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KASEY PANETTA | EDITOR
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This car has bugs

Consider the following: A modern car has 10 million lines of code. In the programming industry, there is an average of one bug per thousand lines of code. A little math reveals the average car has 10,000 latent bugs.

Yikes.

Even worse? More than 50 percent of auto recalls are due to software bugs.

Worse than that? There are 253 million cars and trucks on the road in the U.S., and cars average out at about 4,000 pounds. Those are some terrifying numbers to hear associated with the words "software bug."

It's scary to think that your car could be hacked—thanks for giving me that to worry about, automotive security industry–but what about bugs that are already in the software of your car?

In this issue of ECN, we explore the world of automotive coding quality.

The discussion must begin with how complicated our cars have become. They now have more processing power than a U.S. Joint Strike Fighter.

In our feature story "Innovating processing power in cars" (pg 12), author John Paliotta writes about the dangers inherent in an industry where a lot of code is written, and problems are not always shared.

But the upside is that brands that promote quality software programs are brands that are going to remain strong in the industry.

Paliotta lays out the framework for companies looking to improve their code and their image. It's all about communication, testing, and ensuring that the product being delivered is as well done as possible.

Until next issue,

Kasey Panetta
Editor
Do you have something you'd like to talk about? Email me at Kasey.panetta@advantagemedia.com or tweet at me @kcpanetta.

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Modular PCB enclosures for use with variations of PCB component configurations

Automation Systems Interconnect, Inc. announces the release of DIN Rail mounted Enclosures for use with variations of Printed Circuit Board (PCB) component configurations. This series is modular in nature and is available in three popular widths - 12.5 mm, 17.5 mm and 22.5 mm to accommodate the particular PCB components being used. Each unit securely mounts onto standard DIN Rail. Simply use a screwdriver to open the enclosure and place the printed circuit board into the modular housing. A matching cover is easily snapped into place and completes the look of the high tech design. The cover has pre-cut slots to accept up to four PCB Headers and Connector Plugs. Snap-in covers are available for unused connector slots. Two pre-cut holes are on the left and right corners.

Additionally, the top of the cover can be modified by the user to fit LED and different connector interfaces. Ventilation is provide by slots on both ends of the PCB enclosure housing which stabilizes air flow and reduces stress on the circuits caused by overheating.

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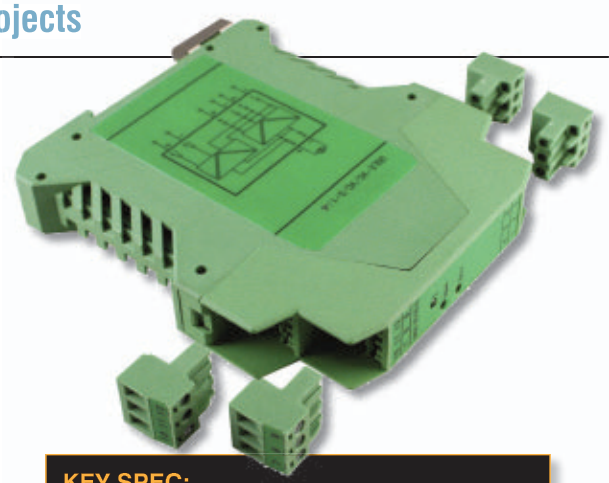

KEY SPEC:
The housing has space for a conveniently located schematic label for quick identification of the circuitry.

Embedded PC weigh less than 3lbs

Saelig Company, Inc. announces the Amplicon Impact-E D 100 - a compact, fan-less embedded PC powered by the latest quad core ATOM™ processor, the Intel® ATOM™ E3845. This small (6.3" x 3.2" x 5.7") and lightweight (less than 3lb) controller is ideal for installations requiring high reliability and where space is at a premium. With a typical power draw of 10W, this embedded system can be powered by either a battery or solar panel when installed in remote installations. Amplicon has carefully chosen the components and CPU family to ensure optimal performance vs. heat and power consumption, so that it will control equipment 24/7 with many years of maintenance-free operation.

For more information, visit www.amplicon.com.

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Wake up time on the International Space Station

The world's most powerful laser

By Jamie Wisniewski, Associate Editor, @JamieECNmag

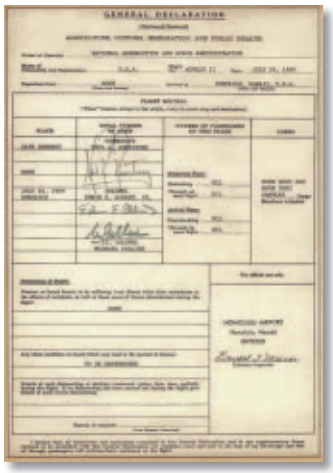
Japan is claiming to have successfully fired the world's most powerful laser. Researchers at Osaka University developed a 2-petawatt laser beam using a device known as the Laser for Fast Ignition Experiment (LFEX). The power of the beam is equivalent to 1,000 times the world's total electricity consumption and it overpowers just about every other system on the planet, following not too far behind the Death Star.

Engineering Update #122: Using whiskers to detect objects

- **Using technology to avoid crowded places**
  Density is a people counter. It's a sensor attached to the doorframe at the entrance of a room or building. It tracks people entering and leaving by using an infrared light and offers real-time and historical data about traffic.
- **3D printed pharmaceuticals**
  3D printed could take on an entirely new meaning when it comes to medical options. The FDA recently approved a 3D printed drug product, the very first time the agency has done so.
- **Using robotic whiskers to detect objects**
  Using whiskers as inspiration, researchers created the Whisker Array-robotic whiskers that could help vehicles or robots to navigate areas that are difficult to manage.

Here is Buzz Aldrin's travel voucher for Apollo 11

By Kasey Panetta, Editor, @kcpanetta


GENERAL DECLARATION

(Source: @TheRealBuzz)

Sometimes even the most awe-inspiring of historical moments have their not-so-exciting bureaucratic requirements. For example, Buzz Aldrin recently posted his travel voucher for one of the greatest moments in aerospace history, reducing a great triumph for man to a sad piece of paperwork. Just to show that not even the men who walked on the moon were excused from the drudgery of governmental procedures, Aldrin assures the world that he too was required to submit a travel voucher.

$490 Million

Price tag for 6 seats on the Russian Soyuz

This is what the Earth looks like from 1 million miles away

By Kasey Panetta, Editor, @kcpanetta

Have you ever wondered what the "dark side of the moon" looks like? Well, wonder no more.

