The wearable computing market: a global analysis

By Jody Ranck

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Executive summary

> "During a Formula 1 race a driver experiences wrenching forces of more than 4.5G. His heart rate may exceed 180 beats per minute and his blood pressure could rise by half. With soaring temperatures inside the cramped cockpit he will also dehydrate, typically losing 2–3 litres of water during the race. Yet the driver must concentrate well enough to achieve lap times that might vary by just a tenth of a second. This is tough, on both mind and body. Hence it is not just the performance of the car itself which an array of sensors keeps an eye on, wirelessly transmitting data about the engine, suspension and so on to the pit crews. The drivers' own vital signs are constantly monitored, too."
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> —*Economist*, Nov. 3, 2011

Wearable computing, or wearables, has recently moved from the realm of science fiction and military technology to being on the cusp of commonplace consumer technology. ABI Research estimates the global market for wearables in health and fitness could reach 170 million devices by 2017. Adding further momentum to the growth of the market is the entry of most of the major platforms into the space, including Google, Microsoft and Apple.

The first several decades of wearable computing failed to produce any notable success stories on the consumer front, but advances in materials sciences, battery power, augmented reality and chip evolution have made the possibilities for wearables grow rapidly. Google's recent unveiling of Project Glass has garnered a great deal of attention, but the market is much broader and includes fashion, health and wellness technologies, and technologies for the aging and disabled. As the quantified-self trend gains traction the use of wearables will grow too. This report covers wearables across these verticals as well as provides examples of how applications developed in one area can enable blue-ocean strategies to open up new market opportunities. (Blue-ocean

strategies imply not competing with existing market competitors but instead opening up the market space, or blue ocean, to make the competition irrelevant.)

Finally, one of the more interesting aspects of wearable computing is the potential impact it could have on the form function of mobiles down the road. Much of the functionality of a smartphone can currently be rendered within a wearable device, and as wearable devices become more common over the next decade mainstream devices such as the cell phone may be rethought.

Introduction

In April 2012 the tech sector was abuzz with the spotting of Google's potential future entry into the wearables augmented-reality market with its Project Glass, which is expected to reach market in 2014. The demo of these glasses, which are armed with an LCD or AMOLED display and location awareness, illustrated the potential of wearable-computing technologies to tap into apps and enable the user to access information (email, directions and other data) in real time through a stream to the user's glasses.

Project Glass is merely one indication of the future market of wearables. We loosely define "wearables" as computing devices that are always on, always accessible and easily worn on the body. They typically feature real-time information access, data-input capabilities, local storage and some form of collaborative-communications ability. Increasingly they also have some aspect of augmented reality. Wearables can be in the form of watches, glasses, smart fabrics, contact lenses, small screens, rings and bracelets, hearing aid–like devices, smart badges, wrist computers and even smart tattoos on the skin.

With the growth of sensors, particularly in the health and medical space, and new materials and fabrics embedded with microelectronics, the potential uses of wearable-

computing technologies is quite broad. Wearables reach to health and fitness, gaming, aging, transportation, fashion, mobile money, education, disabilities and even music.

The fact that Google, Motorola, Apple, Microsoft and a host of fitness-device manufacturers are making significant investments in this area is an indicator that we are on the verge of wearables becoming mainstream devices in the coming years. With the health and fitness sectors potentially taking the lead, wearables will begin to occupy a growing role in the mobile-health sector, and data analytics and big data will become important services linked to their growth. The largest market niches in the health sector will be in remote home monitoring, assisted living and chronic conditions, and clinical and hospital settings. In these scenarios the mobile phone will likely play the role of a hub (although there are competing devices for the function of the hub in the home-telemonitoring space, such as Qualcomm's plug-and-play 2net Platform).

On the mobile scene, apps such as RunKeeper and MapMyFitness are part of a growing ecosystem of platforms and aggregators that can interoperate with a number of devices and apps. The wearables market will increasingly need to address the interoperability issue as the space grows and the mobile phone becomes the hub for a growing array of wellness, fitness and health monitors and trackers.

After the health sector, the other major growth area could likely be in the gaming and entertainment arenas, where augmented reality and wearables may come together in an interesting way to create more-immersive environments for gamers in real time and space.

