IT@Intel White Paper

Intel IT
Mobility
Tablets
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Deploying Tablets Safely in Manufacturing to Boost Productivity

Intel IT is currently deploying ruggedized Intel® architecture-based tablets and Ultrabook™ convertibles for use in Intel's manufacturing environments and tool install design office.

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Executive Overview

To increase business productivity, Intel IT conducted multiple proof of concepts (PoCs) to identify business, safety,[1] and ergonomic requirements for the use of mobile devices, including tablets, in our manufacturing environments. We provided feedback to external suppliers on specifications for ruggedized and intrinsically safe[2] Intel® architecture-based tablets. Using these mobile devices, as well as Ultrabook™ convertibles, will help to boost employee productivity in Intel factories, warehouses, security areas, construction sites, clean rooms, and tool install design office, where using a standard laptop PC is unsuitable.

Our PoCs showed standardization benefits in efficiency, accuracy, and savings in time and costs from using tablets, including the following:

- Facility technicians reported an increase in productivity of up to 17 percent, based on the number of completed work orders
- Factory technicians setting up thousands of tool parameters noted that the process was more accurate with tablets than using print versions
- One PoC reported over 300 pages per tool of printing saved by using online information, along with 30-percent time savings

While in many cases tablets improved efficiency, our research showed that the tested devices were not always a perfect solution. Constraints in many of our manufacturing environments require form factors not yet commercially available. As a result, the devices used in the PoCs often lacked critical features important for the workflow and ergonomics. A team of environmental health and safety engineers, along with ergonomists, analyzed both device usage and work environments to produce detailed recommendations for tablet use.

We are deploying ruggedized Intel architecture-based tablets for use in Intel's manufacturing environments and tool install design office. For some employees, the right fit will be business Ultrabook convertibles[3]; for others, tablets certified as intrinsically safe will be required.

Tablet options will evolve as we continue to work with suppliers to produce enterprise—rather than consumer—versions that fully meet Intel requirements for weight, intellectual property (IP) protection, security, battery life, and other key attributes. This combination of research, discussions with suppliers, and risk mitigation enables Intel to extend mobility to specialized environments safely and further drive Lean processes.

[1] *Safety* refers to both the use of IT equipment and the actual work environment in which the equipment needs to be used.
[2] *Intrinsically safe* devices ensure that the available electrical and thermal energy in the device is always low enough that the ignition of a potentially flammable atmosphere cannot occur.
[3] See "Deploying Business Ultrabook™ Devices in the Enterprise," January 2013.

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BACKGROUND

Intel IT embraces consumerization and mobility as a way to boost employee productivity. Intel employees report saving an average of 57 minutes daily using mobile computing devices, adding up to an annual productivity gain of about 5 million hours.[4] However, employees in some areas of Intel's business have not been able to take full advantage of the benefits of newly available mobile computing form factors, such as tablets, because the currently available consumer devices do not meet our enterprise requirements.

Over 80 percent of Intel employees use mobile computing devices including tablets. The use of portable tablets with touch screens can increase employee mobility and productivity, enabling them to work more efficiently in places where it is unsuitable, inconvenient, or impossible to take their laptop. Employees who travel frequently or spend most of their time away from desks appreciate the portability and connectivity speed of tablets or other mobile devices. These employees cite productivity increases from being able to move between meetings or work sites with instant-on response. They also enjoy the availability of a variety of input methods; some models include touch, a keyboard, a mouse, or a stylus—and in the future—gesture and voice.

As part of our multi-year effort to adopt Lean manufacturing processes, Intel IT has investigated using mobile devices to increase employee productivity and organizational velocity within our design and manufacturing operations, such as factories, clean rooms, and construction sites (see Table 1). Many employees working in our factories and other specialized settings are highly mobile and have specific workflow and safety requirements.

Depending on their role and work environment, these employees may have a desktop or laptop PC or workstation as their primary computing device; some even use tablets as a primary device. In some cases, employees share a computing device with other employees in the same work group.

In a recent proof of concept (PoC), facility technicians reported a productivity increase by using tablets of up to 17 percent, based on the number of completed work orders.[5] Other factory technicians use tablets to access work applications remotely to follow up on work orders or to access instructions while they work next to the equipment. The improved standardization of task performance aligns with Lean process goals and boosts efficiency. In addition to increasing productivity, Intel employees report increased job satisfaction when they are able to use the device that is best suited to their work needs and environment.

