



Smart watches: the start of the wearable electronics revolution?



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Smart watches: the start of the wearable electronics revolution?

The launch of the Samsung Galaxy Gear smart watch has brought the concept of wearable electronics to the attention of consumers. But the wearables revolution is going to start with the advent of flexible electronics – something that is now on the horizon.

When Samsung [announced the launch of its Galaxy Gear smart watch](#) in September 2013, it marked a watershed for wearable electronic accessories. The hype for smart watches – devices that interact with the wearer’s smartphone, to display text messages or emails, among other features - had already been building in 2012. Media outlets spoke excitedly of devices like [the Pebble watch](#), a wearable device with an e-reader-style display that was generated millions of dollars of funding via a crowdfunding website.

It was only a matter of time before global consumer electronics firms like Apple and Samsung were linked with the development of wearable electronic accessories.

Samsung’s Galaxy Gear interacts with the company’s smartphone and tablet products. The device is pitched as a complementary product: a convenient extension of the communication features found in our current range of consumer electronics.

The convenience is in the Gear’s wearability – a text message or email can now be checked with a quick look at the wrist. A photo can be captured from the device’s in-built camera, rather than having to search for your smartphone and launching the camera app.

Other firms are keen to capitalise on this apparent opportunity to make consumers’ lifestyles more convenient with a new range of wearable devices. Sony and Apple are among the other firms rumoured to be planning smart watch products. Other devices with e-paper or other monochrome displays are being launched too: Chinese firm Tomoon is launching a T-Fire smart watch in 2013, while E Ink will be supplying e-paper displays for the upcoming Sonostar smart watch.



But just how 'wearable' and 'convenient' is this generation of smart watches? Most of the products now coming to market are trying to offer smartphone-style quantities of information and notifications in a much more limited form factor. And, as the display for text messages, emails and other notifications cannot wrap fully around the wrist, what can actually be delivered by the smaller, rigid screens available is limited.

Truly wearable

Current offerings are not giving a true picture of the potential of this emerging market, and are therefore not doing the term 'wearable' justice.

The market for truly wearable devices is much bigger than these current smart watch developments would suggest.

Plenty of activity is taking place, in areas such as fitness and healthcare, which will clearly deliver the convenience and wearability hinted at by the emergence of smart watches.

The Samsung Galaxy Gear **Source: Samsung**

This white paper seeks to outline the substantial market opportunities that exist for truly wearable technologies that can offer convenience, comfort, and valuable, additional electronic features to enhance consumers' lifestyles.

Fundamental to this exciting age of wearable electronics will be conformal, flexible electronic components that can be seamlessly integrated into wearable products. With these, developers will be able to create products that match up to consumers' expectations of a wearable electronic device.

Start-ups are creating much of the flexible electronics componentry – from flexible displays, to conformable sensors and batteries – and engineering expertise needed to make wearables practical. And their cooperation behind the scenes on commercial applications should see some truly wearable technologies come to market in the near future.



Smart watches provide an exciting glimpse of how consumers could wear electronics – but do not yet offer the wearability needed. Flexible electronics could change that
Source: Wright Design for Plastic Logic

A definition

Wearable is a rather broad term, and can cover a number of different products that can all impact the electronics market. A wearable object is something that the user actively places on their body, without the need to hold or carry. While the word may conjure up images of clothes, there are many other wearable products that can be grouped together under the category.

Watches are perhaps the wearable technology that is currently in the forefront of most consumers' minds. With smart watch launches and rumours, the technology has done well in highlighting the potential of wearable electronics, even if current offerings do not do the market justice. In

Can a watch be smart?

Watches started out as a technology: first as a series of cogs and springs wound up to power the hands, and then as small electrical items powered by thin lithium batteries. Since then, they have moved to become fashion items, with prestige brands and large, expensive products.

Today, watches are coming back to the age of technology. Many will carry a smartphone in their pocket, and glance at it to tell the time, rather than have a watch on their wrist. A smartphone can do so much more; it is a timer, an alarm, a stopwatch, a camera, a social media portal, and also a telephone.

Therefore, a watch needs to do more than just tell the time. It needs to offer convenience, and it needs to be a multifunctional gadget, something that will appeal to the consumer.