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Innovating processing power in cars

When the quality of your code becomes the quality of your brand.

By John J. Paliotta, Chief Technology Officer, Vector Software

Competition in the automotive industry is intense, and successful companies must constantly innovate by introducing new technology to differentiate and improve their brands. As a result, today's vehicles have evolved from mechanical devices into complex integrated technology platforms with embedded software powering all major systems including: engine control, power train, braking and airbags, driver assistance, and infotainment.

Consider these incredible statistics: today's vehicles have more processing power than any of NASA's early spacecraft, including the Apollo lunar lander. A modern vehicle has more lines of code (10M) than the latest technology in the U.S. Joint Strike Fighter.

These technological changes are affecting automotive brands in subtle ways, as consumer opinions are influenced by their interaction with this technology. In many ways the brand is the user experience, more so than the technical specifications.

Technology defines the brand

A strong brand creates significant value in all industries, and that is certainly the case with automobiles. According to Interbrand's 15th annual Best Global Brands Report, a focus on integrated technology is helping to drive brand loyalty and value for automakers. In the most recent survey conducted, the collective value of the automotive brands appearing on the Global Brands ranking increased 14.6 percent. Three out of the five "Top Risers" listed were from the automotive sector, making the 15th annual report a record-breaking one for the auto industry.

As automobiles evolve from mechanical to software-enabled devices, automakers must rethink fundamental product development principles, including moving from a sequential design process to a more agile approach, with higher degrees of collaboration between self-directed, cross-functional teams.

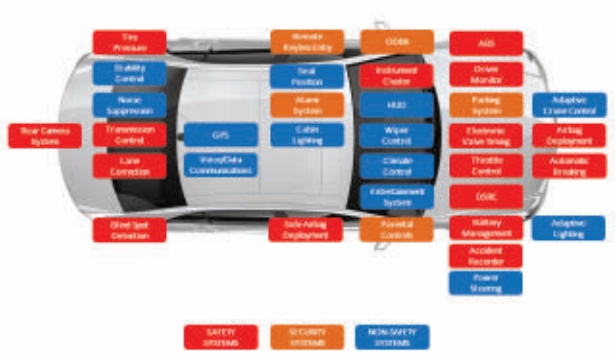

Figure 1: Embedded software powers all major systems of today's automobiles including: engine control, power train, braking and airbags, driver assistance, infotainment and much more. (All figures courtesy of Vector Software).

Software quality must be a priority

Now, more than ever, software quality needs to be at the top of the list for major auto brands looking to preserve – and elevate – brand status.

Statistics show that more than 50 percent of auto recalls are now due to software bugs, not mechanical issues, according to GeekWire. With an industry average of 1 bug per thousand lines of code, the average car has 10,000 latent bugs.

Figure 2: The dashboard in the connected car is similar to a smartphone, making them essentially a "tablet on wheels."

What is the goal of testing?

The first step to improved quality is rethinking the role of testing in the development cycle. Often, the release

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cycle is seen as a zero sum game, where investing more time in testing simply pushes out release dates by the same amount. This mindset neglects the value of these test artifacts over the lifecycle of the product.

This flawed thinking is deeply ingrained in the industry. The first step for organizations searching for improved quality is to start thinking in terms of total lifecycle cost, not simply time to release 1.0. Most organizations have a huge quantity of legacy tests, but often they are not being leveraged properly. The following are common flaws in the implementation of testing:

- Testing completeness is not measured.
- Tests are not easily shared between team members.
- Testing is not automated and continuous.

Measuring testing completeness

Source code coverage analysis is an easy-to-implement way to measure the completeness of existing tests. Measuring code coverage for all types of testing and combining this into a single view provides valuable insight into under-tested and over-tested areas of the application. By understanding gaps in existing tests, users are able to improve testing efficiency, and over time, fill these gaps with new tests. The result is improved application quality.

Sharing tests across teams

Tests are often compartmentalized, with the majority of tests being owned by the Software Quality Assurance (SQA) team. If developers do not have access to these tests, then it is not surprising that bugs are found by SQA late in the release cycle -- after new features are integrated and these tests get run for the first time. The lack of test sharing can also result in an adversarial relationship between developers and SQA as much time is wasted by developers trying to understand bugs, and SQA trying to diagnose test failures. Sharing tests offers a variety of benefits to the whole team:

- Bugs will be fixed on the day they are introduced, not weeks later
- Code changes that break existing tests will not be integrated.
- Team members will focus on edge cases versus nominal path testing.
- SQA will have more time to write new tests.

Automated and continuous testing

The key to creating a sharable testing infrastructure is to ensure that tests are small and run fast, execution is automated and dependable, and results are easy to understand.

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Automated and continuous testing will only work if a common testing platform is implemented across the organization that allows all team members to run existing tests and integrate new tests easily. The tests must capture all preconditions, test values, and expected results so that test execution is as simple as clicking a button and viewing a pass or fail status; and most importantly it must be easy for developers to debug failing tests.

Conclusion

In the 1950's, a revolution in manufacturing quality was initiated by W. Edwards Deming, who taught companies how to produce higher quality products at the lowest cost possible. Central to Deming's philosophy was his criticism of the dominant form of quality control in use at the time: products were inspected for defects only after they were made. In contrast, Deming maintained it was better to design the manufacturing process to ensure that quality products were created from the start.

This seems obvious to us now when we think of manufacturing, but the software industry has been slow to adopt a similar philosophy.

Over the last 50 years, automotive suppliers have revamped design and production processes to control cost, drive quality, and create brand loyalty. These gains may be lost if the same focus on quality is not applied the software that controls the majority of systems in modern automobiles. ECN

Engineering Live (On Demand)

Driverless and talking cars: New technology transforms the way we travel

The U.S. Department of Transportation's National Highway Traffic Safety Administration recently announced its intent to enable vehicle-to-vehicle (V2V) communication technology for light vehicles.

Not only does V2V technology have the potential to improve the safety of road travel, but it also has the potential to reduce environmental impacts and slash travel time.

To help provide us with some insight on this topic, we talked to several experts at IMS2014 involved with test and measurement, power solutions, research and development, IC components, and module solutions. The experts included:

The panelists answered questions on safety concerns, security issues, test and measurement, power, connectivity, standards and protocols, as well as retrofit solutions for current cars that don't possess this type of technology.