ABI Research estimates the market for wearables in the sports and health sectors will grow to nearly 170 million devices by 2017 — an annual growth rate of 41 percent. Forrester Research views growth in the sector as contingent upon the big five software platforms: Apple, Google, Microsoft, Amazon and Facebook. It predicts that Google is

the likely winner in the race for the next major device category, due to the jump Android has with some early device manufacturers. However, fragmentation in the Android sector may not allow this to be as attractive an option as Forrester might think.

This report will provide a historical background, an overview of the technologies in the wearables market and possible future trends as the market expands.

History

Wearable computing has a history that goes back longer than most people expect. In the 1960s various militaries around the world began developing headgear with displays for aviators in combat. Then in the 1970s some of the first wearables were created for predicting roulette-wheel speeds. In 1979 Sony invented the Walkman, considered by many as an early wearable computer. In the early 1980s Steve Mann, one of the pioneers of wearable computing, created a backpack-mounted computer to control photographic equipment, and in 1994 he created a headset that transmitted images to the web. By the late 1990s we could find IBM experimenting with wearable computers based on the ThinkPad, and by 2001 it had introduced a prototype of a wristwatch computer known then as the WatchPad.

Some of the leading companies in the early development of wearables have had a difficult time commercializing the technology. Xybernaut, CDI and VIA Technologies have been some of the first, and most have had to go through bankruptcy filings at least once. Large consumer-technology manufacturers including Sony and Panasonic have attempted to commercialize wearable devices in the past, but these have yet to reach any form of sustainable success. Wearable technologies are not as straightforward as many other mobile technologies, due to issues such as heat and battery power, local storage, privacy and security. And in the context of wearable

fabrics it has been an even longer road to both functional technologies and cultural adoption.

Fitness and wellness devices

The fitness space, as mentioned earlier, is one of the largest markets in the wearable space. A number of popular tracking devices worn on the body dominate the market at the present time, including Striiv, Basic and Adidas miCoach. Below are important companies to this space and the products they offer.

Adidas. The Adidas miCoach was developed to monitor athletic performance and has sensors that measure speed, pace and distance as well as a heart-rate monitor that measures cardio performance. Adidas also collaborates with Polar on technologies such as the adiSTAR Fusion, which is a computer connected to a range of wearables such as shirts and sports bras designed for running. The miCoach Speed_Cell is a tracking device that fits into a line of Adidas shoes and tracks running speed, acceleration, distance and space. So far it has been used most extensively in soccer.

Under Armour. Sports-clothing company Under Armour has developed the E39, a shirt embedded with integrated sensors, an accelerometer and 2 gigabytes of storage. This wearable computer can monitor heart rate, breathing rate, skin surface temperature and acceleration.

Zephyr Technology. Under Armour's shirt was developed jointly with Zephyr Technology, a defense-industry contractor that makes biometric monitoring systems with dual health and defense applications. Zephyr is one of the more advanced companies in the space and has developed a number of wearable technologies for defense and emergency and specializes in smart-fabric technologies. The BioHarness, for instance, measures vital signs that can be monitored via radio, Bluetooth and web-based applications. Some of the tools enable a squad of emergency-first responders,

for example, to be monitored in real-time. Zephyr's Consumer HxM is a device that delivers heart rate, distance and speed data and is integrated with the Smart Fabric Technology. The vital aspect here is that the device can also be integrated with an entire ecosystem of third-party fitness apps including Endomondo and Fit4Life. Interestingly, Zephyr has recently received an undisclosed investment from 3M, the manufacturer of medical devices, diagnostics and networking devices, which has a strong interest in emerging technologies in the mobility space.

Northeastern University. Students at Northeastern University have developed an electromyography-sensor-based shirt that tracks the electrical activity of muscles during workouts so you don't have to manually enter as much data on your workouts. The device monitors this activity and sends the data to an Android-based program that can track one's historical performance. It is expected to be commercially available in two to three years.

Utope Project. Utope's Sporty Supaheroe blends wearables for fitness with fashion to create a stylish smart cycling jacket that has LED displays with an accelerometer and 3D gyroscope. The jacket also alerts users of incoming telephone calls while tracking their movements.