Smart watches represent the biggest hype product at present for the electronic wearable industry. But current devices have tended to be rather bulky, and not able to yet draw on the unique properties that wearable electronics offer. Both Sony and Samsung have launched watches using OLED displays, but firms have not yet progressed to innovative, truly wraparound products.

addition, headsets like [Google Glass](#) can be brought into the same category. So too can sensing wristbands, which offer health and movement tracking.

Clothing certainly plays a part in the future of wearable electronics – for instance, gowns, vests or smart patches for medical patient monitoring of vital signs; or fashion, where integrated electronics could communicate, help the wearer stand out, or allow for dynamic, changing styles. All of the above is being explored, today, by technology developers and multinationals alike.

Wearable technology needs to do a number of things in order to engage the user. It needs to be comfortable, practical, useful and reliable. The ideas for technology to achieve these goals are still developing, even if wearable technology is already becoming available.

A smart wearable device cannot simply be technology for technology's sake – a device that is expected to be bought because it is a gadget. It has to be practical, and do something that the user needs; otherwise it will not be able to carve out a significant market of its own. Smartphones offered connectivity with social media, email and other applications in an easy-to-use interface. Smart wearables need to find their own proposition, around greater convenience or connectivity.

Where will wearables go?

Moving from the smart watch, one of the big opportunities for wearables is in wellbeing and fitness-related devices. The trend for selling devices that monitor the wearer's activity is growing.

Consumers are seeing the value in getting more data on exercise-related metrics, particularly when it is delivered through an inconspicuous device like a wrist strap. Strapping a device to your wrist that you can forget, and that will provide feedback based on heartbeat and movement, has value. This data is often synced with other devices, for users to analyse conveniently – and then enhance the overall picture, by inputting details on other factors such as nutrition.

It is these attributes that wearable electronics can take further. Nike's Fuelband, for instance, uses LEDs to display how much exercise the wearer has done, and reminds them after a certain period that they need to keep active.

Activity tracker supplier Fitbit recently launched a band with a small embedded OLED display that allows users to see detailed information on their movement and activity, while minimising the bulk of the device. The company say it can also monitor movement in sleep.

Consumer electronics firms are taking this opportunity seriously. Aside from standalone fitness monitoring devices, activity monitoring features are being mooted for Apple's planned smart watch, for instance.

Sportswear opportunities

According to Data from ABI Research, sports and activity trackers account for the largest chunk of wearable technologies shipped today. Smart activity trackers are widely available, and are pitched as a desirable lifestyle accessory in ways that make them popular with a broad range of customers. It is estimated 61% of the wearable technologies market can be attributed to sport and activity trackers in 2013.

Juniper Research suggests in its [*Smart Wearable Devices: Fitness, Healthcare, Entertainment & Enterprise 2013-2018 \(second edition\)*](#) report that today's markets for mobile wearable smart devices are worth \$1.4 billion. That is expected to grow to \$19 billion by 2018. These numbers updated [a report to 2017](#), in which Juniper previously stated that 'fitness and sports wearables, followed by healthcare devices are forecast to dominate the market with a combined market share of over 80%' by the end of the forecast period. Clearly a market is already emerging for wearable fitness devices – one that will continue to grow, providing devices can continually develop to meet the requirements of users.

In light of this emerging trend, a broader range of wearable products is being developed for wellbeing applications.

Adidas was one of the first companies to make a move in wearables, acquiring electronics firm Textronics in 2008. The sportswear firm then launched the miCoach system: a clip-on control unit that collects data and provides audible coaching, with the option to couple with a complementary range of sports bras and vests to monitor heart rate as part of the data collection.

Some companies are looking to establish the use of wearables in athletics first. Here, low-volume, premium devices will gain the exposure needed to capture the attention of High Street sportswear manufacturers, leading to higher volume markets.

Massachusetts-based start-up mc10 was formed in 2008 to commercialise research by professor John Rogers of University of Illinois Urbana-Champaign and other scientists. The company sees the human body, with all its complex curves and contours, as the ultimate challenge for its conformable electronics technology. The company's approach takes high-performance semiconductors and integrates them into elastic substrates, like silicones and plastics, linked up by proprietary interconnect and packaging technology.

Athletes' apparel

mc10 has also been working with sports clothing manufacturer Reebok, to develop a helmet that can be worn in sporting events. The device detects blows to the head and feeds back to the sidelines regarding impact, which coaches and medical staff can use to gauge whether a substitution or treatment is necessary.