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Spring-loaded concealed pull handles feature triggered handle

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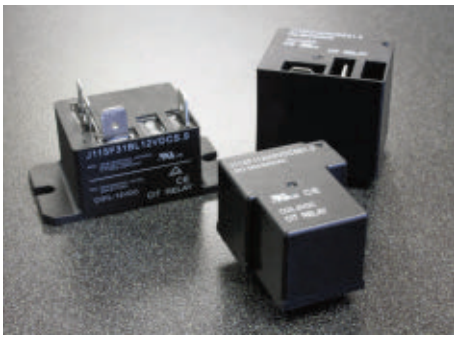

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Smart systems require smart connectivity

Developing robust connectors for a smarter world.

By Tom Anderson, Connector Product Manager, AVX.

Continued growth in the LED, smart grid, and smart meter markets represents a constant challenge for the connector industry to develop robust connectors that are smaller, more functional, and more capable of withstanding harsh environments than existing components. Product design engineers are increasingly challenging connector manufacturers to push the envelope of creativity, primarily due to space limitations in their designs. Conversely, connector manufacturers aim to develop connectors that meet the requirements of multiple customers across a wide range of markets. Where these two different paths intersect is at the point of invention, when the material and manufacturing limits have been pushed, tugged, and rethought to the point of realizing the next generation of product design. This process depends on an open and ongoing dialogue between engineers to go beyond their initial thoughts and ideas, challenging themselves to try what has not been tried before.

The keys to connector innovation for these evolving markets are to meet this next generation of product needs with innovative designs, processes, and technology that did not exist five years ago. "Smart" products are just that — smarter than their predecessors— and thus require the ability to take measurements, monitor and track performance, initiate notifications, and even make system corrections automatically. This is only achievable through the connecting the system's "brain" (i.e., the processor), which is fed with critical and timely input data from a host of downstream components, including such devices as: drivers, switches, fuses, motors, fans, back-up power sources, and sensors that measure temperature, flow, and vibration. All of these devices gathering input and generating action have to be simply and reliably connected together for the system to function effectively.

Two connector design evolutions have occurred in the last year to make this possible: 1) the miniaturization of discrete wire insulation displacement connectors and 2) poke home wire-to-board (WTB) terminations. Both technologies have proven track records in providing reliable connections of wires and components to a PCB in harsh industrial applications.

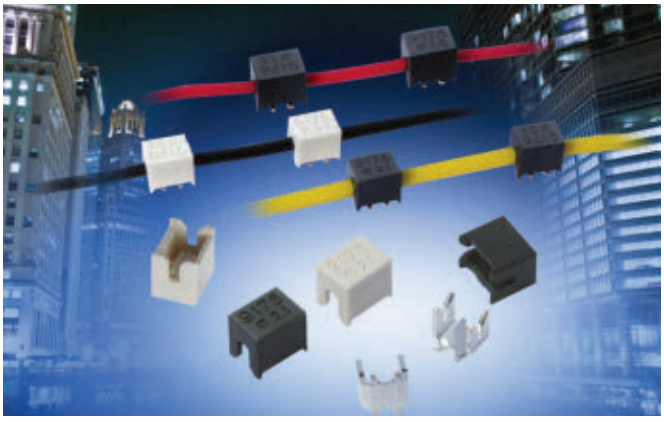

Figure 1: AVX's 9176-500 Series single, uninsulated contacts (i.e., naked connectors) provide dual IDC tine connections to 18–28AWG wire in a miniature, low cost, UL-rated product. Adding the white cap provides added robustness in high vibration applications. (All images courtesy of AVX).

Insulation displacement connector (IDC) technology delivers one of the most reliable wire terminations available in a connector. Once terminated, the connection can easily be potted or over-molded without fear of jeopardizing the electrical integrity of the connection. This enables the designer to encapsulate his electronic package or remote sensing unit to survive in harsh environments, which is critical for any meter or component that needs to survive in outdoor elements and environments. Reliable IDC connectors with single-wire contacts are available to support larger 12–16AWG motor and drive control circuits, 18–24AWG for the common bus level connections, and 26–28AWG for the sensor signal integration that provides the critical input of data into the system's processor.

IDC contacts are able to achieve and maintain a reliable connection only if they have been properly designed for these harsh environments, especially as it relates to base material selection in the contacts. Phosphor bronze, which is common in more reliable

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contact systems, provides the ideal tensile strength to maintain high opposing compression forces onto the wire, even under severe thermal and motion stresses. IDC contacts were designed to displace or deform the insulation around the wire, be it solid or stranded, making an impregnable metal-on-metal bond without damaging the wire's integrity or strength, and thus allowing the connection to survive in harsh environments. In fact, IDC terminations are so reliable that typical contact resistance ratings are more than 50 percent lower than traditional terminations. As such, they provide years of reliable performance ideal for use in next-generation smart products with long operational lifetimes.

From a miniaturization standpoint, single-wire or uninsulated IDC contacts combine all of the functionality and reliability of a conventional insulated IDC device into a connector with smaller height, footprint, and cost. The latest development in IDC connector miniaturization has produced cost and volume savings in both SMT and PTH formats using a single contact system to achieve 18–24AWG discrete wire-to-board connectivity.

Poke home connectors and low cost single contact devices have proven to be extremely user-friendly

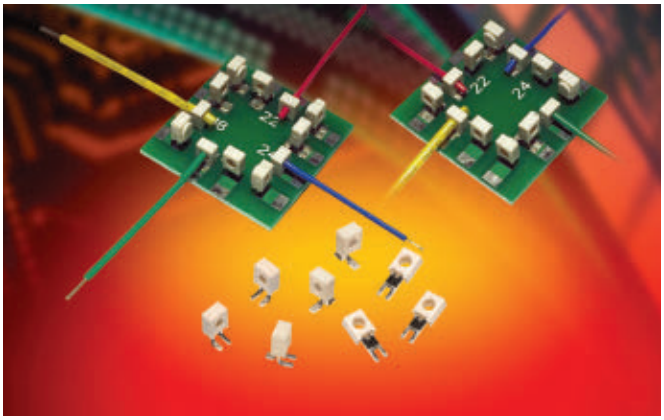

Figure 2: The latest development in IDC connector miniaturization, AVX's single tine 9176-65X Series IDC contacts, exhibit robust, reliable IDC performance while reducing cost by 25%, width by 50%, and height by 10%, the latter of which is especially valuable for SSL applications to help prevent shadowing.

for these same applications, especially when wire termination is required in the field, as they allow the wire to simply be stripped and inserted into the connector. Contact material is still a critical aspect from a performance and reliability perspective, though, and, again, phosphor bronze provides the necessary performance level for creating the dual high spring force