Until recently, most "standalone" tablet models—as opposed to the business Ultrabook™ convertibles—have been designed for the consumer market and are intended to be used in a non-business environment. Because these types of consumer tablets are being used primarily as inexpensive media consumption devices, raw processing power and information security are not as important for this type of content distribution platform.

Employee workflows in our manufacturing and other specialized environments require form factors that have not been readily available on the consumer market. Consumer tablets are not designed to be used outdoors, carried long distances, or operated 24 hours a day, as in a factory environment. In addition, consumer models tend to change rapidly, with new models being introduced annually to meet consumer demand, which makes them difficult to support long-term in an enterprise environment.

[4] See 2012-2013 Intel IT Performance Report.

[5] See "Improving Facility Operations with Intel® Architecture-based Tablets," August 2012.

Tablet Model Variations Meet Differing Needs

Tablet is a term that covers multiple mobile devices that vary in purpose, power, size, and portability.

The **slate** type of tablet is one representation of the tablet PC. It is basically a flat computer screen that can be placed on the desk. On-screen manipulation is done with a stylus instead of the conventional keyboard and mouse. The slate can be used as one would a piece of paper that can be handwritten on directly; no typing is required. A keyboard and other accessories can be used but are not built in. Slate tablets can be either a consumer or enterprise device and come with 64-bit processors while traditional tablet PCs are typically Intel® Atom™ processor-based devices.

The **convertible** tablet is a hybrid of a laptop and a tablet. The screen can be flipped open and manipulated by using the attached keyboard and touch pad. Convertibles are designed to convert from a laptop to a tablet. These models feature screens that slide, detach or rotate, where the keyboard and screen can be configured in different, model-specific ways. Most convertibles have built-in Wi-Fi* capability for accessing the Internet. Some convertibles are designed for consumers; others for enterprise use.

On some convertibles, the screen swivels 180 degrees and can be set down over the keyboard so a stylus can be used like a slate tablet. The business Ultrabook™ convertible devices Intel is deploying[+] to employees can allow the screen to detach from the keyboard, so an employee can carry just the screen and use it as a tablet. Not all convertibles are **detachables**.

Rugged or *ruggedized* tablet PCs are versatile. They can withstand excessive heat and perform equally well at below-freezing temperatures. They can be dropped onto hard surfaces and are not easily damaged by the dirt and debris encountered at manufacturing facilities and construction sites. Rugged tablets generally meet military standards and international protection ratings for vibration, drop, dust, humidity, and water protection. As a result of this extra protection, rugged tablets weigh more than standard tablets and are predominantly enterprise devices.

Intrinsically safe tablets are a special category of PCs that are certified to include protection standards when used in potentially explosive atmospheres, commonly called *hazardous locations*. These tablets are usually ruggedized because they are designed for industrial environments, but not all rugged tablets meet these specific safety specifications and approval ratings.

Some popular, strictly **consumer** tablets are not truly computers because they don't run a full OS such as Microsoft Windows*; they use a limited version of a mobile phone OS. These tablets—often a type of note pad or reader device—are not as powerful or functional as a "true" tablet computer, but they are much lighter, less expensive, and usually come with built-in 3G broadband modems.

The size and weight of a tablet (including convertibles) influences whether one model is the right choice for a particular use. For example, 10-inch screens offer high detail and legibility for reading and creating documents but are not designed for carrying in pockets. Seven-inch screen tablets are typically light and easy to hold but can crowd screen objects and are also not designed for pockets. Five-inch screens are highly portable but can make browsing and typing difficult. The latter are often the popular consumer models mentioned above and are more like mobile phones than laptops.

Slate Tablet
Flat computer screen; input is done with a stylus

Convertible Tablet
Hybrid of a laptop and a tablet; input is done with attached keyboard and touch pad

Ruggedized Tablet
Able to withstand excessive temperatures, are not easily damaged by dropping or dirt and debris

Intrinsically Safe Tablet
Similar to ruggedized tablets; however, they are certified for hazardous locations

Examples of four tablet types.

[+] See "Deploying Business Ultrabook Devices in the Enterprise," January 2013.