Elyse Kabinoff, marketing and communications manager at mc10, comments: 'A heavy impact to the head can cause concussion, if not more serious damage. mc10's technology will allow team members to see whether an impact has occurred and how heavy it was, and help them decide whether a player should be rested, and checked. The helmet can be used in all sports. The sensor inside the helmet, which is encased in a breathable mesh skullcap, measures the force of the impact and displays it to allow the correct course of action to be taken.'

The technology could also be used in other fields, such as in motorsports, where impacts to the driver's heads can be recorded and monitored, to allow medical teams to see potential problems.

These developments provide a good indication of the opportunities for wellbeing-related wearables – and, with big-name sportswear brands involved in the development, the commercial impact could be significant.

With access to conformal, flexible electronics, wellbeing applications could be more readily achieved. Clip-on and rigid devices could be replaced by wraparound, discreet wristbands – taking the trend for Fitbit-style devices further. And product developers would have some of the core components needed to produce a range of sportswear with seamlessly integrated sensors. Entire ranges of sportswear could gather a host of complementary data, synced in one easy-to-use online interface – a hub that allows fitness enthusiasts to get the most out of their workouts and sporting activities.

Wearables for wellbeing will help keep fitness enthusiasts in shape; but such convenient access to unprecedented amounts of health-related data could also be applied for clinical purposes. Many developers are creating exciting advances in patient treatment that could revolutionise national healthcare.

Once a patient has been diagnosed with a chronic illness or disease, a critical part of managing a condition is the ability to monitor physiological signs regularly.

Wearable sensors will be one of the biggest application areas for smart fabrics and other wearable health technologies in the coming years, enabling patients and doctors to monitor an illness as part of a total telemedicine package.

"Imagine a healthcare system that can monitor patients' vital signs throughout the day; store that data for further, in-depth analysis; and can provide alerts to doctors or nurses in case of emergencies – all via comfortable, convenient wearable devices"

Monitoring health

The opportunity in healthcare is considerable. Consider the burden of healthcare in its current form. In many parts of the world, there is concern about caring for an ageing population. [A Faculty of Public Health Study in 2010](#) looked at the UK's healthcare requirements and predicted cost increase of 0.48%-1.12% per year for the National Health Service. When taken in the context of a 2011-12 NHS budget of £106 billion, the extent of this burden becomes clearer.

Not only is there an urgent need for smarter healthcare to minimise these additional cost burdens; there is also appetite to find new, better approaches. The UK government's Department of Health published a 'command paper' in 2009 called *NHS 2010 - 2015: from good to great. Preventative, people-centred, productive*. The report 'describes practical measures to meet the demands of an ageing population and the increased prevalence of lifestyle diseases. The vision is for an NHS that is organised around patients whether at home, in a community setting or in hospital.'

Now imagine a healthcare system that can monitor patients' vital signs throughout the day; store that data for further, in-depth analysis; and can provide alerts to doctors or nurses in case of emergencies – all via comfortable, convenient wearable devices. Similarly, the elderly or those with chronic illnesses could be monitored in their homes without needing constant check-ups, thanks to comfortable and robust wearable electronics.

Fashioning a wearable electronics market

The wearable electronics revolution logically progresses to integration directly into the clothing we wear every day. Here, the world of fashion is taking a lead in experimenting with this concept – and generating publicity in the process.

Smart fashion has caught the eye of mainstream media much more over the last year. Pop group the Black Eyed Peas recently completed a world tour, in which lead singer Fergie wore a dress covered in small OLED lighting panels, supplied by Philips.

Singer Katy Perry is another to sport electronic clothing, wearing a colour-changing LED dress to an awards ceremony. The dress was designed by CuteCircuit, a UK company established to exploit the smart textile industry.