European sector

In Europe the wearables market is growing as well. With the 2012 Olympic games on the horizon, we can expect to see growing interest and quite a bit of public relations buzz on the use of wearables by Olympic athletes.

The Slovenian firm TMG-BMC is a biomechanics and kinesiology company focusing on sports and rehabilitative medicine with a list of clients including Olympic sprinters and FC Barcelona. The medical area it focuses on is tensiomyography (TMG), or the diagnosis of muscle imbalances that are often at the heart of athletic injuries.

Noninvasive sensors and a suite of other tools are used to measure these imbalances and optimize training programs that can minimize injuries.

SmartLife Tech has developed a HealthVest that contains ECG electrodes, respiratory sensors and an accompanying platform for data cleaning and collection. The markets the company is focusing on include cardiac care, the military, dangerous environments and fitness.

Other areas of fitness

Adjacent to the fitness industry is the outdoor sporting market for backpackers, extreme expeditions and military applications of wearables. It's worth noting that many of the original technologies developed in the wearables space were originally intended for military needs.

Brenig. The high-performance outdoor-clothing manufacturer has embedded wearable technologies in polar-expedition lines of clothing to create a sleeve compass. The rationale behind the clothing is that it's easier to access than cumbersome handheld technologies when one is wearing gloves and thick parkas.

Microsoft. The ability to manipulate smart fabrics in order to control phones and other devices is an area Microsoft is currently exploring. Through these fabrics one will be able to see, for example, that a call is coming in and either dismiss the call or have simple messages sent via pressure-sensitive buttons in one's clothing.

Wearables in the enterprise environment

Wearable computers are growing in the enterprise environment, particularly in the category of rugged computers. These are particularly valuable for workers in assembly lines and warehouses or in other contexts where tablets, for example, could be easily

damaged. Wearable computers can be worn on the arm and provide hands-free computing possibilities in industries from shipping to supply chains in pharmaceuticals.

The enterprise environment will play an important role in the growth of wearable computing because of the hands-free nature of the work. In contexts such as hardware repair, maintenance of heavy infrastructure (e.g., nuclear reactors and sophisticated hardware) or outdoor construction, where real-time geographical information is required, wearables can be ideal.

The challenge here will be to find the right technology to fit with the overall enterprise architecture of the firm and interoperate with existing devices in a world where the range of devices and data systems is proliferating. In Japan the National Institute of Advanced Industrial Science and Technology is developing augmented-reality wearables that enable off-site experts to share insights and experience with new workers in challenging work environments. HP Labs is doing a great deal of work on flexible displays and the materials science that can enable a wider range of form factors for computing surfaces that could help drive development in this area. Some additional companies working in this niche include Barcode ID Systems, Motorola and Geophysical Survey Systems.

Optical ware

Earlier in this report we covered a number of goggles and glasses used in sports including Project Glass and others. Optical devices are likely to become a mainstay of the wearable-computing market in the coming years. Google's Project Glass will have a device available in limited supply in 2013 that will run for $1,500. The prototype that is available now has a camera that can collect and store images and video, and it also has a gyroscope, accelerometer, compass and microphones as well as Wi-Fi and Bluetooth. According to the interview in *Wired*, Google has been focusing on an

interface that does not create too much clutter between the viewer and the field of vision, so it will likely be somewhat of a departure from many augmented-reality-style interfaces. The focus at the moment is to enhance our ability to communicate through images. One of the challenges it notes is the need for an efficient means to sort through the substantial amount of content these devices could record in a day, so users can sort for the most meaningful content.

Many of the optical devices were developed first for the military and are now being adapted to consumer price points and contexts. Vuzix initially focused on eyewear for military purposes and now offers products at consumer and enterprise levels. That includes Smart Glasses for entertainment and cinema, flight simulation and gaming environments. It is also developing augmented-reality see-through glasses in collaboration with Nokia that will enable better fusing of virtual and real visual data simultaneously.

