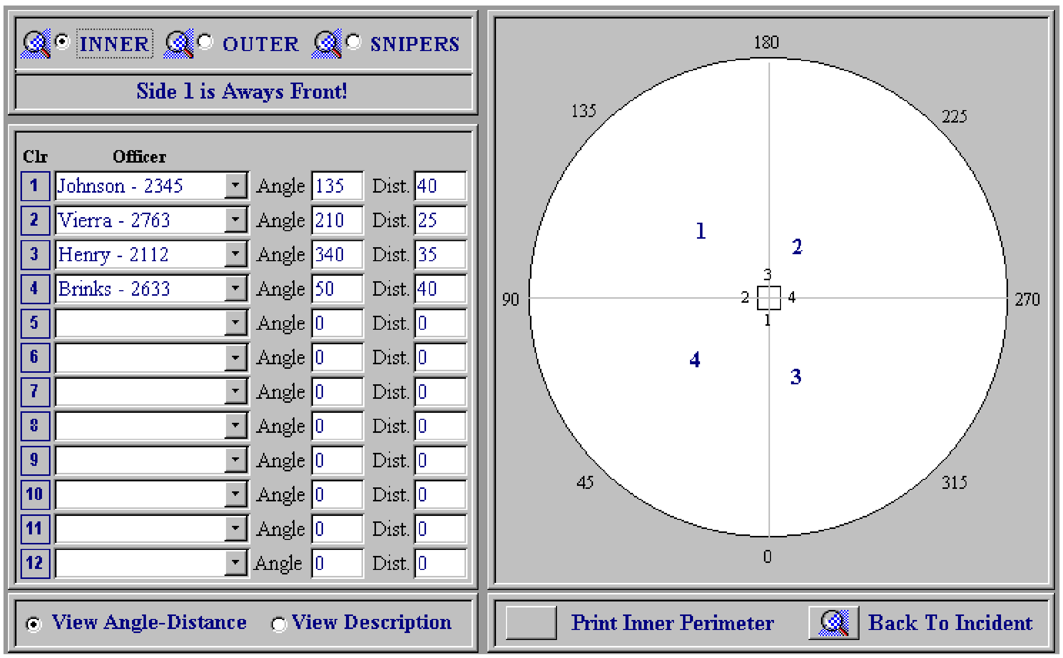
In addition to instantly responding to crisis situations, S.W.A.T. teams are responsible for carrying out strategic operations. “Taking out” a drug factory, for example, may require months of planning, beginning with a district or federal attorney securing arrest warrants and removing other legal obstacles to the staging of a raid.

Details and timetables for the planned raid are established with military precision. Everything from the protection of nearby residents to the foliage and sightlines outside the factory has to be factored in. The number of officers needed to conduct the initial raid and the number needed to be held in reserve has to be calculated. Each man’s location prior to the raid, his movements when the raid begins, and the type of weapon he will carry have to be determined.

There are also decisions involving the type and number of special officers initially required on the scene. Will HazMat specialists be needed to disperse toxic chemicals stored in the structure? Is there any evidence children frequent the building? Should child-welfare agents be standing by?

Hundreds, if not thousands, of tactical decisions must be made prior to this type of operation; many will have to be modified or even completely revised immediately before the operation begins and while it is in progress. The need to quickly, accurately, and, if possible, visually circulate those changes and modifications is a challenge we feel the Flex can easily be readied to meet.

Currently, the number of law-enforcement applications specifically intended for use by special tactics squads is very limited. Of them, Tactical Incident



Perimeter screen display in Tactical Incident Response 2000

Response 2000 by the Advanced Police Software Company has been endorsed by the National Tactical Officers Association and is probably the best known.

TIR 2000 is a multifaceted, menu-driven, Windows program designed for use in all areas of S.W.A.T. operations, from pre-planning stages to the writing of after-action reports. Endowed with complete network functionality, it is currently run on precinct-station-based workstations and laptops deployed at incident command sites.

Utilizing its real-time operation-management module, tactical decision-makers using Toughbooks or other computers with keyboard-input capability could continuously—using text and/or graphic images—update Flex-equipped commanders moving around the area on foot of situational changes as the operation develops.

The increased security of communicating over a secure computer network instead of a radio network would be advantageous even when distributing simple informative messages such as the “subject has demanded a car be made available in two hours.”

Note: In recent years encrypted police-radio communications have replaced unscrambled conversation in many locales. Hostage-takers and other terrorists monitoring public service-band frequencies can easily ascertain that the police are communicating using scrambling devices and threaten reprisals if they are not deactivated.

