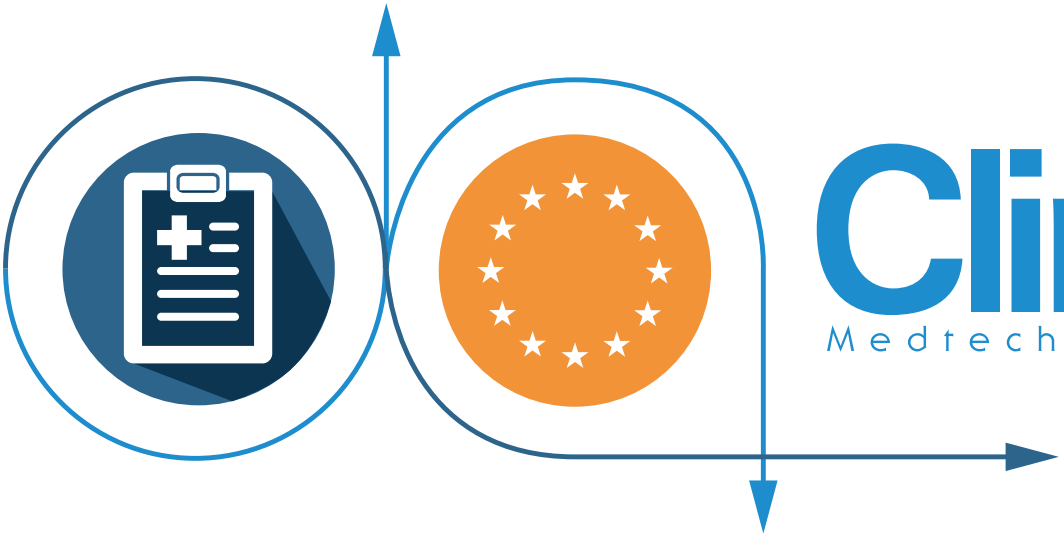

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How to benefit from the bigger opportunities in wearable technologies

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How to benefit from the bigger opportunities in wearable technologies

By David Pettigrew

TO DATE, THE MARKET FOR WEARABLE DEVICES has been focused on individual applications in health & wellness and there has been limited scope for differentiation. There are however new and untapped opportunities to take this further into areas that could have a real impact on patients and the way in which the medical industry interacts with them. David Pettigrew* discusses where the opportunities in wearables lie, how he sees the market developing and the technical challenges that need to be considered

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Wearables are very much 'in vogue'. Companies from diverse sectors – Apple and Nike through to Samsung and Ralph Lauren – have all thrown their hats into the ring, keen to secure their slice of a market predicted to be worth $70bn by 2024, according to a report by IDTechEx. Until now, the focus of investment has largely been on introducing new and increasingly attractive fitness and physical activity monitors. Devices such as Fitbit, Jawbone and Nike FuelBand have all proven to be popular and there are reasonably high hopes for Apple's HealthKit, a central platform for health information that works with third party apps, as well as Samsung's Simband, which leverages an array of hardware and software to accelerate innovation in personal health technology.

Whilst these developments are certainly interesting, they only scratch the surface of what could be possible. This is largely because the wearables industry is still relatively young and new entrants have prudently focused on quick wins and the short term; they are keen to test the waters and consumers' acceptance of the product category before they go too much further. Keeping innovation focused on aspects such as visually appealing design and software algorithms has been the safest way to do this. But this won't be the case forever. As we move beyond hype and find ourselves securely in a more sustainable marketplace, it will become increasingly difficult to ignore the unexplored potential at the technological level and the plethora of opportunity this could open up in terms of product reach and consumer promise. With only the tip of the wearables iceberg uncovered, this presents a really exciting opportunity for forward-thinking companies to reap the longer term benefits.

Wearables in healthcare today

In essence, wearable technologies are devices that contain a tiny computer that senses, processes, displays, stores and forwards data to a remote device via wireless communications. These devices usually fall into one of two camps: fitness and wellness monitors and medical devices, the latter being less developed to date. Regardless of the application, however, current wearables fundamentally rely on the same core building blocks. For example, accelerometers and gyroscopes are used to monitor movements; optical technologies are used to monitor oxygenation and pulse rate; Bluetooth low energy is usually the primary means of communicating data to and from a product; and a smart phone is typically used as the primary user interface and gateway to the internet.