Contact lenses are another device entering the wearable-computing space. In the military setting Innovega has a contract with the U.S. Department of Defense to develop iOptik, an augmented-reality contact lens. It has two different lenses that help to overcome the limitation of traditional heads-up-display technologies, which require the user to focus too heavily on the device, an obvious hazard in combat situations. This enables both near- and far-focused attention simultaneously. It expects to release the technology for civilian applications by 2014.

On another front, the University of Washington and Microsoft have created a contact lens that is a prosthetic device for the sight-impaired that uses LED. The lens can monitor glucose levels for diabetics and help them self-manage their condition in a less invasive manner than current technologies can.

Skin sensors

Haptic technologies that allow the user to take advantage of the sense of touch are a major piece of the wearables technology space too.

For example, the Tap Tap scarf is a haptic device that allows the transmission of tactile information and can be used for emotional therapy with children and adults.

Haptic massage therapy uses heat sensors to trigger haptic information to be sent to an area that, in turn, actuates a device that can stimulate that area of the body. Other applications can sense the movement of the body of an athlete to detect improper form, which triggers a reminder to the rower, for example, to adopt the correct positioning.

Nokia has been developing magnetic or vibrating tattoos that can alert the user when there is an incoming call or a warning alert for a dead battery from a mobile phone. Some tech bloggers find the concept suspect and a bit too sci-fi-like, noting it may have limited applicability.

Smart tattoos for monitoring vital signs are also in development. The University of Illinois has developed a smart tattoo that integrates sensing, diagnostics and communications on an ultrathin patch attached directly to the skin. Blurring the boundary between technology and biology, the patch is an actual platform that has a wide range of technologies that can be used. Mc10, a company that is spinning off the commercialization of the patch, is planning to add Wi-Fi capabilities soon as well. Similarly, Sano Intelligence, a Rock Health class of 2012 startups, has a wearable patch that can continually monitor glucose levels, kidney function and metabolite levels.

Disability technologies

Wearable technologies have many applications for disabled bodies and include applications for the deaf, blind, paralyzed and elderly. Glasses with captioning functionality are in development for those with hearing impairments. Wayfinding technologies are being developed (and are in use) for the blind. Some of these combine wearables with spatial language to point out physical devices and points of interest. Here are a few of the most interesting technologies out there.

Hear ware. There is some interest in embedding jewelry with technologies that can enhance social functioning for those with disabilities. In 2006 the Victoria and Albert Museum in London hosted a fascinating exhibition on hear ware. These were technologies developed in response to a call from the UK Design Council to rethink the hearing aid beyond the cumbersome, unattractive and often not very effective current device. The call for proposals was based on the fact that the market for hearing devices in Europe was estimated at over $5 billion but that only 30 percent of the market was using the devices. Furthermore, hearing impairment can impact everyone, and innovating these wearable devices could affect not only the deaf and hearing-impaired but also a much larger market.

The result was a fascinating array of wearable technologies outfitted with sensors and hearing devices. This included patches that could communicate wirelessly to an earbud in the hearing-impaired person's ears and that could be distributed to members of a group that the hearing-impaired person wants to communicate with. Another example was jewelry that, when noise levels were high enough to damage the ear, would vibrate on the cervical vertebrae and warn the user to move to a safer location. Other technologies included glasses with hearing aids and earbuds that attached to sensors at a table in a bar, for example, that could help the user block out noise and hear only the relevant conversation. Additional devices focused on over-the-counter hearing aids that could be developed for different strengths and types of hearing loss and a hearing

bud that records the last 10 seconds of sound once activated. The FDA has also recently approved the SoundBite Hearing System, a device for single-side hearing loss that is based on bone conduction and is worn in the mouth, similar to a denture.

Design Research Lab. The Design Research Lab has developed a unique technology for the deaf-blind that enables them to use a glove to send a text message. Lorm is the language used by the deaf-blind that uses touch to sign language on the palm of the hand. The Mobile Lorm Glove enables a user to translate messages composed on the palm of the glove into text messages that can be sent to another user wearing the same glove.

Point Locus. Point Locus has developed a "tactile way-finding vest" for the blind that communicates directions via vibrations on the user's triceps. The technology serves as a replacement for the standard GPS device that creates obvious challenges for the blind.