Technologically sophisticated terrorists could also demand that officials cease communicating via computer networks, but verifying whether or not that demand had been met would be virtually impossible without a lab full of specialized monitoring equipment.

Applications: Law Enforcement; Prisons

The criminal justice system in the United States has been in a continuous state of growth since before the British gave up the fight and went home over 200 years ago.

Like the gaming business in Las Vegas, the corrections industry is unfazed by depression or recession, boom or bust, war or peace. For every convict who enters the system only a fraction of one is released. Of those who are released, the majority remain under some kind of law-enforcement supervision for upwards of one year.

Graph courtesy of U.S. Department of Justice

As of 1999, the last year for which complete statistics are available, more than 6.3 million people—over 2,000,000 incarcerated—were under some form of correctional supervision, a 77 percent increase since 1990.

On the last day of the 20th century, according to the Department of Justice, state prisons were operating at between 1 and 17 percent above capacity and the prison load at Federal penal institutions was a whooping 32 percent over design limits.

Such massive overcrowding creates stress points in every area of criminal management—security, food and medical services, sanitation, recreational facilities, transportation to and from court hearings, and more. As increase-ingly stringent judges have been ordering more convicts behind bars for longer periods of time, the need to create cell space for the new arrivals has led to a record number of felons gaining early release, drastically increasing parole-officer case loads.

The situation has become, in the opinion of many corrections experts, a pile of dynamite, one stick of which goes off every time a prisoner uses confusion to cover an escape…every time a prison knifing or rape takes place…every time an alcoholic murderer on parole makes another kill because an overworked parole officer lost track of him and didn't realize he'd started hanging out in bars.

No advance in computer technology can solve the kind of societal problems confronting today's chaotic criminal justice system. What a flexible, highly mobile, tightly networked computer system *can* do is help bring some order to that chaos, help alleviate the problems caused by a decreasing ratio of warders to criminals by making each “keeper” more efficient. Help increase—if only by a bit—the safety and security of communities outside the prison walls.

Applications: Law Enforcement, Prisons

Good prison management solution software programs, such as the Golden Eagle Inmate Management System from Eagle Law Enforcement Systems**,** cover a lot of ground.

In addition to general information about prison conditions, incident levels, policies, schedules, budgets, staffing, etc., their databases contain a wealth of information about each inmate.

Individual data files track all negative and positive incidents since the inmate’s arrival at the facility, medical history, work and exercise schedules, recreational pursuits and the identity and frequency of visitors. The files contain full information on the inmate’s criminal record, prior associates, gang affiliations, and identifying marks. Also included are mugshots, fingerprint records and handwriting samples.

And yet, despite all this, escapees are often able to get a 12- 24- or 48-hour jump on their pursuers simply by persuading another prisoner to impersonate them at roll call.

In some cases, prisoners not scheduled for release have been misidentified by officials and given street clothes, money and their freedom. Meanwhile, crime rates within many prisons are rising out of proportion to increases in population and violent attacks on both prisoners and corrections officers are becoming more common,

To some degree all of these issues can be charged to the difficulty inherent in keeping control of large numbers of unstable individuals in increasingly confined spaces.

Maintaining control of any institution requires that the people in charge have access to accurate, up-to-date information. The more volatile the situation inside the institution, the greater demands on the information resources.

When employees have to try and make critical, immediate decisions without access to key data, situations can get out of hand easily. Avoidable circumstances become inevitable. Things easily controlled become uncontrollable.

The frontline troops in a penal institution are the correction agents, usually not equipped with lethal weapons, who spend their workdays barely separated from the inmates or, very often, not separated from them at all. Of everyone working in the prison it is these guards who have the least access to core data of any type.

Configuring the Flex for use by prison guards should be a relatively straightforward matter of developing an interface between the wireless display system and information already residing on the prison's server.

Since it is unlikely officers patrolling cellblocks would ever need to scan in dental records or type in detailed criminal histories, the complex software running the prison's "back office" would not have to be ported to the Flex. A simple, menu-driven data-exchange application should suffice.

Among other benefits, such a system would:

-- Drastically reduce mistaken identity errors by allowing officers "inventorying" inmates to view names and photographs on the screen instead of just printed names on a paper list. Compared to electronic prisoner ID systems using plastic bracelets that have to be hand scanned, "mug shot" identification via the Flex would reduce the risk of guards being injured by allowing them to remain more than an arm's length away from the prisoners while confirming their identities.