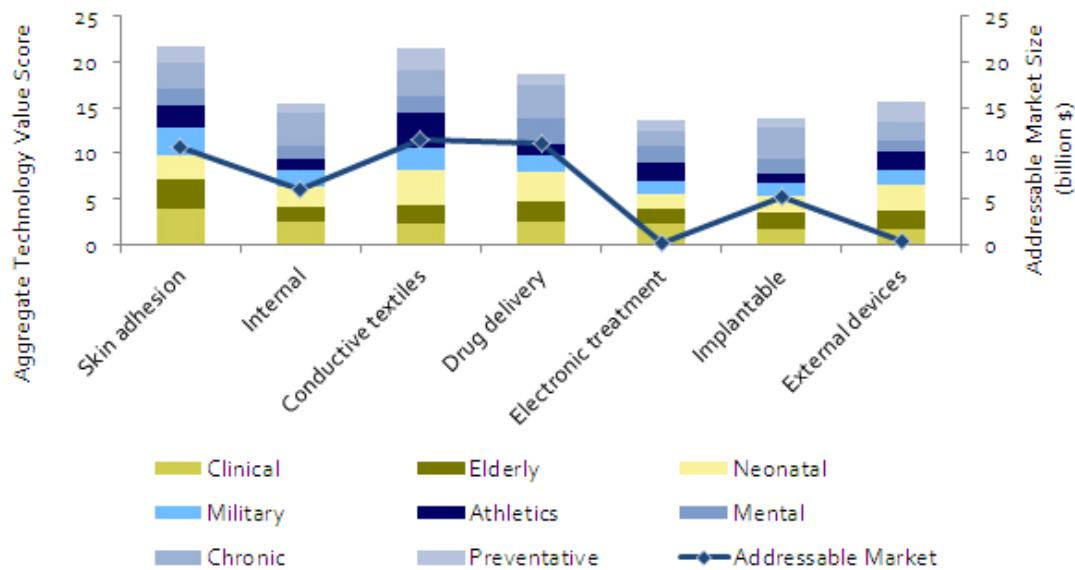
UK-based company CuteCircuit has been designing dresses featuring wearable technology for a number of years. The company's best known designs include a dress studded with LEDs, that allow it to change colour and reflect the mood of the wearer; and a 'Twitter dress', which links to a mobile device and is able to display status updates from social media sites, using integrated LEDs woven into the fabric. This was modelled by singer Nicole Scherzinger in 2012, and caught the eye of a number of media outlets. Designs such as this have created discussion, and throughout many areas of the public, a desire for these items of clothing.

Lux Research highlighted the potential of wearable electronics in its 2012 report, *Keeping the doctor away: The opportunities for emerging electronics in healthcare*. The report highlights the potential for flexible electronics to take a share of the \$300 billion healthcare market. One area alone – electronics in diabetic monitoring – is expected to reach \$10 billion yearly turnover. And there are many other opportunities for skin adhesion sensors, electronic treatments and conductive textiles.

The applications in this field are incredibly diverse. UK firm Ambicare Health sells a wearable, LED-based plaster for 'photodynamic therapy,' (PDT) a skin cancer treatment whereby light is used to target light-sensitive drugs on localised areas of the skin. The technology is also being used as an acne treatment, with the light being used to clear up acne-causing bacteria on the skin. The more portable device means patients can undergo treatment at home, rather than having to visit the site of an expensive PDT facility.

Spanish firm Nuubo has trialled its wearable electronic vests in hospitals, to provide comprehensive and up-to-date information on patients. The Madrid-based company's shirts have been trialled for European and US market certification. The Nuubo system centres on medical-quality electrocardiogram, heart rate and activity monitors.

Beyond medical facilities, such sensing clothing could combine monitors of a patient's health with GPS to locate those recovering at home – and alert healthcare providers in case of emergency.



Lux Research has highlighted the various addressable markets for printed, flexible and organic electronics in healthcare
Source: Lux Research (2012)

Small, conformal 'patches' or 'plaster' could even be worn on the skin, providing a temporary source of sensory data. mc10 has also explored this area, creating dissolvable electronic patches that could be placed on the heart or brain. These temporary items could provide diagnostics during surgery, noting signs of conditions like epilepsy or arrhythmia – and then dissolve harmlessly after an operation.

Central to achieving these market opportunities in healthcare will be reliable technologies, of course, as lives will be relying on their functioning. Developers are working extensively on achieving the required standards of performance through assiduous testing and trials.

Another significant factor for healthcare is comfort. These wearable electronics should offer less invasive means of monitoring patients and those at risk. In order to be accepted they will need to be inconspicuous and conformal to the wearer – particularly if they are to remain in use by people

receiving remote healthcare. Highly flexible technologies will be needed to avoid discomfort and ensure that at-risk patients, the elderly, and other candidates for remote healthcare keep wearing their sensing clothing.