Other technology. Orpyx's SurroSense Rx for diabetics is a self-monitoring device for diabetics with neuropathy who cannot feel the pain in the early stages of damage to the feet. This pain can result in ulceration and even amputations. The SurroSense collects pressure data that can detect when damage is being done and sends a signal to the user to change behaviors in order to lessen the damage.

Grathio Labs has created the Tacit glove, a device known as "sonar for the blind" that uses haptic technology to measures the distance to things and translates this into vibrations or tactile responses on the back of the user's hand.

Lynne Bruning, famous for her work on eTextiles, has been engaged with developing new eTextiles that can be useful for diabetics with neurologically impaired feet. She has also been working on the Keyglove, an open-source device that uses gestures and touch to enter text data, control a mouse, switch between applications, and even play

immersive games or MMORPGs. The device could be ideal for those with repetitive stress injuries as well.

Many of the above technologies can be readily repurposed for the growing technology market for the aging. BlueLibris, for example, focuses on mHealth and safety and was recently bought by Numera. The Libri is a sensor device the user can wear or carry that is connected to the cloud and enables communication with a caregiver. The technologies involved here can be used for real-time monitoring and fall detection.

Some other companies focusing on the aging space include Tunstall; Everon, with its Vega bracelet for Alzheimer's and cognitive impairment; BodyTel; and the Vicon Revue, with its wearable cameras for those with memory loss.

Recently Founders Fund and Khosla Ventures invested $7.6 million in Misfit Wearables, a company created by one of the founders of mHealth company AgaMatrix. While covering the investment, TechCrunch noted that fashion and health would not be viewed as trade-offs in the new products developed by Misfit but that health, fashion and usability together would be viewed as critical to future success.

Fashion and alternative paradigms for computing

Any spectator of a Lady Gaga performance has witnessed the phenomenon of wearable technologies in fashion via her "living dress." Here the LED often reigns supreme. Female technologists looking for avenues to increase girls' participation in the tech sector are building on this through the development of fashionable wearables. *Bitch* magazine recently ran an article highlighting a number of these initiatives and websites, including blogs such as Fashioning Technology, Switch, Electricfoxy and talk2myshirt.com as well as the Arduino microcontroller board designed specifically for fashion-oriented wearables, LilyPad Arduino.

The fashion space has tremendous potential, and our list is far from exhaustive. Here are a few of the most interesting initiatives.

CuteCircuit, the London-based fashion-design firm, bills itself as a pioneer in the field of interactive fashion and the use of wearables with smart textiles and microelectronics. It is the developer of the Hug Shirt, which can give and receive hugs via mobile phone and which *Time* rated as one of the best inventions of 2006. The shirt is a Bluetooth accessory for a Java–enabled phone that sends a signal from the shirt's sensors to the phone, which triggers a text message.

Electricfoxy has a number of interesting wearable-computing technologies that rarely make the lists of mobile and sensor technologies in mainstream blogs. The Move garment uses gentle signals to lead the user to adopt the right movements in anything from yoga and pilates to dance performances or physical therapy. Pulse is a heart-rate monitor in the form of a ring that connects to your smartphone via an app to help you stay in the right target zone for your workouts. Ping is a fashionable garment that contains a sensor in the shoulder that "pings" the user when a message is received from a connection on Facebook.

LilyPad Arduino has recently become the focal point of an MIT research group called High-Low Tech that has created a computational-textiles curriculum to teach students how to build gesture-recognition gloves and other technologies that can bring the wearable-computing idea to mainstream audiences. Other programs include soft circuits and adhesives. One MIT LilyPad user created a jacket that displays a turn signal useful for cyclists.

One further data point about fashion and wearables is the success of the Pebble on Kickstarter. The Pebble is a concept for rethinking the watch to work with the iPhone to receive text messages, among other things. In a short period of time the Pebble has broken records for Kickstarter in the amount of money raised: over 7 million in a

matter of weeks. The growing consumer demand and the potential application spaces for wearable computers and platforms could make these devices a significant growth market in the coming years.

The intersection of wearables, gaming and entertainment

On the border of emotional sensing and fashion, a new area is using sensors in clothing to detect and display emotions or states of being.