With a goal to increase employee productivity and improve workflows, we researched use cases and conducted PoCs to identify requirements for enterprise mobile devices that are fit for purpose, safe, and meet ergonomic requirements for the situations in some of our work environments. Fit for purpose refers to the ability to meet business requirements and handle special conditions, including adverse weather, dusty or wet work environments, security restrictions, and the potential for dropping or damaging the tablet.

While employee needs vary, we wanted to minimize the number of tablet platforms deployed in the field to reduce support costs. To do this, we needed to clearly identify the appropriate requirements and select devices that had the flexibility to support multiple use cases. Our process included evaluating devices, engaging with our internal customers to learn about typical work situations, conducting PoCs, and then analyzing the results and employee feedback.

The results from our PoCs helped us develop a list of requirements for tablets and convertibles, including ones that will improve ergonomics and safe use of these devices at Intel. After consulting with suppliers and providing feedback on specifications, we intend to deploy models of ruggedized Intel® architecture-based tablets within some areas of our manufacturing operations, as well as the business Ultrabook convertibles. We are also planning future PoCs to continue to research requirements and address the potential areas where we can improve employee productivity and organizational velocity using tablet and convertible form factors.

RESEARCHING AND DEFINING REQUIREMENTS

Through our multiple PoCs, internal research on use cases, and product research, we identified the business, safety, and ergonomic requirements for enterprise tablets and business Ultrabook convertibles in our manufacturing and specialized environments. We provided input to external suppliers on design specifications for tablets that meet our enterprise needs. Our discussions with suppliers on intellectual property (IP) concerns, use cases, ergonomics, and support models have resulted in increased suitability of devices that support our enterprise needs.

Extending Mobility Safely to Manufacturing Environments

Many Intel employees within manufacturing work in specialized, non-office environments. These include construction, warehousing, and flammable substance environments, as well as factories, assembly and test sites, and clean rooms. Additionally, while on patrol, the mobile security staff have specialized requirements.

In the factories alone, technicians complete over 60,000 planned maintenance activities each year.[6] Often these workers must rely on paper processes or other methods to retrieve information to do their work, because the available compute devices do not match their workflow needs. These workers have special needs for devices to be field-ready and fit for purpose.

Battery life, size, weight, and ergonomic features are all important mobility and safety requirements. Other requirements include the appropriate accessories, carrying handles, a rugged, waterproof exterior, and, for security reasons, an absent or disabled camera to protect IP within our manufacturing facilities.

[6] See "Improving Facility Operations with Intel® Architecture-based Tablets," August 2012.

Matching the Solution to the Environment

Each of our specialized, non-office work environments involves special use cases that require the appropriate device in terms of workflow, safety, and ergonomic ease of use. While conducting 19 PoCs across the company in different geographical and work settings, we gathered the details of our customer requirements and feedback on available tablets. Examples of use cases included the following:

- Mobile campus security employees testing rugged tablets
- Construction workers reviewing project details with tablets
- Engineers using tablets in meetings within clean rooms
- Technicians using slate tablets to carry out configuration and maintenance tasks within clean rooms
- Facility equipment control employees using intrinsically safe tablets that comply with applicable safety regulations
- Tool qualification technicians using rugged tablets

Our primary goal for these PoCs was to understand the business needs for each use case in order to provide the appropriate device for the user. We researched how employees currently performed their jobs and in what circumstances the use of a tablet might increase their productivity. We also needed to ensure the tablet could be used safely within the environment and with proper ergonomics.

Once we understood the business requirements and potential value of using mobile devices to improve workflow, we examined what was available, how the devices and applications could support process improvements, and whether we could deliver an appropriate solution.

Table 1 outlines some of the challenges and constraints employees face in using computing devices within a variety of manufacturing environments at Intel.

Proof-of-Concept Challenges

We encountered several challenges during our PoCs, which focused on a variety of form factors, including traditional laptops, consumer tablets, rugged tablets, intrinsically safe tablets, and slate tablets.

The consumer tablets used in the PoCs were not designed for enterprise use or for the specific use cases in our manufacturing environments. We modified these consumer tablets prior to testing to address Intel's security requirements. Because of IP concerns in our manufacturing environments, we disabled the tablets' cameras. Other IP concerns included management of the data potentially stored on the devices and how the data is transferred to and from the device. To address this, we created an engineering build with multi-user logon capabilities (see sidebar).