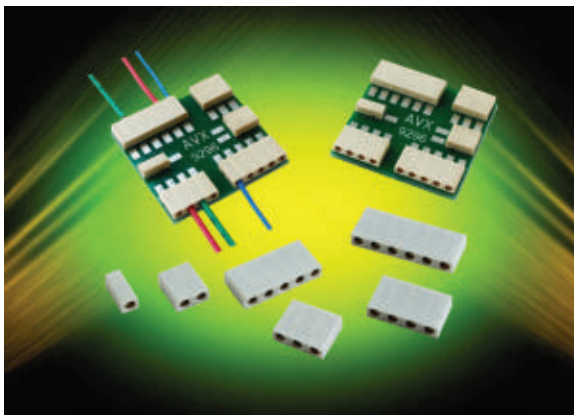

Figure 3: AVX's 9296 Series low profile horizontal poke-home connectors are perfectly matched for emerging smart grid products, as they provide the smallest footprint in the industry, yet can handle relatively large 20AWG wires when higher power is needed and 24–28AWG when employed in common sensors and other electronic devices.

opposing contact beams that grab and hold onto the stripped wires.

Recent miniaturizations in the poke-home arena have produced both connectors and contacts capable of handling 20–28AWG horizontal wire termination in a 2.5 mm or less "Z" axis height, as well as revolutionary 18–24AWG vertical applications comprising top and inverse (i.e., bottom) entry wire insertion. Until now, the available range of vertical WTB connectors has primarily been costly two-piece header and crimped wire connection systems. This new type of vertical poke-home connectors and contacts offers engineers a lower profile and lower cost option compared to existing solutions, in addition to more simplified wire preparation and ease of connection, and all without sacrificing robustness and reliability.

The new and next generations of smart energy products and LED lighting technology require innovative connectors with enhanced functionality, performance, and reliability in order to survive extreme thermal and environmental conditions in products that offer long lifetime warranties. Driven by customer dialogue and requirements, miniature IDC, naked poke-home, and other new connectors are providing miniaturization and robust performance at the price point needed to develop the connectivity necessary for this next generation of smart devices. For example, the recent innovation of single contact or "naked" connector technology has provided lower cost and lower profile options than ever existed before. Performance and reliability have also been key drivers in the material selection and design of these types of connectors. Additionally, many of these new connectors and single contacts now carry UL certifications, as the industry has recognized their performance and reliability for a growing number of applications. ECN

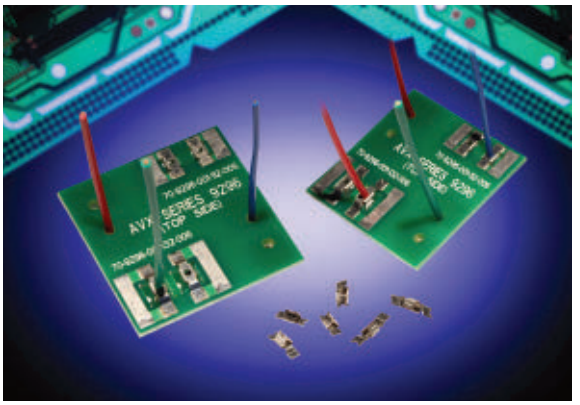

Figure 4: AVX's 9296 Series single vertical contacts (shown) and connectors offer the industry's first broad line product availability in low cost, single-piece connections ideal for connecting power- and signal-level devices in any harsh smart grid application.

Wearing out wearables

The importance of battery technology in wearables

By **Paul Pickering,** Technical Contributor

Wearables are on a tear, with the market projected to grow from $20 billion in 2015 to almost $70 billion in 2025. In the consumer market, new products have more features than most consumers will ever use – the Apple watch sports 20 built-in apps – but there's one area that continues to lag expectations: the battery system that has to power all of that technology.

Even though low-power design is resulting in ever more capable micocontrollers consuming less and less power, higher resolution screens in larger sizes and "always-on" applications such as GNSS keep raising the bar, especially on wearable devices with their limited battery capacity. Sadly, there's no Moore's Law for batteries: the annual rate of improvement in battery capacity is only around 6 to 8 percent, so longer battery life and shorter charging time have long been at the top of user wish lists. Current batteries are also bulky, slow to charge and prone to overheating, but several new developments are aiming to, ahem, "jump-start" this lamentable state of affairs. Sorry.

Battery chemistry based around lithium has gradually become the leading choice in rechargeable since its commercial introduction in 1991. There are a number of reasons for its supremacy: lithium is highly electropositive, resulting in a higher cell voltage (3.6 V vs.1.2 – 1.5 V for Ni-based batteries); it's the lightest metal, giving a high energy density (1470 Wh/kg) and high capacity (3.82 Ah/g); it's relatively easy to manufacture; and it can be recharged thousands of times. Over the years, various pretenders to the throne have come and gone, but promising results in the lab are just the beginning. Commercial products must also operate under a wide range of environmental conditions, be economic to manufacture, minimize the use of scarce natural resources, and be easy to dispose of. Oh, and preferably not burst into flames when punctured or overheated, as has happened to lithium batteries on several well-publicized occasions.

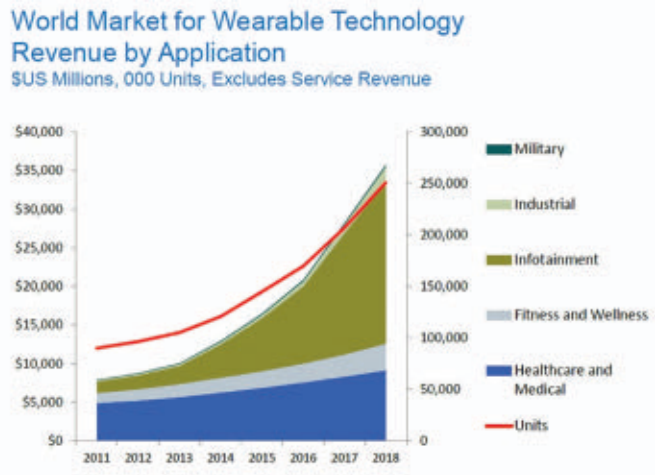

Figure 1: Wearables market forecast (Source: IHS)

Solid-state batteries solve this problem by replacing the flammable liquid electrolyte of traditional lithium batteries with a solid material of high ionic conductivity. They're particularly suited for wearables because they can be made to fit into curved watch faces or flexible wristbands. A battery is made by layering a high capacity cathode, a lithium metal anode and a solid electrolyte. Gaps in the electrolyte can lead to short circuits; this has been a barrier to high-volume production, but major equipment manufacturers such as Applied Materials are now shipping equipment that they claim solves the problem.