Wearables expanded

Once initial applications like the above have come to fruition, there are many further opportunities for wearable electronics. Various professions require staff to regularly use internal communication systems – for instance, the radio communications devices used by some police forces. The military are also required to carry a number of electronic devices, for communication and data gathering.

There are various other situations where workers could benefit from the capability to wear dynamic signage, communications tools, sensors, or energy harvesting devices.

Other wearable electronic concepts are emerging for consumers too, designed to conveniently integrate with modern lifestyles. Items containing near-field communication (NFC) chips provide good examples. Developers see an opportunity to turn NFC into a pervasive tool for identification – allowing wearers of NFC chip rings or wristbands to unlock doors, smartphones, or even pay for goods quickly and easily.

A project to realise this concept, called the [NFC Ring](#), raised funds via crowdfunding site Kickstarter earlier in 2013. The campaign raised more than eight times the funding goal of £30,000.

From wellbeing and healthcare, to a broad array of professional and consumer applications, there are developers are creating wearable electronics products that meet substantial or urgent market needs. These early projects hope to deliver useful data, communications or security, in a convenient and reliable fashion.

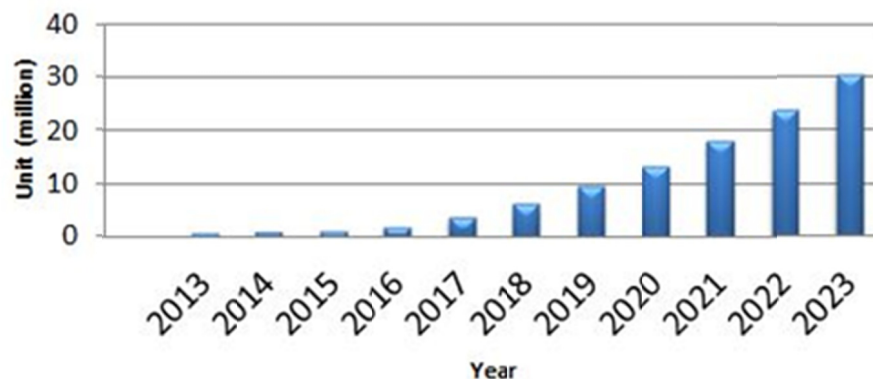
Products that can improve our lifestyles – whether that be in terms of wellbeing, national healthcare provision, or as consumers in a modern, connected environment – are likely to succeed.

And an important factor in improving lifestyles will be technologies The unmet market needs in these areas are great enough to generate significant market pull for flexible technologies that are good enough for real-life applications.

The need for flexible electronics

According to research from the analyst firm Berg Insight, sales of smart glasses, smart watches and wearable fitness trackers reached 8.3 million units worldwide in 2012, up from 3.1 million devices in the previous year. Growing at a compound annual growth rate of 50.6%, total shipments of wearable technology devices are expected to reach 64 million units in 2017.

Flexible and curved displays for smart watch (million)



Touch Display Research sees the flexible displays market growing considerably in the coming years, with wearable accessories driving this trend

Source: Touch Display Research (2013)

Today wearable fitness and activity trackers constitute the vast majority of the shipments. According to Berg, by the end of the forecast period, smart watches are predicted to incorporate much of the functionality of these and will then be the largest wearable device segment.

However, these numbers do not represent a large amount when contrasted with the smartphone market, which is expected to sell over 1 billion units in 2013. This could be down to the fact that truly flexible displays are still in development, and the consumer will not wish to buy something that does not fully deliver the convenience and comfort they need.

As for smart watches, consultancy Touch Display Research predicts that this product category will be using 30 million flexible and curved displays by 2023.

Jennifer Colegrove, president and analyst of Touch Display Research, comments: 'We believe flexible and curved displays are more ergonomic for the wrist, and a larger-sized curved display – such as 2.x-inch or 3.x-inch – can fit well and could show more information. A larger curved display will be the differentiating factor for high-end wearable devices. Furthermore, curved touch screens will be adopted as well on wearable devices for better user interface.'

The 30 million unit figure once again pales into insignificance compared to sales of smartphones; but as the technology will be established with more rigid forms, and still out shipping products such as e-readers, the market will be adapting to new flexible displays that will only have just proved themselves to be reliable and useful.

These figures show that some of the initial wearable electronics markets are shifting rapidly to flexible components. Clearly the capabilities of flexible components fit well with what product developers want to achieve with (and what consumers desire from) wearable electronic products.