Table 1. Examples of Specialized Workplace Challenges

Environment	Employee Profile or Task	Challenges and Constraints
Factory, including the Clean Room	▪ Technicians suited in head-to-toe clean room suits and gloves; elaborate robing and disrobing protocols ▪ Technicians performing tasks, including maintenance and tool qualification, in various postures	▪ No place to set things down, except on the floor ▪ Carrying bag must be site-approved ▪ Likelihood of dropping the device due to low friction between suit sleeves, gloves, and device ▪ Latex gloves with underliners may not work well for tapping tasks with a tablet; need a stylus ▪ Equipment must meet clean room specifications ▪ Devices cannot be recharged in the immediate area ▪ To preserve intellectual property (IP), cameras are not allowed
Construction and Facilities	▪ Employees moving from one area to another as necessary, often carrying tools	▪ Dusty, dirty sites could affect device performance ▪ WLAN connectivity is often limited, such as at sites under construction or in remote locations on site ▪ Outdoor conditions such as rain affect visibility, usability, and device durability ▪ Equipment susceptible to physical damage ▪ Must often hold the device while standing; ergonomic guidelines required ▪ Gloves may be required either because of regulations or temperature; need a stylus ▪ Must often hold or transport devices, such as in confined or restricted areas or carrying up ladders
Flammable Materials Areas	▪ Workers in or delivering materials to these areas	▪ Specialized safety requirements for devices that could ignite flammable materials ▪ Devices not allowed in certain safety perimeters ▪ Chemical-resistant gloves reduce accuracy for tapping and lessens grip on device ▪ Potential contamination of device with chemicals

Sharing Tablets to Reduce Costs

Because mobile devices are often used as companion devices for Intel employees, using a shared pool of devices in our manufacturing work environment offers many benefits. Ruggedized devices can be multiple times the cost of standard consumer ones and intrinsically safe versions are even more expensive. By sharing a single device across multiple shifts of workers, initial investment costs are reduced and capital equipment costs are avoided. Managing fewer devices also helps to reduce support and refresh costs.

Sharing devices involves taking additional precautions prior to deployment. In order for employees at the ends of their shifts to transfer the tablets to others employees, or to return the device to the toolbox, any personally generated documents or information such as emails must be properly encrypted and inaccessible to the next user.

To do this, Intel IT created multi-logon engineering builds to support multiple users. We developed authorization and authentication procedures that match our existing processes for laptops. For example, we used a process where a user signs in and out of their personalized account. This approach enabled more employees to participate in our tablet proof of concepts, which provided additional employee feedback and helped save time and reduce costs.

Common Requirements

The PoCs helped us develop a list of common requirements for mobile devices across a variety of use cases within our manufacturing environments. These requirements include gathering, accessing, or transmitting data at the point of service or point of activity.

For any proposed solution, we determined that the device must include the following capabilities:

- Meet Intel IT safety, security, and ergonomics standards
- Be designed for enterprise use and for the enterprise lifecycle
- Have an efficient touch screen that is usable with latex gloves and have suitable processing performance
- Be durable and water resistant, for devices used outside of the office environment
- Have long-lasting battery life or hot-swappable batteries for continuous power

By design, rugged tablets are sturdier and heavier than typical laptops. For use cases where weight is a factor, the convertibles used must not weigh more—and ideally weigh less—than a typical laptop, which is about 3 pounds (~360kg).

In addition to ergonomic and environmental considerations, Intel has specific tablet hardware and software requirements and specific OS and build requirements. Security includes controls for authorization, authentication, access, encryption, and disabling the camera, as well as physical locking.

A tablet must also have the following capabilities for our manufacturing environments:

- Ability to be used on WLANs or cellular networks, if a WLAN is not available
- Allow direct connectivity to our enterprise network and applications
- Support Intel's enterprise Microsoft Windows*-based applications

Another requirement is a stylus must be connected to the device to avoid loss.

Safety and Ergonomic Considerations

Intel continuously improves its safety program, evaluating and addressing risks to enhance workplace ergonomics and overall employee safety. The compact nature of handheld devices poses unique ergonomic challenges, which must be managed effectively to avoid injury or accidents. Terms such as "tablet shoulder" and "gorilla thumb" commonly refer to the ill effects that can stem from the overuse of devices with poorly designed ergonomics.

Prior to device selection and during our PoCs, we studied the safety and ergonomic aspects for tablet use in our manufacturing environments. We developed safety requirements to help narrow the selection of the devices, as well as guidelines for using tablets safely.