Note: For "roll call" use, the system would have to be programmed to display batches of photos sorted by cell block, work details, etc. These batches would be automatically generated based on server-stored information listing each prisoner's assigned location at a particular day-part.

-- Allow guards to instantly enter anomaly alerts. A simplified example: A guard in charge of ten cells finds two inmates reluctant to go into the exercise yard at the specified time. Without breaking stride, the guard enters this information via a touchscreen menu.

Before starting his first patrol of the day, the guard covering those cells on the next shift would check for alerts and find all the previous guard's entries. Significant items—such as a note on two prisoners exchanging threats—would appear highlighted. Patterns of erratic behavior over longer time periods would be automatically tracked. The guard coming on duty would begin his shift with a greater sense of the mental and physical state existing in his area than previously possible.

-- Automatically notify guards of any changes in the status of a prisoner or a group of prisoners that could generate instability.

Books, movies and even songs have referenced “making little ones out of big ones,” a 19th century practice of having convicts sentenced to hard labor spend all day chained together while splitting boulders with sledgehammers.

In today’s prison reality, big problems are more frequently created out of little hurts.

A prisoner’s parole application is rejected and he goes into the dining hall looking for trouble and sure to find it.

Members of an ethnic gang hear that five “brothers” have been convicted of a burglary and are soon to join them on the inside, swelling their numbers and increasing their power. Without waiting for the new arrivals, they increase their degree of swagger. A rival gang responds to the show of arrogance and a shoving match begins; weapons appear and a near riot follows.

A model convict scheduled for release after serving five years gets a letter from a wife or girlfriend informing him that she won’t be waiting at the bus stop when he comes home. An hour after lights out he tries to strangle his cellmate.

Like the proverbial camel’s back, normal prison discipline and routine can be easily shattered by a straw. A computer system which could instantly alert guards in any location to “straws” close to critical mass would be a potent tool in identifying and defusing potential emergencies.

Applications: Law Enforcement; Client Supervision

Throughout much of America, parole, probation, child welfare and other officers charged with supervising non-incarcerated individuals under some sort of legal sanction have two things in common: An excessive caseload and poor (if any) access to timely, centralized data about their clients.

To them, the phrase “case file” refers to a battered manila folder overflowing with papers, most of them out-of-date court documents and reports they and their predecessors have made after each “client” contact.

What doesn’t get in the bulky folders these supervisory officers carry with them all day and, on many occasions, into the night?

Police contacts with the subjects of those folders. Changes in family or work status. Failure to make fine or restitution payments on schedule. Missed classes at court-ordered alcoholic abuse, drug abuse, or anger-management classes. A positive result on a periodic drug test.

The content of those folders could accurately be called the paper trail to nowhere…and it extends in both directions.

Police officers who come into contact with a drug-offense probationer and “run” him through their computer don’t find out the subject failed a “surprise” urine test three weeks earlier. How could they? The probation officer’s paper report still hasn’t been manually entered into a database.

The probation officer *never* finds out about the police contact. How could he? No arrest—which would have automatically sent him a paper or e-mail advisory— was made. The computer-generated contact report was quietly added to the subject’s file on a server inaccessible to the probation officer.

Communications problems are always serious. In law enforcement the inability to transfer information to all pertinent agencies and individuals in a timely, consistent manner can have catastrophic consequences.

With the Flex system, public agencies can empower investigative and supervisory officers with the same real-time duplex data access provided to patrol officers using notebooks and police executives using workstations.

Using the Flex and working closely with appropriate software developers, Panasonic can put itself in the unique position of being able to supply a unified solution for all municipal law-enforcement mobile-data-access needs. A consistent, compatible solution that works for everyone, whether they ride in a patrol car, pedal a bicycle, patrol a jail, raid a crack house, or visit a wrecking yard to check on whether a parolee is still showing up for work.

Applications: Public Utility

Potential markets for the Flex exist throughout the public-utility industry. Many of these opportunities lie in areas covered in the GIS and Construction sections. Other applications include:

Applications: Public Utility; Telephone Company

Given the success of the P2C2/Tempo collaboration leading to the mass deployment of Toughbooks to SBC Communications telephone-line technicians, the Committee feels that offering approximately the same feature set in a different form factor is a logical extension of the Toughbook line.

One factor in the committee's thinking was IBM, Xybernaut and Bell Canada's early 2001 test of the Xybernaut Mobile Assistant IV as a tool for telephone company field technicians in the Toronto area.