Philips has developed the Emotions Jacket, which explores the connection between emotions and touch. The jacket is used in conjunction with a DVD of a movie to create linkages between the user of the jacket and the emotional content of the movie, in order for the viewer to experience part of what the character on-screen is feeling. The jacket is being developed explicitly for use in the entertainment sector to create more-immersive experiences.

The Design Research Lab's Skintimacy project features a skin-based wearable used for musical collaboration. The technology has been developed to make a more interpersonal musical experience as well as to facilitate the development of alternative digital musical instruments. On the interactive side, the goal is to enhance intimacy through sound and explore how the boundaries of intimacy can change with computer-generated music and interpersonal touch.

TN Games has created a heavy-duty vest called the 3rd Space that enables the user to have more-realistic gaming experiences and actually feel gaming characters' sensory experiences such as kicks, stabs and g-forces.

Fast Company writes of wearables as the new "fifth screen" in the advertising space, because advertisers will be able to utilize both high-involvement and low-involvement

types of advertising. In the article, Kit Eaton argues that with the rise of wearables everyone will be competing for consumers' attention on the fifth screen (the other four screens being the TV, PC, smartphone and tablet). The difference is that wearables are potentially with you all the time. Furthermore, the range of advertising modalities is a new paradigm for the advertising industry that will require more-advanced understandings of behavior. A new platform, more data and perhaps more controversy? The question will be whether consumers find new forms of advertising useful and entertaining or just another nuisance that contributes to information overload.

Augmented reality and wearable technologies

The growing field of augmented reality opens up many possibilities for the use of wearable technologies. The Mobile Individual Measurements of Air Quality project, or MIMAQ, is an interesting example that illustrates the possibilities well. The project uses mobiles and mobile sensors focused on the individual's surroundings rather than the usual government air-quality measurements to provide real-time pollution indicators. These are sent to the user via augmented-reality wearables that also compute averages over time. The information is displayed on the phone for the prototype but could readily take advantage of the eyeglass platforms in the future wearables market.

Oakley has been developing glasses, or heads-up-display technology, that can project data onto lenses, along the same lines as the Google Glass project. DARPA is also collaborating with Lockheed Martin on next-generation holographic glasses that can overlay battlefield data in the wearer's line of vision.

The distraction of data streamed into the user's line of sight has been one of the design challenges for wearables in the augmented-reality space. This is particularly troublesome for the military and can result in distractions leading to death. The

coming generation of wearable augmented-reality applications is likely to demonstrate improvements in the visual design of data, which makes the possibilities for military-grade augmented reality interesting to explore. These can include data from other soldiers as well as real-time intelligence streamed into the field from surveillance cameras. The cameras embedded in devices also can communicate back to the home base and enable analysts in the war room to assist and coordinate actions in the field. There are also potential medical applications used in combat trauma for surgery that may have very similar mainstream medical applications as well.

There are many existing applications that can provide insights into where AR apps and wearable technologies may go, including Augmented Car Finder, which helps users find their car in parking lots, and Twitter 360, which shows where people around you are tweeting from. Omron has developed AR apps that instantaneously translate signs or menus from foreign languages. Aurasma is "the world's first visual browser" designed for the iPhone and iPad: It allows the user to find location-specific data on points of interest as well as create AR apps that function within the Aurasma environment.

Trends

There are a number of technological and social trends that will play a role in wearable adoption in the coming years. Developments in the materials sciences are re-imagining the ease of embedding new technologies in fabrics as well as the use of implantable devices and biosensors. Many have observed that products like Google's Project Glass will need to overcome some social norms around fashion and social propriety to become widespread. In the health sector, however, the wearable market will need to address the issue of outcomes and reimbursement policies that plagues the mHealth space at the moment. Below we address a number of developments that will play a growing role in this device segment.

Advances in materials sciences may make new form factors and materials available for wearable computing and electronics. The University of Exeter in the U.K. recently announced the development of a new material called GraphExeter that can conduct electricity. The developers of the material claim it could potentially revolutionize wearable computing in the future, because the material is more flexible than indium tin oxide, the expensive material used in most electronics that is expected to run out in 2017.