Early in the PoC program, Intel IT evaluated the ergonomics of multiple devices to reduce the number of choices and better understand the issues associated with mobile devices. Eventually, we chose a device for the clean room and fabrication center, as well as a ruggedized one used in the facilities, which are specialized locations outside the factory floors and areas between factory buildings. A separate PoC with maintenance technicians addressed the safety concerns with using an intrinsically safe device.

Our first step was to identify unique ergonomic challenges during our PoC tests through direct observation. Partnering with the key stakeholders resulted in a robust process for risk management while following currently available best practices and meeting local workplace safety regulations. The ergonomic factors included the following:

- Tablet weight during transportation
- The correlation between tablet weight and postures during use
- Standing and sitting postures during use
- Use of accessories
- Legibility of text on-screen
- Use of gloves
- Cognitive overload and distraction of the work setting and device

Intel experts in environmental health, safety, and ergonomics produced detailed recommendations to address the risks associated with these factors (see Table 2). For example, even though tablets are perceived as a lightweight device, how they are carried or held may result in user discomfort. These experts advised employees on how to carry and hold the devices.

Table 2. Examples of Recommendations for Ergonomic Safety

Factor	Risk	Recommendation
Device Weight	▪ Holding heavy devices produces stress and fatigue	▪ Investigate using stands or jigs to hold devices ▪ Place tablet on a surface at regular intervals ▪ Do not use a tablet without support for tasks that require continuous standing
Posture	▪ Awkward postures result in fatigue after short periods ▪ Using a touch screen when seated can produce static shock	▪ Work in portrait mode to focus more on the top of the screen ▪ Vary posture and the distance to the screen ▪ Use a stylus to reduce static shock
Accessories	▪ Dropping or damaging the device ▪ Tripping or neck strain ▪ Losing the stylus	▪ Wrist straps can help prevent dropping ▪ Avoid using neck straps as these can impose additional neck forces and trip hazards ▪ Use a stylus that is attached to the device
Gloves	▪ Poor friction between gloves and the device ▪ Poor interface with the screen and functions	▪ Wrist straps can help prevent dropping ▪ Use a stylus to access smaller areas of the screen

Our recommended specifications include maximum weight for a tablet and guidelines on how long devices should be used in different postures.

For those who hold the device while using it, varying the postures is the key to minimizing user fatigue. Other suggestions for ergonomic safety include using a stand or a jig, how to grip the device, and postures to avoid. For those who stand while using the device, we developed guidelines that cover time periods and breaks. For those who sit during use, we made recommendations on elevation, wrist posture, accessories, and viewing angles to minimize risks.

Screen visibility and legibility are key aspect of usability. We recommend that our tablets have a matte surface to minimize glare from bright sunlight or overhead lighting.

Results and Employee Feedback

Across the 19 PoCs conducted, employees reported a variety of advantages to using tablets, including highlighting the need for companion devices in Intel manufacturing environments. The feedback varied depending on the user's past level of experience with tablets. Overall, 85 percent said the PoC experience was better than the current device or methods they used[7] (see Figure 1). Some use cases involved employees who previously did not have a compute device, such as those delivering goods to flammable materials sites, where special safety regulations are in place (see sidebar). For other use cases, employees used rugged devices or laptops in the PoC but not for every task.

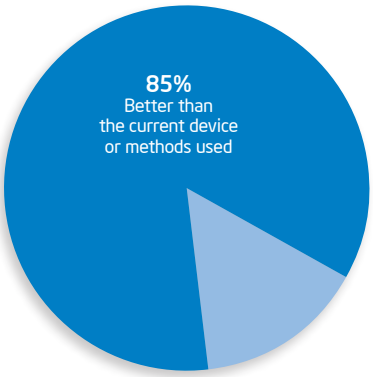

Figure 1. Eighty-five percent of participants said using a tablet was better than the current device or methods they used.

[7] Interestingly, although younger employees are generally portrayed by the high-tech industry as more likely to be early adopters of technology, we did not experience any age-related correlation to whether a participant in the proof of concept liked or disliked using a tablet.

Safety Requirements for Potentially Flammable Environments

Intel has work zones where special safety precautions, including meeting ATEX[§] requirements, must be followed. In particular, all equipment used in areas classified as containing flammable materials[Δ] must be designed and constructed to prevent the possibility of ignition. This can limit the type of compute devices allowed in use, and where.