With over 13.6 million access lines, 2.7 million wireless customers and 5,000 field technicians, most equipped with vehicle-mounted IBM ThinkPad notebooks, Bell South is the largest telephone-service provider in Canada.

While the physical MA IV configurations and software being tested have not been announced, it is unlikely that the Xybernaut device will be found feasible (see Competition section) for this application. Whether used with the company's heads-up display or arm-mounted touchscreen, the Sam Browne-type belt containing the battery pack and computer module would get in the way of the myriad of other tools carried by line technicians and the tangle of cables connecting the system components would be an inconvenience at best and a safety hazard at worst.

Though it is believed that the current Xybernaut hardware is unsuited for this work, a major telco's interest in a non-laptop, no-keyboard solution indicates an unfulfilled technological need waiting for a product such as the wireless display system.

Of note: SBC Communications owns 20 percent of Bell Canada; the Toronto tests were instigated by IBM, offering additional evidence that IBM may be using Xybernaut as a stalking horse in the wearable computer arena (see Competition section).

One area where substantial sales to telephone companies are possible is the construction, relocation and modernization of telephone systems. For these applications the wireless display system's potential is as great as in other parts of the construction industry. (See Applications: Construction.)

Also in the telco area, limited sales of the system as a Toughbook companion product for supervisors who are in and out of their vehicles on a constant basis are envisioned.

Applications: Public Utility; General

Virtually all utilities dispatch vehicles, build, dig, survey, and perform jobs that could be performed more efficiently by either one or a combination of GIS, inspection, data gathering, construction or dispatching technologies (as described in the appropriate sections) on a wireless display system supporting appropriate input sensors and communication protocols.

Ground-Penetrating Radar technology is a relatively new underground mapping solution of specific usefulness to a great many utility companies of differing types.

Developed by Geophysical Survey Systems and a consortium of utility companies, the Pathfinder Utility Mapping system is a lawn-mower-like device which is manually moved over the survey area.

Used in conjunction with Differential GPS or laser sensors, Pathfinder can identify and map underground pipes and conduits with up to one-inch accuracy. All sensors are connected to a receiver mounted near the bottom of the “lawn-mower. The receiver interprets the data and would output it to a Flex module located somewhere on the “lawn mower” via the unit’s serial port. The wireless display-screen would be attached to the “mower’s” handlebars.

CAD- and AutoCAD-compatible, the Pathfinder System is suitable for numerous tasks including right-of-way inspection prior to entrenching operations, guiding boring crews, and preventing potentially life-threatening damage to existing gas or water mains. Its ability to quickly identify and precisely locate underground obstacles and hazards should also significantly increase productivity in many areas of utility operations.

Applications: Warehousing

Automation came early to the warehouse industry with the convergence of barcode and computer technologies enabling the creation of highly sophisticated inventory-control systems.

Many of these are based on single-purpose computing devices, including such items as hat-mounted barcode scanners. Other solutions utilize full-function portable computers with an external scanning wand. Most are based on barcode scanning; a few are based on voice input. All communicate with inventory servers in real time using one of a number of wireless protocols.

There are numerous ways in which the wireless display system could be integrated into existing systems to make them more efficient or cost-effective. Exploiting those opportunities, however, would have to be done on a case-by-case basis with Panasonic sales agents analyzing a company's current system and identifying areas where the Flex would be superior to the current hardware.

A close look at the warehousing industry reveals that there are some areas in which full automation has yet to be achieved. In many companies one of these is the removal of product from inventory after it has been sold.

Mass merchandisers and catalog-fulfillment companies make money by processing orders and shipping product as quickly and efficiently as possible. Inefficiency invariably leads to increased labor cost and unhappy consumers. And, in many cases, the actual transfer of funds from the customer's credit-card account to the merchant cannot legally be made until the order is shipped.

To achieve maximum productivity, a pseudo-assembly-line process is used. Regardless of how it is received (phone call, Internet, fax, or mail), an incoming order goes to a processing center where the amount and method of payment is noted and approved and the order is entered into the computer system. From there it is automatically forwarded to the accounting, inventory, shipping, and other related departments,

On the warehouse floor, an inventory picker working from a printed job-order list locates the item, swipes it with a barcode reader to subtract it from the inventory database, and hauls it to the shipping department. When he fills all the listed orders, he goes back to the dispatcher and gets a new set.