When it comes to packaging and form factor, flexible and printed batteries both hold promise for wearable devices. These include thin lithium and lithium polymer batteries, solid-state batteries, curved lithium ion batteries, flexible supercapacitors, and printed zinc-based batteries. There are multiple wearable applications where flexible batteries offer a distinct advantage, such as skin patches for transdermal drug delivery, patient temperature sensors, or RFID tracking. There are also applications in other areas such as greeting cards, RFID tags, and smart credit cards. Solicore's Flexion line of lithium polymer batteries have capacities of 10 mAh to 25 mAh, 3 V output voltage, and thicknesses as low as 0.37 mm.

Another option is a traditional battery in a miniature package. Panasonic's Li-Ion CG-320 comes in a cylindrical package of 3.5 mm diameter and 20 mm length. The small size make it well-suited for wearables such as smart glasses, hearing aids and fitness bands, and

Figure 2: Panasonic's CG-320 (source: PDD)

its nominal capacity of 13 mAh and 3.75 V output allows for Bluetooth and NFC (near-field communication) links with smartphones.

Wireless battery charging, estimated by IHS to be an $8.5 billion market by 2018, is in the early adoption stage for wearables. The main technique uses near-field charging (NFC): a transmitting coil produces a magnetic field that transfers energy via induction to a receiving coil in close proximity. Depending on the distance between the transmit and receive coils, only a fraction of the magnetic flux generated by the transmitter coil penetrates the receiver coil and contributes to the power transmission. The efficiency of the power transfer depends on the coupling (k) between the inductors and their quality factor (Q). Usually the device containing the receiver coil is placed against the transmitter device, so the distance between them is only the thickness of their respective cases, a few mm. This results in the most efficient transfer of power but at the cost of high sensitivity to coil misalignment, so only one device can be charged at a time. A different approach uses a resonant receiver and resonant transmitter in conjunction with looser coupling. This technique gives less efficient operation, but allows multi-device charging.

Reminiscent of the VHS-Betamax wars in the 70s and 80s, wireless charging is currently bedeviled by competing wireless standards. Qi from the Wireless Power Consortium (WPC) employs tightly coupled coils to transfer around 5W of power and is used in cellphones such as the Nexus S4 & S5, Microsoft's Lumia and Samsung's Galaxy S5. Qi has been around since 2008 and is supported by over 200 manufacturers.

The competing solution is a combination of both resonant and tightly-coupled standards from former competitors A4WP (Alliance for Wireless Power) and PMA (Power Matters Alliance), which merged their organizations in June. A4WP's Rezence standard is a resonant system operating at a transmission frequency of 6.78 MHz; up to eight devices can be powered from a single transmitter depending on

transmitter and receiver geometry and power levels. A Bluetooth Smart link controls power levels, identification of valid loads and protection of non-compliant devices. PMA partner Energous' WattUp technology can charge up to 12 devices as far as 15 feet from the transmitter; at that distance only 1 W of power is delivered, which rises to 4 W at shorter distances.

Some manufacturers aren't waiting to see which standard wins out, though; the Samsung S6 supports both the Qi and PMA standards.

Improvements in battery performance can't come too soon for the industry. According to research from Endeavour Partners, one-third of Americans who own a wearable device stop using it within the first six months. One of the reasons? Limited battery life. ECN

Looking beyond the consumer

By Sri Peruvemba, Head of Marketing, The Society for Information Display

In the business environment, one vision involves wearable devices that can expand when you need them. Imagine projecting images or a presentation on the wall or onto a conference table from your bracelet or wristband. Or perhaps utilizing a foldout display that provides a great deal of information, and then folds or rolls back into your wearable product.

In the non-consumer space, designs can be more forgiving. For a broad range of monitoring devices –healthcare systems in medical facilities, devices in mines, in spacecraft, in oil fields and nuclear reactors, to name a few – the devices' accuracy and output value are more important than their aesthetics. By incorporating replacement materials for ITO that are high tech, lower cost, flexible, rugged, thin, light and highly responsive, new touch sensors will be far easier and more pleasant to use. They can also allow us to use touch accurately in extremes of temperature, as well as wet or sandy environments.

Marketers will have to find ways to advertise via wearable devices, but will users allow them? If the device is given away for free by, say, a shoe company, would the user share exercise habits as a barter? Wearables could replace mobile phones for some segments of the market just as tablets replaced some laptops… and if wearable devices offer all the features of a mobile phone, they could potentially replace a majority of those devices in a few years. Why carry a phone when you can wear it like jewelry? ECN

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Why displays are making wearables a viable technology

By Sri Peruvemba, Head of Marketing,
The Society for Information Display

In today's connected world, we spend an increasing amount of time using and interacting with some type of electronic display. Thus, the display industry continues to innovate, finding new ways to allow us to access the content we need anytime, anywhere, in an increasingly transparent manner. Wearable devices, in particular, are making displays ever more useful and flexible (both literally and figuratively).

Wearable devices have burst onto the scene within the last several years and quickly taken hold, thanks to speedy product development and quick, cost-effective transfer by manufacturers from the lab to the fab. Market research firm IDTechEx predicts the global market for wearable devices will reach $72 billion by 2025. Examples of current wearable devices include watches, glasses, contact lenses, e-textiles and smart fabrics, headwear, jewelry, and hearing aid-like devices that are designed to look like earrings. The technology offers futuristic promise in virtual and augmented reality systems.

To bring these new products to market requires some key elements that play an important role in enabling emerging applications in the area of electronic wearables. These devices are the next big wave in personal computing, but adoption is still slower than manufacturers would like. People want devices that work as advertised; although that's not always what they're getting, today's wearables have come a long way from their early beginnings.

Wearable (r)evolution

Wearable technology isn't a new concept. The first wearables were introduced in the 1960s and 1970s. The earliest application familiar to most of us is the calculator watch that emerged in the 1980s, which became popular as holiday and birthday gifts.

As the technology has continued to evolve, growing more sophisticated and adaptable, new applications have emerged that are aimed at making our lives better. They monitor our health, they motivate us to exercise, they help train the athlete, they entertain, they make it convenient to make phone calls and answer text messages, they provide us with information only when

we want it – they are on our person all the time.