We investigated a specific work environment where workers load or unload flammable materials from tanker trucks—outdoors and in all weather conditions—to see if new technology could be used safely to streamline existing procedures. Because of the hazardous nature of the work environment, technicians wear chemical-resistant coveralls, face shields, safety glasses, and chemical-resistant gloves.

No technology devices, including smartphones, are permitted in a perimeter around the loading area because they are a potential source of ignition. Based on risk assessments, procedures require the technician to remain with the truck throughout the loading process. As a result of the risks, the technician must use an ATEX-rated radio to call a colleague for information on loading rates and other details. The colleague then accesses information on a workstation and reads the appropriate data to the technician.

While this process follows all the safety guidelines, it is time-consuming and ties up two employees for a single job. If technicians cannot contact colleagues on the radio, they have to stop the process and return to the nearest workstation to check for the data. Poor radio communications and the potential for interference between different conversations can compound the problem.

Intel IT performed a proof of concept (PoC) with an intrinsically safe, ruggedized Intel® architecture-based device. The technician could safely access all the necessary information from an area about 32 feet (10 meters) from the truck, outside the safety perimeter, eliminating the need to use a second resource during loading or unloading.

The findings from the PoC, where the task was made Lean and safe at the same time, enabled the successful rollout of an intrinsically safe, rugged device suitable for outdoor use. We are providing this solution to other Intel sites, including factories, for use in production processes.

[§] The ATEX directive consists of two European Union directives describing what equipment is allowed in an environment with an explosive atmosphere. ATEX derives its name from the French title of the EC directive: *Appareils destinés à être utilisés en ATmosphères EXplosives.*

[Δ] Examples of such substances include solvents, such as acetone and ethanol.

Employees generally agreed that having the compute device at the actual point of activity is an advantage. Employees enjoyed being able to complete their tasks more quickly and effectively. In fact, many PoC participants didn't want to return the device.

Users noted benefits in efficiency, accuracy, and savings:

- "On three separate occasions, I was able to quickly pull up [the application] to stop a tool from going down."
- "Doing the procedure [at the point of activity] makes my work much more accurate."
- "We saved an estimated 300 pages per tool of printing, along with a 30-percent time savings."

However, according to some of the employees, the tablets were not a perfect match for all use cases largely because the ones we used in the PoCs were not specifically designed for their particular use case. For example, the tablets tested were not ruggedized or designed to be used outdoors in inclement weather. The tablets were unsuited for dirty, dusty construction sites or wet conditions. Overall, battery life, size, weight, and ergonomics, as well as an operating system not designed for touch, were the key points of dissatisfaction for employees in some of the PoCs.

One surprising response from a few technicians was that some maintenance tasks actually took longer because with tablets they were following standard step-by-step procedures. With a compute device at the point of activity, technicians were more likely to carry out the specific task the same way each time. And when new or unusual conditions arose, technicians had the ability to access reference materials quickly and make appropriate and accurate decisions.

Typing on tablets with gloves presented problems, particularly for those doing extensive typing in forms and other word-processing applications. Intel automation systems are not yet designed for touch, which meant switching to a stylus or keyboard. The stylus was sometimes lost or not available when needed. These factors required employees to use keyboards and mice, which increased the cost and number of components. As more automation systems are designed to take advantage of touch capabilities, these usability issues should decrease. For now, the need for a keyboard suggests that a business Ultrabook convertible is a better fit for such a task.

> "We saved an estimated 300 pages per tool of printing, along with a 30-percent time savings."

Currently, no tablet on the consumer market features a battery life than can last an entire shift of 8 to 12 hours. Therefore, until the market matures, technicians have to either recharge their devices during their shifts, typically during a break, or have extra rechargeable batteries on hand. However, several enterprise devices now include extended-life or hot-swap batteries, which help overcome one of the main drawbacks associated with laptop usage.

As a result of these drawbacks, less than three-quarters of users (69 percent) rated the test devices as acceptable for use. This does not pass Intel IT's product standard goal of 80 percent. We included this feedback in our conversations with mobile device suppliers.

We concluded that tablets have a great potential for improving employee productivity and organizational velocity, but those currently available don't fully meet our requirements for general use cases. This unavailability led to including business Ultrabook convertibles on the device roadmap for manufacturing employees as a standard supported device. More specific use cases highlighted the need and value of rugged tablets, which were available to meet requirements.