Using the Flex system, jobs would be automatically relayed to the picker along with visual directions to the exact location of the particular item. If the picker has room on his forklift or cart for more items after that pickup, he will be automatically directed to those that are closest to his current location.

A screen tap indicating he has the product would delete it from inventory, eliminating the time-wasting process of twisting and turning boxes to find, reach and scan barcodes.

Since the weight, size and other salient information about each product would already reside in the server, shipping charges based on the customer's choice of method would be calculated automatically. A small wireless printer mounted near the picker's location could be used to generate an adhesive-backed shipping label. The picker would attach the label, take the product(s) to shipping, tap the screen, and get his next on-screen job ticket.

Attaching the labels would take pickers a few seconds (probably under 20), but that would be offset by increased shipping-department productivity.

Accountability, who picked up what and when, would be builtin and virtually unerring.

Value-Added Resellers

According to a survey by VARBusiness magazine, approximately 25 percent of all VARs will focus their efforts on providing consulting services in 2001, with that percentage increasing annually for the foreseeable future.

We consider this shift in the VAR business model a positive development in marketing an advanced product like the Flex because it gives VARs—traditionally considered implementers—an added dimension as technological gurus. In this role, their influence in decisions about adopting new technologies will almost certainly be greater than when they were almost entirely devoted to providing solutions for known problems.

The Committee therefore recommends that Panasonic consider expanding its relationships with vertical-market VARs as a beneficial and logical component of the Flex marketing process.

As one Committee member put it, “Relationships with VARs and their ability to make money packaging your hardware with their options, software and support can be a significant factor in the launch of a new product.”

VARS: Suggested Initiatives

-- Survey VARs for suggestions on how Flex can best be integrated into the markets they serve. Exploit their desire to grow their business by adding an advanced new hardware product to their arsenal of solutions, by having them research their customers’ needs and uncover what configuration, application and peripheral options will be needed to sell to those companies.

-- Schedule an orientation tour in which a sales team visits VARs, demonstrates prototypes, and brings them up to speed on the system’s abilities, longevity and high potential profit margins on both the base system and later peripherals. Where advisable, the sales team could also visit key clients with the VAR and demonstrate how the wireless display system could extend the reach and efficiency of that company.

Future Technology

As has been demonstrated during its prototype development cycle, the technology driving the Flex system is constantly being refined, a condition the Committee—based on the history of the Toughbook notebook line—believes will continue throughout the life cycle of the product.

Trying to predict where this process of continuous development might lead over time is beyond the scope of this report and, indeed, beyond the powers of anyone without the knowledge of a world-class technology engineer and the clairvoyance of an ancient prophet.

There are several areas where next-generation technology overlaps today's marketing opportunities, however, and the Committee feels these are worthy of a brief discussion.

Voice Recognition Output and Audio Input

Military conflicts are generally very noisy and a speech recognition-based interface will be useless if commands spoken by the soldier cannot be recognized over the din of war.

-- Peter Fisher, Army Research Laboratory

Though noise surrounds us everywhere, most applications for which the Flex is intended are nowhere near as noisy as a battlefield.

Throughout our study of the potential market for a wireless mobile-computing system similar to the Flex we found a very strong desire for a hands-free solution that would allow users to interact with the system while continuing manual tasks like parts assembly.

The many voice-recognition technologies currently available can be roughly divided into two groups, software solutions and software-plus-digital-signal processing-chip solutions.

Of the two, the software-only solution costs less and can be user-implemented at anytime. Its shortcomings include slow operation and an inability to accurately recognize individual voices without a long, tedious training period. (A subset of software voice-recognition systems, usually embedded in specific applications, attempts to overcome this by limiting the system's "vocabulary" to a small number of command and response words.)

DSP-enabled voice-recognition programs, such as those used for telephone reservation, banking, and brokerage services, generally achieve 90-plus percent accuracy without training, respond quickly and would generally be a superior solution when more than one user would be using the system.

There is also the issue of preserving the wireless nature of the Flex system. The Committee recommends one of two solutions:

-- Creation of a miniature-battery-powered, ergonomically correct headset featuring a microphone and earphone linked to the Flex module by a wireless analog audio protocol.

-- Adding a small speaker and a noise-canceling microphone to the display-screen component.

Heads-Up Display Technology

Though the Committee believes that the current demand for a heads-up display option is not as great as that for voice-recognition technology, there is no doubt that eyes-free, as well as hands-free, operation is an option some potential users want now and more will want in the future.