One of the key drivers of wearables is the release of **Bluetooth 4.0**, which uses less power and can instantaneously pair with devices. Bluetooth 4.0 is also a boost in the health market, due to connectivity with medical devices and greater use with bracelets and watches, which are rapidly becoming important device platforms in the fitness and body-monitoring spaces.

NFC, or near field communication, will likely play a growing role in wearables too as it becomes a more commonplace technology used in mobile-money applications and services. There is already talk of embedding NFC technology in wearable devices so users can pay for movie tickets, subway tokens, sporting events and a latte at Starbucks without even pulling out a card or phone. This is provided consumers trust the technology to handle their financial transactions.

Wearables are already causing a **rethinking of the boundaries of the body** and materials. In her TED talk, Lucy McRae demonstrated some of the work Philips Electronics is researching and coined the term “maybe tech” for technologies that are not purely off or on the body and have the effect of blurring the boundaries of the body. She gave the example of electronic tattoos that can conduct electricity and redefine the skin. In this way we can see how the body is becoming a platform or an API as nanotechnologies and computing converge in interesting ways. While currently without practical application, these artistic uses of wearables and implantables can

work to change popular perceptions of the body, and they have the potential to inform future applications that we may not currently imagine.

Wearables with the sensors already available can help make the body more transparent and shareable (from a data perspective), as Italian philosopher of information Luciano Floridi has noted in his work on inforgs and information ecologies. In his TED talk on the "fourth technological revolution" he examined how the algorithmic revolution is not only changing medicine and democratizing medical knowledge but also enabling the sharing of data and knowledge about the body and opening up the body in a manner that makes it more visible. We can expect wearable-computing technologies to play a potentially major role in this growing trend.

Furthermore, we are already seeing a **convergence of application areas**. The hear-ware example provided earlier is a fascinating case of a blue-ocean strategy. The brilliance of the design approach to hear ware is that it moves beyond the traditional medical device that is stigmatized to exploit new technological approaches and form factors. In this way, the market for hearing devices can expand beyond those who are hearing-impaired to include almost everyone.

Keeping an eye on the interdisciplinary nature of wearables and the opportunities in fashion, for example, may reveal novel blue-ocean types of market possibilities in health, fitness and professional sports. Likewise, the technologies used for aging populations facing declines in mobility, such as arthritis sufferers with decreased tactile ability, could be quite useful to workers who must use mobile phones or other computing technologies in extreme environments, such as cold climates.

Wearables may have many more application opportunities than mobiles in this respect, and they could potentially be the form factor for future mobile phones beyond the platform as we currently see it. The Mobile World Congress 2012 exhibitions prompted some observers to conclude that the potential for form-factor innovations in

mobile has reached a ceiling. Batteries and displays have reached a limit where there are serious trade-offs in performance for upgrades in size. It is speculated that projectors, flexible screens and larger cameras are the final frontier. But wearable-computing technologies offer entirely new form factors, from glasses and head ware to the hear-ware revolution. We see the potential for very different platforms from the traditional mobile phone. This will also depend on how we use phones in the future: more for data and less for voice.

Floridi has noted several changes that could play a role in future form factors. First, we are becoming information organisms, or inforgs, who consume increasing amounts of data and information. This is driven in part by the growth of information that is becoming part of our environments, particularly with the growth of the Internet of things in coming decades. Connecting the dots among these trends could open opportunities for new ways of imagining form factors and wearable technologies.

Companies to watch

A Forrester Research report suggests wearables will be a major area of interest for the top platforms in the future, with Google perhaps having an advantage.

Microsoft is a major player in this ecosystem, and with devices such as the Kinect there are tremendous opportunities for wearables to alter the gaming industry. Microsoft has recently patented a wearable technology called the electromyography-based controller that would allow users to control smartphones, Xboxes and many other devices. Given the evolution of the Kinect and the growing number of user-led innovations, this could make for a promising platform for wearables in the future.

Others think Apple risks falling behind in the wearables race; this is supported by a view that Apple took the lead originally with the iPod, but despite integration with

Nike+ it will need to make far more than watches and lightweight wearables to remain competitive.