Evolving to a Better Fit through Discussions with Suppliers

Based on the research conducted during the PoCs, we identified the business and safety requirements common to a variety of use cases. Intel IT recognizes that different form factors are required for different needs and environments; one size does not fit all. However, to minimize the number of tablet form factors and support costs, we wanted to find enterprise tablet versions that met multiple needs.

Our discussions with suppliers over the last several months about IP concerns, use cases, ergonomics, and support models have resulted in increased availability of devices to support our enterprise needs. For example, currently all consumer devices on the market include built-in cameras. For the short term, we are encouraging manufacturers and OEMs to provide enterprise solutions that do not include a camera. Future solutions under evaluation should enable managed security control, such as passive radio-frequency identification devices used with software to disable the camera and USB port when entering a restricted area.

More than one tablet is now available with Intel-based architecture and is designed for enterprise use. Ruggedized criteria requires that the device be durable, sealed, and easy to clean and disinfect. It must resist moisture, heat, and dust. The extended battery life and hot-swap battery feature must allow it to stay powered and mobile. Field-ready conditions require tablets to have reduced glare for outdoor visibility with a 180-degree viewing angle. An integrated handle should allow for ease in handling and use while holding.

NEXT STEPS

Intel plans to have tablet form factors available to employees—intrinsically safe, rugged, and convertible—with availability depending on geography. Some employees will be able to use business Ultrabook convertibles; some will require more specialized tablets to meet their environmental and work flow needs.

We are currently acquiring ruggedized tablets for use in Intel warehouses, construction sites, and tool install design office, as well as for the security staff while they are on patrol. In addition, based on positive results from a pilot test, we are providing intrinsically safe tablets for flammable materials areas that comply with applicable safety regulations. Where weight is a factor and a keyboard is needed, business Ultrabook convertibles are a good solution for non-rugged settings.

We found additional ergonomic challenges with the rugged tablet model—whether intrinsically safe or not—because it's heavier. As mitigation, we have modified work environments, including building shelves to hold the device, to enable ease of use by technicians. To help reduce future risks, we plan to regularly reevaluate tablets as the technology progresses.

As we gain additional feedback from our employees using tablets, we will reexamine their processes and procedures to enable Lean work practices and produce additional savings. For example, future interfaces on tablets could be customized by our employees to show only what is needed for their tasks, thus improving workflow and productivity. As applications and user interfaces incorporate more touch features, the user experience will also improve.

Each time we review a new device, we perform an ergonomic assessment that determines if the device is suitable for use and how it should be used. We plan to continue to work with suppliers to provide tablets that are the best fit for the employees working in our manufacturing and other specialized environments. We also plan to use Intel architecture-based enterprise mobile devices with Microsoft Windows 8 and touch applications later this year.

CONCLUSION

Providing the right tablet to Intel employees involves understanding how the tablet will be used, the work conditions it will be used in, and any unique safety and ergonomic factors. Intel IT's research, combined with product evaluation and supplier discussions, identified business Ultrabook convertibles, ruggedized tablets, and intrinsically safe tablets that meet applicable safety regulations as well as our enterprise needs in factories, security, construction, clean rooms, and other manufacturing environments.

The results of multiple PoCs focused on the use of such tablets or convertibles indicate both a desire and need for increased mobility. Bringing the compute device directly to the task, whether outside or in a manufacturing setting, adds great value.

Tablet design will evolve as we continue to work with suppliers to develop enterprise versions that fully meet Intel requirements for weight, IP protection, security, safety, battery life, and other key factors. Our goal is to minimize the number of form factors to deploy and support, while ensuring the right fit for specific workflow and safety needs.

Intel environmental health and safety engineers, along with ergonomists, will continue to analyze available devices and train employees on the optimum methods of tablet use to reduce risk of injury or other issues.

Extending mobility to specialized environments safely promotes Lean processes, increases job satisfaction through improved productivity, and results in time and cost savings.

FOR MORE INFORMATION

Visit www.intel.com/it to find white papers on related topics:

- "Evaluating Ultrabook™ Devices for the Enterprise"
- "Improving Workplace Ergonomics through IT"

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ACRONYMS

IP	intellectual property
PoC	proof of concept

For more information on Intel IT best practices, visit www.intel.com/it.

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