Certainly a degree of flexibility and robustness will be required across most of the potential applications for wearable electronics. Components such as displays, sensors and power sources will need to be integrated seamlessly into wearable products.

As such, the toolkit of flexible electronic components will be fundamental to unlocking the potential of the wearable electronics markets. So what is the current state of this wearable electronics toolkit?

Toolkit

There are a number of companies globally that are developing the flexible electronics technology needed to realise the exciting possibilities of wearable electronics. Institutes are coming up with technologies like the energy harvesting tools outlined earlier in this paper, which could eventually power a variety of on-body electronics.

Flexible electronics developers have created solar cells that can be attached to clothing, or accessories like backpacks. Though these remain at the stage of demonstrator, or low-volume production runs, they hint at a future of more integrated, mobile power sources.

And energy harvesting stretches across many sources. In 2012, UK mobile phone provider Orange backed a T-Shirt design which used piezoelectrics to provide charge to a mobile phone. The clothing would use sound waves, the idea being that wearers could charge mobile devices at a festival or anywhere without a plug-in point. While the panel would not be washable, it would be removable, allowing for washing.

Another element of the toolkit to power these integrated electronics is the flexible battery. Flexible batteries will be a required element for wearables to be fully functional in some other application areas, in order to create thin, comfortable and conformable applications. US institute NorthWestern University and the University of Illinois at Urbana-Champaign demonstrated a stretchable battery in March 2013. The team showcased the achievement by using it to power a commercially available LED. The battery can work for around eight hours

Features of wearable electronics

Wearable electronics will succeed in applications where they can add value in the following areas for consumers:

Comfort: Wearable electronics centre on making electronic components and circuitry fully integrated, conformal items in an accessory or item of clothing. Developers are seeking to make it increasingly unlikely that consumers will notice the electronics integrated into what they are wearing. Many people who are currently required to wear electronics – for instance, monitoring systems for at-risk hospital patients, or emergency services workers using radio communications – could do so in greater comfort than before with integrated electronics.

Convenience: Having email accounts, web browsing, social media and many other features in one smartphone device made consumers' lives much easier. These devices provided a better fit with consumers' lifestyles, as so much more of the information they use and interaction with others was to be found online.

Wearable electronics could enable consumers to add convenience to their lives on a number of fronts. For instance, communication tools could be accessible via a smart wrist watch. Or more data could be gathered by wearable wellbeing devices, allowing consumers to make better, more informed decisions about their health and activity.

With the potential to integrate communication, sensing, data, displays, energy harvesting and other features in accessories or even clothing, wearable electronics could create a revolution in consumer lifestyles.

Portability: Increasing the portability of technologies we need regularly throughout the day. This was part of the value of smartphones and, to a lesser extent, tablets – making PC tools and information available on the move. Wearable electronics could integrate many of these features to a greater degree than is possible today.

Robustness: Making existing devices that need to be worn or carried on the person more resistant to damage certainly adds value for consumers. This may involve directly making a device like a watch shatterproof; or it may involve helping consumers avoid breaking devices like smartphones, by reducing how often they need to be taken out of pockets and bags.

before it needs recharging, which can be done wirelessly, and can be stretched and flexed repeatedly.

The battery could take at least three years to be developed for market. Future research will be needed on developments of new slurry chemistries, separator materials, and stretchable, air-impermeable packaging materials, so as to improve the cyclic performance of the battery. These steps could increase the lifetime of the battery, which is important for commercial applications.

Two core elements of the wearable electronics toolkit – displays and sensors – will similarly need to achieve robustness and prove their performance.

Flexible displays already exist with e-paper, but even these currently need rigid cases to contain delicate electronics and batteries. Even devices such as the e-paper-equipped Sonostar watch use a curved display behind a transparent, rigid substrate. The Pebble smart watch, which many think of as an e-paper smart watch, uses a 'transflective' LCD from Sharp, and houses the screen in a bulky frame.

"Fundamental to achieving this watershed in wearable electronics will be the flexible transistors used to drive a display, or manage the function of a number of sensors"

Large consumer electronics firms like Samsung and LG are working on flexible OLED displays, but have yet to overcome all of the challenges to make these market-ready. These companies are instead launching products with curved displays in the near-term, which will continue to require rigidity and glass covers.

Truly robust and flexible displays will be a much better fit for many of the market opportunities mentioned earlier in this paper. Conformable displays will allow users to forget the device they are wearing, and use it conveniently.