Forrester sees the major platforms building partnerships with the apparels industry over the next few years, and the major platform players will follow the script from the mobile space. According to Forrester, the scenario will likely unfold as follows: Apple will first create an early ecosystem, followed by Google developing a more open ecosystem via Android (provided Android's fragmentation doesn't become a hindrance). Microsoft will follow with an antiplatform based on open-web standards that tries to offer more flexibility than Apple's and Google's platforms.

In the health space, a major segment of this market, we may see a different cast of characters that combine big-data analytics with wearables and a broader ecosystem of platforms that dominate across the fitness app, personal-health-record and self-tracking spaces. RunKeeper is becoming the health layer in the fitness space, and it remains to be seen if any major player can assume a substantial integrative or aggregator role for health data.

Key takeaways

- The health and wellness areas will see the biggest early jump in market numbers, due to the rapid growth of mHealth and medical home interventions, where the sensors in wearables can be cross-purposed for everything from fitness to technology for the aging.
- We can expect some cross-fertilization between fashion and the health-wellness space. Many consumers are unsatisfied with medical devices that look like medical devices and prefer the design aesthetics of a company like Apple. With the growth of wearables in fashion we could see sporting-goods manufacturers such as Adidas and Nike build on their own fashionable brands and offer wearables with health and wellness applications.
- Developments in the materials sciences will expand the range of form factors and materials used for wearables and impact haptic technologies and gestural interfaces.
- We are already beginning to see many wearable technologies developed for military use make their way into the sports and outdoor markets. This trend will likely continue, particularly with augmented-reality applications.
- Most big technology players are looking at major new platforms, and this could have an impact on areas such as the mobile phone. We shouldn't be surprised if in ten to fifteen years the form factor of the phone is quite different and has been driven by the widespread adoption of wearables. Smartphones increasingly include sensors and a range of technologies that make them more than just a phone. Could the future of the phone be seen in devices like Google's Project Glass?

About Jody Ranck

Jody Ranck has a career in health, development and innovation that spans over 20 years. His current work has emphasized global health, innovation and social media in public health. He is currently on the executive team of the mHealth Alliance at the United Nations Foundation and consults with a number of organizations such as IntraHealth, Cisco, the UN Economic Commission for Africa, GigaOM, the Qatar Foundation International and the Public Health Institute. He was also involved as a convener of the Rockefeller Foundation's work in eHealth and mobile health through the 2008 Bellagio Summit.

His previous accomplishments have included working in post-genocide Rwanda, investigating risk and new biotechnologies at the Rockefeller Foundation, working at the Grameen Bank in Bangladesh, and leading the global health practice and Health Horizons at the Institute for the Future in Palo Alto, Calif. He has a doctorate in Health Policy and Administration from UC Berkeley; an MA in International Relations and Economics from Johns Hopkins University, SAIS; and a BA in biology from Ithaca College. Some of his honors have included a Fulbright Fellowship in Bangladesh and serving as a Rotary Fellow in Tunisia.

About GigaOM Pro

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Further reading

The quantified self: hacking the body for better health and performance

The quantified-self movement is a community of individuals deploying mobile health applications, fitness trackers and social media platforms to share information on their health behaviors like eating, sleeping, fitness and medication. It's an important movement to watch, as its growth has huge potential implications for the health care sector's future evolution. This report discusses the quantified-self movement, from the concepts driving it to the technology vital to its growth. Of course, the movement comes bundled with its fair share of ethical and regulatory challenges, which will need to be overcome as we move forward.

The living room reinvented: trends, technologies and companies to watch

The adoption of tablets, social media and new interfaces and the changing nature of the TV itself mean the digital living room will continue on its path of rapid change, thanks to new ways of creating, viewing, bundling, distributing and selling content. The goal of this report is to help readers understand the different technologies driving this shift. We asked four Pro analysts to identify key trends reshaping their market and to name key players and technologies that will ultimately be counted among the winners.

The big theme of MWC: how to live in a connected world

The big thing at Mobile World Congress 2012 wasn't a phone or new network architecture but the much more subtle shift in focus on how we live in a hyperconnected world. This year the industry seemed to move beyond starry-eyed soothsaying about a world of 50 billion connected devices to start talking about how these mammoth networks of objects and appliances would actually work and how they would be managed.