However, current devices, for the most part, are clunky, aesthetically displeasing, unreliable, lacking durability, limited in features and quite costly. On top of this, they're awaiting the killer app that will move them from "cool" or "nice to have" to a true must-have technology.

Technology challenges

Bringing viable wearable products to market requires overall improved reliability, enabled by some key factors, including:

- Accurate sensors with minimal latency
- Pleasing haptic technology
- Improved battery performance
- High-quality displays and touchscreens
- Improved materials for thin, light, flexible, conformable devices.

Unfortunately, most of the current wearable devices use technology that was created for other, bulkier products like mobile phones and tablets. The chips used in these apps still tend to be lacking in the degree of processing power they deliver, and they are too big to wear comfortably. They also have latency issues – they don't deliver readings/results in real time, and the touch interactivity is poor.

Figure 1. This wearable device features haptic actuators that are buried in the band. (Photo courtesy Novasentis.)

In addition, haptic feedback needs improving. Haptic technology is tactile-feedback technology that recreates the sense of touch by applying force, vibration or motion to the user. This feature enhances the touch interface on a display and creates a more immersive experience. The haptic feedback on most wearable devices is poor, generating an irritating "buzz" for every type of feedback

the device aims to provide (regardless of whether the information is vital or unimportant). As it continues to evolve, haptic technology must be virtually invisible and merge seamlessly with the wearable device. The vibro-tactile feedback should be pleasing, and enable a variety of feedback, to convey the difference in urgency and importance of information being conveyed. An example of new, improved haptic technology is shown in Figure 1.

Battery performance has been another key roadblock in terms of wearable adoption. In a *Fortune*/SurveyMonkey poll of 1,000 adults conducted after this year's Consumer Electronics Show, 33 percent cited "improved battery life" as the area in which they were most excited to see improvement in smartphones, which are notorious for their battery-draining propensity, and most cited skepticism about adopting new battery-driven smartwatches and other wearables. Chat boards are rife with complaints from health-band users whose rechargeable devices keep failing on them.

Touchscreens on wearable devices are another area that requires improvement. They aren't consistently responsive, they don't work well when you use gloves (hello, Minnesota), when your hands are sweating (hello, Miami), or when there is sand on the surface of the touch screen (hello, Myrtle Beach). There are, however, ongoing advancements taking place in the area of touch technology, as indicated by the popularity of the Touch Market Focus Conference held during Display Week 2015.

Figure 2. Touch technology that can work with gloves, sweaty fingers and even in dirt and sand. (Photo courtesy UICO).

In addition, the displays currently being used are rigid,

rectangular, difficult to read in outdoor settings, and tend to be both heavy and fragile. Brittle glass and brittle indium tin oxide (ITO) substrates dominate the display and touch materials used, and neither is optimal for devices that need to conform to the wearer's wrist or shoulder.

Finding solutions

For wearable devices in the consumer market to take off, designers need to create human-centric rather than techno-centric designs. Our wrists are not rigid, they are not rectangular, they are not a perfectly flat, two-dimensional surface. Designs need to incorporate the flexibility to accommodate the human form – something for the wrist should look like an expensive watch, rather than an expensive phone that's been sized down and strapped on. In this market, organic LED (OLED) and ePaper displays are gaining market share because they're thinner and lighter, with better color performance with OLED and better battery performance with ePaper.

The first products with curved displays have already come to market, and the industry is bringing out next-generation devices that feature brighter screens with stronger touch capabilities and better visibility in high ambient environments. Because these devices are thinner and lighter, more durable and resistant to water and weather, as well as more comfortable, we'll be more likely to want to wear them.

IDTechEx foresees the market for plastic and flexible active-matrix OLED (AMOLED) displays will reach $16 billion by 2020. We've already begun to see clothing with embedded displays come to market, as technology has been developed to adapt itself to the rigors of fabric wear and maintenance. This will allow wearable devices to be incorporated into virtually anything that can be worn on the body: helmets, headbands, earphones/headphones, shoulder bands, chest strap/heart monitoring devices, wristbands, bracelets, watches, jackets, children's protective garments, face masks for air quality. These are just some of the wearable products that exist today or are being designed to help improve our productivity and quality of life, and many more are on the horizon.

Healthcare could be that potential killer app for wearable devices. Some of the functions that could be performed via wearables include measuring blood pressure several times a day rather than just twice a year at your medical checkups; sensing blood glucose levels and alerting the user; monitoring your pulse, the chemical composition of your sweat and alerting you to drink water or take supplements.

Insurance companies and large employers would be delighted to get employee stats from wearable devices to fine tune their offerings. If you thought

the current subsidies on gym memberships and ride to work incentives were great, there is a whole host of customized incentives on their way, paved by big data collected from wearable devices.

The IoT and security

Going forward, wearable devices will further interact with the Internet of Things (IoT), allowing us to communicate with other people and with a wide range of devices, from fitness and entertainment systems to home appliances, lighting and AC control, garage doors and electric cars. Some of these devices may even migrate from a wristband to a ring that's small, yet packed with electronics and can deliver unparalleled electronic assistance and support. We'll also be looking at more immersive retail experiences, targeted messaging, and faster and more accurate transactions that will allow us to leave home without our wallets because our wearable devices will pay the restaurant or shopping bill without the checkout counters and the lines.

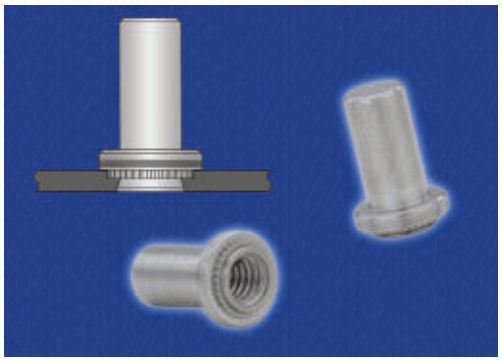
A key challenge to implementing some new applications, which the industry is working to address, is the issue of security. With software driving more technologies going forward, companies must pay closer attention to building in security measures that safeguard us and our information. More than any onboard functionality, security concerns will be the biggest gating factor to broad adoption and use of some of these futuristic applications for wearable devices. Efforts to design-in embedded security will drive innovation in secure connected device services, and further drive broader wearables adoption. ECN