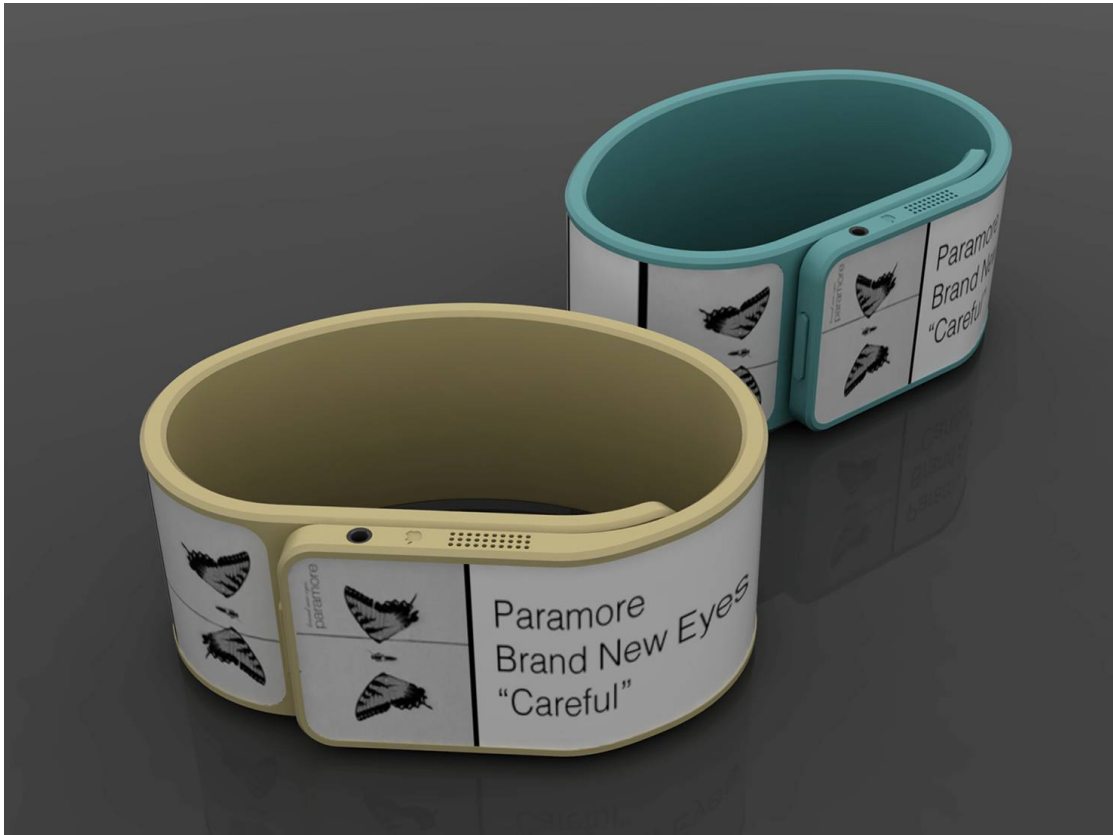
Accessories could fit around the wrist, for instance, with information scrolling all the way round on a single, wraparound display. Sensing functions, too, could be added to the fully integrated product. And all of this would be possible in a robust device that can handle all of the bumps and knocks that a conventional watch withstands on a daily basis.

Fundamental to achieving this watershed in wearable electronics, therefore, will be the flexible transistor backplanes used to drive a display, or manage the function of a number of sensors.

Developments

One company developing displays for the future is Plastic Logic. Once known for its work in the early e-reader market, the UK company has successfully refocused to being a technology provider that works with partners to enable multiple end applications. The company has demonstrated an array of such applications for robust, flexible displays, in everything from smartphone accessories to large-area digital signage.

Plastic Logic is also working on developments for the smart watch industry. It has already demonstrated the potential of genuinely flexible displays in a device that included colour layers and a completely flexible substrate wrapped around a wrist. This was powered by an external source, but shows the potential if flexible, stretchable batteries come together with flexible displays.



Flexible electronics would enable wraparound displays and sensors, unlocking some of the true potential of wearable devices

Source: Wright Design for Plastic Logic

The company has a production facility in Dresden, Germany, delivering flexible displays using organic thin-film transistors (OTFTs) at high yields. These backplanes have been produced containing 1.2 million transistors. Displays have been tested extensively for bendability, among other relevant features for robust – and potentially wearable – electronics.