With many of the building blocks in common, today's wearables products are differentiated by the way they look and the set of services they provide. For example, some movement sensors target the fitness market whereas others are focused on sleep monitoring, and their form factor will follow suit. Importantly, the core patentable aspects of today's products are the algorithms; taking the common inputs (raw data) and turning them into actionable and engaging information that appeal to the user.

> David Pettigrew: "There are some technological advances taking place that support a whole new set of product features and will allow products to interact and engage with consumers at a new level"

This has led to an increasingly visually appealing set of wearable medical and wellness 'gadgets' that have gained significant traction with consumers. We have even reached a stage where it is not inconceivable for a diabetes patient to not only have a glucose monitor and an insulin patch pump, but also an activity monitor, a healthy eating app and even a smart watch to help them manage their condition. But we may have reached saturation point and now that these products have become more common place, consumers are finding themselves inundated with various touch points of information and real estate on the body is coming at a premium. The end result is that companies are struggling to retain user engagement and business models are being questioned.

Luckily, there are some technological advances taking place that support a whole new set of product features and will allow products to interact and engage with consumers at a new level. This includes:

- The miniaturization of a computer's size but with increased capabilities;
- Increased availability of low cost solid state storage capacity;
- Enhanced audible, visual, or haptic interfaces which makes feedback more immediate and effective;
- Rapidly evolving wireless communication techniques that makes communications more efficient with higher data rates and lower power;
- Increases in sensor sensitivity and accuracy enabled by micro-electromechanical systems and nanotechnologies;
- Dramatic increases in processing capabilities, delivering high performance at low power

The advances highlighted in the 'wearable human' in Figure 1 are all areas that developers can use to move beyond off-the-shelf, commodity technologies, offering something more ambitious and more differentiated. This will allow more advanced measurements and will enable multiple and new physical and vital parameters being measured all in one consolidated product. So consumers and/or patients will need fewer individual devices and get more out of them.

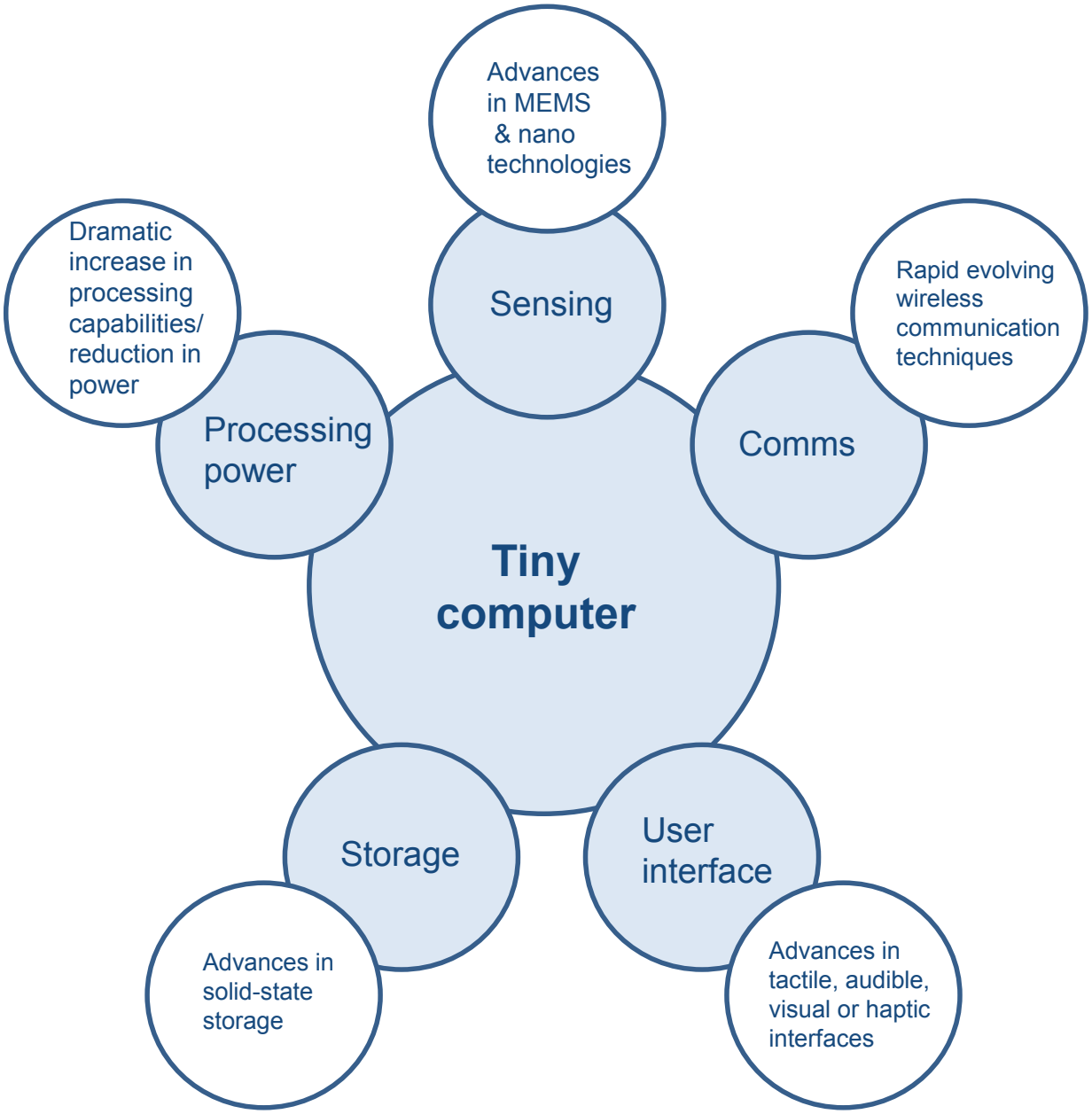
A great example of a company that seems to be looking at this type of advancement is Scanadu. Scanadu have developed a solution for accurately measuring blood pressure in a handheld or wearable device without the need for a cumbersome inflatable cuff. The key enabling technology is believed to be based on a novel combination of optical photoplethysmography (PPG) and electrocardiogram (ECG) measurements. It is this new core technology that will elevate Scanadu above their competitors, who primarily seek to differentiate themselves from each other with minor differences in form factor, connectivity options and data presentation.