NEW PRODUCTS

Sensor designed for fitness tracking in smart watches, fitness armbands

The new SFH 7060 sensor from Osram Opto Semiconductors is designed to measure pulse rates and the oxygen saturation level of blood. It offers excellent signal quality and low energy consumption. The main market segment for this component includes mobile devices such as smart watches and fitness armbands – also known as wearables – for continuously monitoring fitness levels. This integrated optical sensor contains five light emitting diodes with three different wavelengths and one high-sensitivity photodiode. The SFH 7060 is a further development of optical sensor SFH 7050, which Osram introduced in the fall of 2014. It performs the same functions as its predecessor but with improved power consumption and signal quality. The SFH 7060 consists of three green LEDs, one red LED, one infrared LED and one large-format photodiode, which is optically separated from the emitters by an opaque barrier. It works by shining light into the skin. Different amounts of this light are absorbed by blood and the surrounding tissue. The light that is not absorbed is reflected to the detector. Absorption measurements with different wavelengths are used to determine the pulse rate and the saturation level of oxygen in the blood. **For more information, visit www.osram-os.com**

Self-clinching blind nuts offer quick installation



PEM® self-clinching blind nuts from PennEngineering® permanently install into thin metal sheets to provide reliable and re-usable metal threads for accepting mating screws and completing final component attachment in an assembly. Their "blind," closed-end design effectively creates a barrier to protect the nut's threads against foreign matter and to prevent potential damage to internal components from mating screws. The carbon steel (Type B) and stainless steel (Type BS) nuts install quickly and permanently into aluminum or steel sheets as thin as .040" / 1mm. The nut is inserted into a properly sized mounting hole in the metal sheet and then sufficient squeezing force is applied using a PEMSERTER® or any standard press until the nut's flange contacts the mounting sheet. Upon installation, the nut becomes a permanent part of an assembly and throughout the process no secondary operations are required.

For more information, visit www.pemnet.com.

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GEMSTAR™ Custom Hard Cases has expanded its Stronghold® case line with new sizes to meet diverse customer requirements. Featuring double-walled, durable polyethylene construction, GEMSTAR Stronghold rotationally molded cases provide superior protection in the most rugged terrain.

To satisfy applications requiring protection in large to confined spaces, GEMSTAR Stronghold cases are available in multiple sizes and configurations. Outside dimensions range from 10 to 29.5 inches in width, 19 to 73.6 inches in length and 9 to 27.7 inches in height. With weights ranging from 13 to 58 pounds, Stronghold cases offer a variety of lid and bottom depths.

With a rotationally molded design, Stronghold cases offer thicker corners and stress-free walls. Further, all hardware is stainless steel, which ensures enhanced durability. Featuring a unique arrow design on the lid and bottom, Stronghold cases can be easily stacked and interlocked together for a seamless protection solution.

For more information: www.gemstarmfg.com

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MODERATED BY JAMIE WISNIEWSKI
ASSOCIATE EDITOR

Q: What's the next big thing in alternative energy?

Sol Jacobs, Tadiran Batteries

Everything around us is becoming smaller and more interconnected. Remote wireless devices powered by alternative energy are becoming increasingly feature-rich yet miniaturized, with increased product functionality being packed into smaller form factors. Meanwhile, extended battery life is an ever growing requirement. Efforts to minimize power consumption of the microcontroller and integrated peripherals can only go so far towards achieving these inherently contradictory goals, especially for devices that rely upon two-way communications. The ideal answer must also involve the right choice of power supply: a solution that delivers the normal background current required during periods of inactivity (the dormant mode), along with the high pulses needed to initiate data queries and wireless communications. Design engineers typically have two choices for storing the harvested energy: supercapacitors and rechargeable Lithium-ion (Li-ion) batteries. Of these alternatives, Li-ion batteries are better designed to support product miniaturization, as supercapacitors require bulky circuitry while delivering a lower temperature range and higher annual self-discharge rate. Also, multiple supercapacitors utilized in series require balancing circuits. Meanwhile, the recent introduction of an industrial grade Li-ion battery offers a valuable alternative to consumer grade rechargeable batteries, as these ruggedized batteries can deliver up to 20-year operating life, 5,000 full recharge cycles, and an extended temperature range. Enhanced rechargeable Li-ion battery technology will continue to play a role in supporting product innovation, as futuristic solutions using nanomaterials are still years away from commercial development.

Kaitlyn Bunker, Ph.D., Rocky Mountain Institute Associate, Society of Women Engineers Member

Microgrids and distributed energy resources (DERs) are the next big thing in alternative energy; the question is how they will interact with our current system. The electricity grid is evolving, with a trend away from the traditional centralized grid and toward

a more distributed grid utilizing local sources of electricity generation, resulting in more and more microgrids that utilize distributed energy resources. DERs include electricity generation sources like solar PV, electricity storage like batteries, and other resources such as smart thermostats and appliances. It's clear that DERs are becoming more common, but there is an open question about they will be incorporated with our current electrical grid system.

Microgrids and DERs will surely be a crucial part of our future electricity system. Decisions that we make in the near future around pricing and rate reform, new business models, and new regulatory models will help determine whether we move towards increased grid defection and separation, or instead towards a more integrated grid.

In The Economics of Load Defection, a recent report by my colleagues at Rocky Mountain Institute, two possible forward paths are outlined in regard to DERs. One path leads to grid defection, where customers disconnect from the grid and small-scale solar, storage, and other DERs are used to meet only local electricity needs. This results in an overbuilt system with excess sunk capital and stranded assets, both at the local level (installing more generation capacity than we collectively need) and at a larger scale (not utilizing the existing electricity grid infrastructure). Alternatively, the other path leads to a more integrated grid, where DERs are used in a connected, optimized way with the existing grid. In this case, DERs contribute value and services to the grid and to individual homes and businesses, just like traditional generators and other assets.

Sagar Jethani, Head of Content, element14

We're always looking for a better energy source to power our portable electronics. Rechargeable batteries have been a recommended solution for years and experiments with lithium batteries have been the most successful to date. Highly reactive chemicals within Li-ion containers, however, can overheat and even catch fire. Something better is needed.

Researchers have produced a new lithium battery that

combats the overheating hazard while increasing energy output levels. A research team from Stanford University has made new advances by using lithium as both the cathode and the anode. These pure lithium batteries could more than triple the energy yield of traditional batteries and be sold at a lower cost.

With improved performance metrics, these batteries have the potential to make a large impact on multiple industries, including electric cars. Battery life is a major issue preventing the advent of electric cars and is often the determining factor for consumers considering a purchase. Not only would pure lithium batteries increase the range of battery life for these vehicles, they could also significantly decrease the price point. If this new battery composition can be standardized into a manufacturing process for commercial use, it could greatly improve user satisfaction with portable electronics.