Based on this expertise, Plastic Logic is now working with big-name firms in consumer electronics and other fields on a number of commercial demonstrator projects for wearable devices.

Allowing products to wrap around our bodies, and therefore conform to our everyday lives, is key for the market to move forward. Flexible displays will allow smart watches to become practical

pieces of technology that can display more, and integrate with our lives. Wristbands could merge with flexible smart watches to create an 'all-in-one' product. Flexible batteries will enable better fitting, and more mobile, sensor equipment for healthcare and fashion industries. And a better understanding of piezoelectrics will allow for clothing that can charge devices, and work on their own without the need for a separate power source.

"Truly wearable electronics will do a better job of addressing the needs that products like smart watches and wearable fitness monitors are clearly trying to satisfy"

Challenges

There are still a number of challenges to address for all possible uses of wearable electronics to be realised. If electronics end up being integrated into many items of clothing, the robustness of electronics will need to continue to improve. And washability is a hurdle that has yet to be overcome, though a number of wearable electronics products do allow for gentle 'wipe clean' steps on a regular basis. Nevertheless the progress made so far shows that truly wearable electronics can be created.

The launch of products like smart watches has certainly got people thinking about new ways in which electronic devices can be carried and used. But this is not yet the dawn of the wearable electronics revolution.

Smart watches have been positioned as a new category of device; but, in essence, they are simply displays with a strap.

When Apple launched the third-generation iPod Nano, it did so with a case accessory, that could allowed the mp3 player to be worn around the arm, so those who used the device when running could do so without worrying about it falling from pockets, or off belt clips.

Therefore, this was an iPod with a strap, and not a wearable electronic device. This is the same as current smart watches. In reality, they are displays with straps, rather than fully wearable electronics.

If we take the priorities of wearables – such as convenience, comfort and practicality – smart watches in their current forms fail to deliver. They are an extension of a smartphone; but consumers are used to managing large amounts of data on a phone's screen. A smart watch with

a small display will not be able to provide all the data needed. The possibility of getting a four-inch planar display onto a wrist is impossible.

This is where flexible electronics will come in. The huge market opportunities discussed here will rely on a set of electronics that can deliver the convenience and robustness consumers are looking for from wearable products.

Realisation

Thanks to the progress being made by technology developers, various wearable electronics products are now close to market, as developers partner with high-profile brand owners and OEMs on product designs. When these come to market, the true potential of wearable electronics will be apparent to consumers.

The convenience and portability they provide could quickly become a fundamental expectation of consumers, much as the smartphone's feature set has progressed from revolutionary to everyday.

Truly wearable electronics will do a better job of addressing the needs that products like smart watches and wearable fitness monitors are clearly trying to satisfy. Robust, flexible electronics will make integration, wearing and use easier. Fundamental to this is the wearable electronics toolkit – the range of components needed to realise the many and varied opportunities in the marketplace.

The smart watch may fall short as a demonstration of what wearable electronics can achieve, but it has shown that both big consumer electronics firms and the consumers they serve, have an appetite for more portable, convenient electronic products. This is a demand that truly wearable electronic technologies could satisfy.

With some commercial launches on the horizon, a revolution of truly wearable electronics could soon be underway.

About this white paper

This white paper was produced by *+Plastic Electronics*, in association with Plastic Logic.

+Plastic Electronics

+Plastic Electronics provides authoritative analysis for the printable, flexible and organic electronics industry. *+Plastic Electronics* magazine was launched in 2007 to provide exclusive insight and analysis of market developments for businesses across the plastic electronics value chain. *+Plastic Electronics* now produces a range of free and subscriber-only content on plastic electronics, including a digital subscription service, quarterly print publication, and range of industry insights.

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Plastic Logic

Plastic Logic is a leading developer and supplier of flexible electronics, based in Cambridge and Dresden, where it has been at the forefront of research and investment into plastic electronics.

The company was the first to fully industrialise the mass-production of plastic electronics in the world's first organic electronics factory, achieving production yields of flexible plastic electronic displays comparable to the LCD industry.

Plastic Logic now leverages its R&D and manufacturing resources to allow partners such as OEMs, system integrators and device manufacturers to utilise its flexible display technologies.

For more information visit www.plasticlogic.com.