Another relevant example of disruptive innovation in the wearables space is in the measurement of blood glucose. Incumbent manufacturers have offered a wearable solution for monitoring blood glucose continuously, but the utility of their current offerings is limited by the fact that they all use the same legacy electrochemical technology to measure glucose. Again, differentiation is in the form factor and services built around this sensor, and in relatively minor incremental improvements in the sensor itself. New wearable solutions from Google X and Senseonics are breaking this mold by integrating more advanced sensors in contact lens and/or micro-implantable formats. These solutions will result in a step change in sensor accuracy and form factor and will give these companies a clear advantage over the incumbent "me-too" crowd.

Three evolutionary waves of wearables

So from the wearable products we have seen to date, a range of established and consolidated 'back end' services and platforms have been leveraged and, as mentioned previously, novel analysis algorithms have been layered on top of these to provide core product differentiators. Android and iOS-based smartphones are obvious examples of common platforms; providing both an engaging user interface and a means of uploading the data, but less visible examples such as Amazon's cloud service have also been important in providing the necessary infrastructure to upload and store user data. In the future, these 'back end' solutions will continue to converge and consolidate, and common analysis tools will be essential for making sense of all the data. This means that in the future, true differentiation will come via the emer-

Figure 1: 'The wearable human': Key advances enabling wearable technology

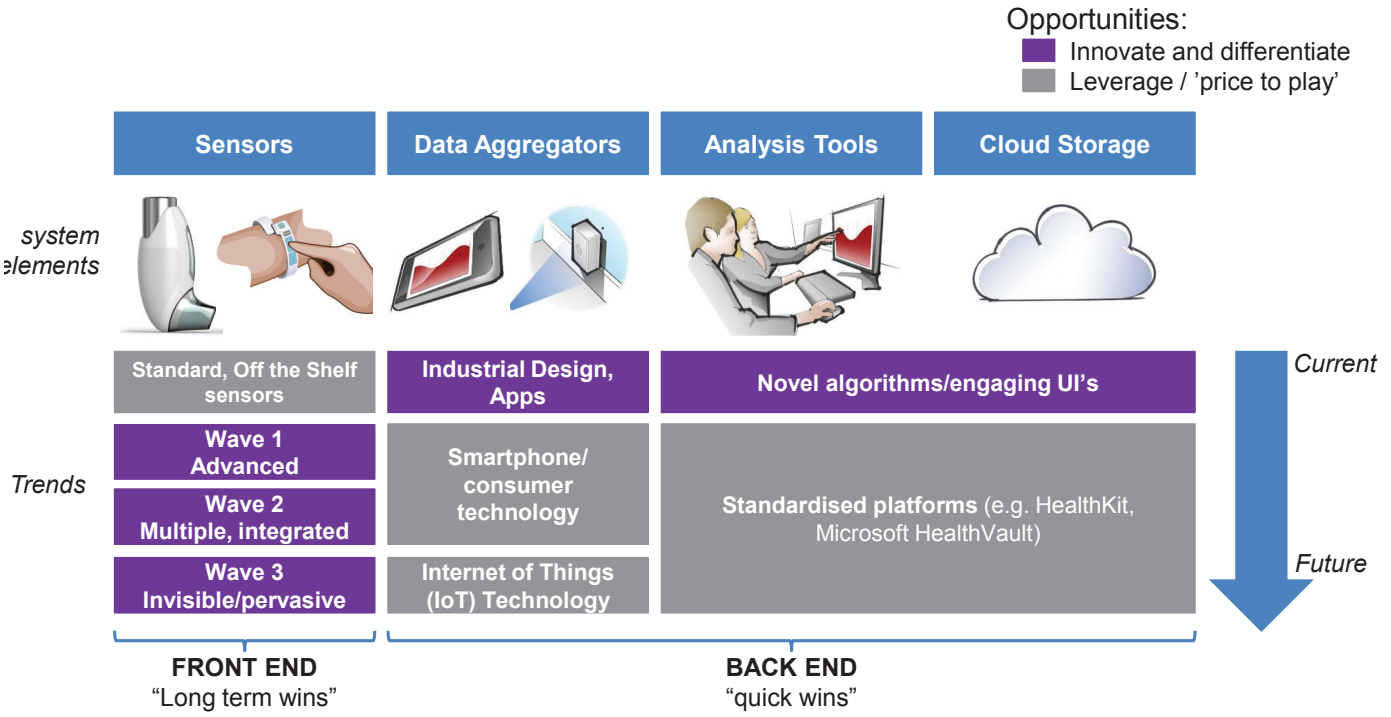


gence of novel 'front end' solutions which collect the data and plug into the common 'back end' systems.

The timing of the evolution of wearables is difficult to predict but one can easily see it unfolding in three distinct waves or phases (as illustrated below and in Figure 2):

- **1st Wave (standardization):** As it stands, the majority of wearable devices measure a single parameter, or a combination of a very limited number of 'easy to measure' parameters, for example, your heart rate, movement, etc. They are also designed with specific applications in mind – for example diabetes care or 'wellness'. These solutions use commodity sensors and so seek differentiation through the 'back end' in terms of how they aggregate and serve up that data to the individual. Increasingly though, the standardization of data collection, analytics and cloud platforms will drive more companies to shift their focus to developing advanced 'front end' sensors in order to carve out new market opportunities.