Marcelo Schupbach, Ph.D.,
Technical Marketing Manager, Cree Inc.

SiC MOSFET-based inverters, which deliver a quantum improvement in power density, along with higher efficiency and improved performance, are the next big thing in alternative energy. SiC MOSFET inverter technology is poised to significantly reduce both the installation and operating costs for new PV installations, and will subsequently lower the cost of the energy that such installations produce, which is likely to improve the global rate of adoption for solar energy.

Silicon carbide (SiC) MOSFETs have the potential to further advance inverter performance gains. Replacing the silicon (Si) IGBTs used in conventional string solar inverter designs with SiC MOSFETs offers several benefits. A SiC MOSFET-based topology enables smaller and lower cost inverters with significant efficiency improvements. For example, a 50 kW string solar inverter using SiC MOSFETs and SiC Schottky diodes is approximately one-fifth the weight and volume of a comparably rated inverter designed with Si IGBTs. Additionally, the use of SiC devices reduces inverter losses by 40 percent, enabling an overall efficiency of 98.5 percent.

This dramatic improvement in weight, volume, and performance is due to the fundamental advantages of SiC device technology. SiC MOSFETs have significantly lower (6–10x) switching losses than Si IGBTs and switch at much higher frequencies with minimal cooling demands. The recovery charge of SiC diodes is also negligible, virtually eliminating diode switching losses. Finally, the higher switching frequency of SiC devices reduces the overall size and weight of inverter components, including inductors and filtering capacitors. The increase in frequency also has a

substantial compounding effect, enabling size, weight, and cost reductions for other components, such as enclosures, wiring, and mounting hardware. Although the cost of SiC MOSFETs is higher than Si IGBTs, a SiC-based inverter design effectively reduces the cost of other components (e.g., the enclosure, inductors, and heatsinks), enabling a 15 percent BOM reduction.

With higher power density and lower weight, SiC-based inverters deliver a 40 percent reduction of solar inverter installation costs, which are estimated to be as much as 5 percent of the total installation cost. Thus, a SiC-based string inverter capable of delivering this type of competitive cost savings will have a distinct advantage compared to traditional inverter designs.

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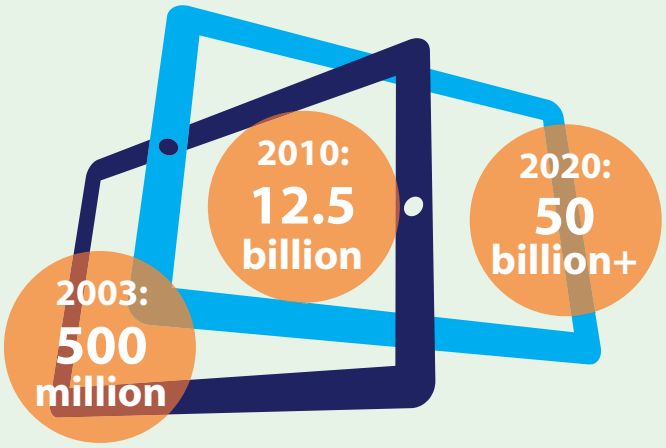
The White Board

Internet of Things

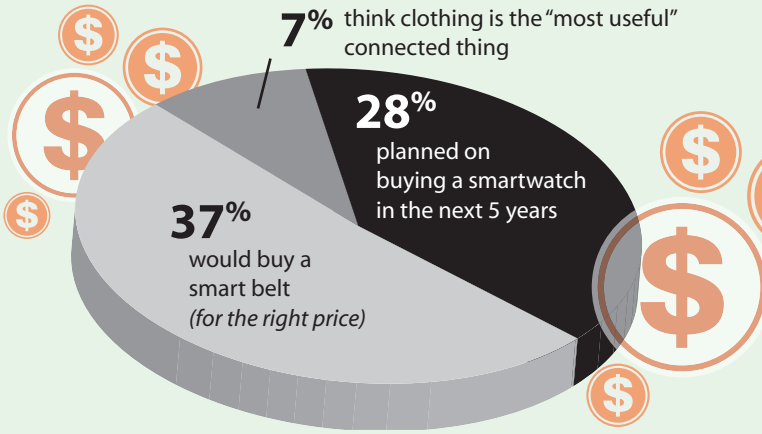
By Kasey Panetta, Editor

This infographic is based on a study of 3500 engineers in Australia, Europe, Asia, and North America conducted by element14. Engineers were asked how IoT and connectivity would fit into the future world.

Number of Connected Devices

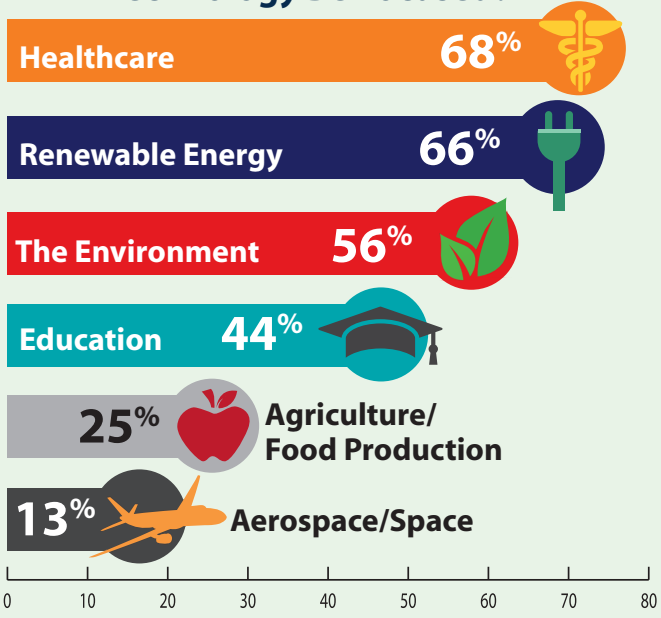


Put Your Money Where Your Mouth Is



element14

Where Should Connected Technology Be Focused?



The Worldwide Focus:

China: *Aerospace*
UK +U.S.: *Healthcare*
Austalia: *Renewable Energy*
India: *Finance*

Source: Report from element14 available at http://www.element14.com/community/groups/internet-of-things/blog/2015/04/20/element14-study-engineering-a-connected-world

designed by Larry Corby, Digital Artist

Consumer grade Lithium-ion batteries are short lived.

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