Law-enforcement officers wearing riot gear, emergency or industrial workers who must wear protective helmets, battlefield soldiers, front-line firemen and others in hazardous occupations are simply not able to use any portable computing system without a head-or-helmet-wearable display.

As a first step in providing one, the Committee recommends development of a monocular, see-through display system based on sports-goggle design. Such goggles are easy to pull on and off, sealed against dust and dirt, and stable even when the user is in rapid motion.

Also, the broad elastic band common to sports goggles could easily support a miniature transceiver and battery pack enabling the display to operate without a wired connection to the module.

Appendix I: Opinion Leader Committee Members

Elliot Borin, a veteran writer, editor and analyst in technology and marketing, is vice-president/marketing of International Brands, Inc. Prior to joining IBI, he was editor-in-chief of *Portable Computing* magazine and *PC Laptop* magazine. Educated at Michigan State University and the Golden Gate School of Law, Mr. Borin is a frequent contributor to *Knowledge Management*, *Field Force Automation*, *CRM* and other publications.

Prof. Steven K. Feiner, Phd, directs the Computer Graphics and User Interfaces Laboratory at Columbia University. His research interests include knowledge-based design of graphics, user interfaces, virtual worlds and augmented reality, animation, visual languages, image synthesis, hypermedia, and visualization. Dr. Feiner is coauthor of *Computer Graphics: Principles and Practice* (Addison-Wesley, 1990.)

Jack Gold, vice-president of META Group's Web & Collaborative Strategies Service, specializes in research and analysis in the areas of intranet and LAN management, mobile computing, help desk support and training, client platforms, mobile platforms, telecommuting and related areas. Before joining META in 1993, he was an independent technology consultant, founder and executive officer of PCS Systems.

David Mack, president of Technology Business Research, leads that company's consulting practice in the areas of market, product, channel and technological opportunities for major vendor corporations. Prior to the formation of TBR, Mr. Mack established the consulting division at Yankee Group. Mr. Mack has authored or contributed to well over 200 studies in such research areas as imaging, printing, advanced memory systems and other lead-edge technologies.

Michael McGuire is a principal analyst in the Mobile Computing section of the Gartner Group's worldwide Computer Systems and Peripheral Group. His areas of special interest include portable computing, data communications, systems components, information services, software and consumer electronics.

Brian Nadel, editor-in-chief of *Mobile Computing and Communications*, is a 1984 graduate of the Science and Environmental Reporting Program at New York University and a former senior editor at *PC Magazine*. During his 15-year career in technology journalism Mr. Nadel has served as associate editor of *Business Tokyo*, automotive editor of *Popular Science* and a news writer for the NBC Radio Network.

G. Matthew Snyder, Technology Clearinghouse Administrator of the International Association of Chiefs of Police is a 1992 graduate of James Madison University. Mr. Snyder served as an officer in the Waynesboro, Virginia, Police Department and as a Military Police Drill Sergeant in the U.S. Army Reserve prior to joining the IACP staff. He received a 1999 Federal 100 Award for his work in founding the Clearinghouse and initiating the Advanced Law Enforcement Response Transport system.

Tom Steele, Maryland State Police Chief of Information Technology, is former Commander of Automated Systems of the Alexandria, Virginia Police Department, where he implemented one of law-enforcement's first non-vehicle-docked wireless remote data access systems. After leaving Alexandria and before joining the MASP, Mr. Steele was on the staff of the Capital Wireless Integrated Network project, a partnership between the States of Maryland and Virginia and the District of Columbia to develop an integrated transportation and criminal justice information wireless network.

Appendix II: Company Contacts

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Cerulean Technology, Inc.
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Communication Intelligence Computer Corp.
275 Shoreline Drive, Suite 500
Redwood Shores, CA 94065-1413
1-650-802-7888

Comtec Information Systems
30 Plan Way
Warwick. RI 02886
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Condor Earth Technologies, Inc.
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Sonora, CA 95370
1-209-532-0361

Eagle Law Enforcement Systems
1333 West Campbell Road
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Richardson, TX 75080
1-972-690-8050

EDS
5400 Legacy Drive
Plano, Texas 75024-3199 USA
1-972-604-6000

Fujitsu PC Corporation
5200 Patrick Henry Drive
Santa Clara, CA 95054
1-408-982-9500

Geophysical Survey Systems Inc.
13 Klein Drive
North Salem, NH 03073
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Guidance Software, Inc.
572 East Green Street #300
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IBM Corporation
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Walkabout Computers
2655 N. Ocean Drive
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Welch Allyn Medical Products
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