- **2nd Wave (convergence):** Invariably, a more concentrated developer's focus on the front end will be the result of the standardization outlined above. This will lead to companies and manufacturers seeking to develop novel solutions for integrating and converging more technologies into one wearable device. These devices will be able to measure multiple advanced parameters for more than one applica-

Figure 2: The evolution of innovation in wearable technology



tion. At this point, supported by miniaturization, we will see more varied and wide-spread applications of novel sensors that will allow new ways of monitoring multiple measurements. For example, devices will be able to both sample the required fluids and measure the constituent molecules using sensor arrays within the wearable.

- **3rd Wave (transparency):** This is the most exciting stage, where ultimately wearable devices will essentially become invisible and pervasive. Here we are likely to see innovations such as electronic "tattoos" which are actually integrated into or conformed onto the skin, or even tiny implantables which measure multiple indicators and communicate with smart devices outside of the body. The technology for this advancement in wearables exists today in different and less developed guises, for example MC10 are developing an electronic tattoo capable of measuring temperature and ECG, amongst other parameters. A company in Norway has chipped employees with implantable RFID chips in order for them to gain access to the building. This technological foundation will be widely leveraged in wearables within the next 7-10 years.

As we begin to move from wave 1 to wave 2 and beyond, we will also see a measurable impact on the patient experience and the delivery of healthcare- by making wearables more functional, adaptable and pervasive. It will also be possible to engage the patient more and empower them to make informed lifestyle changes which will benefit their health. If problems do occur, medical intervention can happen earlier in the care pathway and result in improved outcomes, ultimately reducing the cost of care.

Technical challenges

It would be remiss not to state the obvious; the cool stuff doesn't come without its fair share of potential product development challenges. Companies that do solve these complex issues, however, will have the greatest opportunity to reap the market rewards.

- **Batteries:** Batteries are the fundamental driver of product development in mobile electronics. The rapid growth in modern wearable technologies has created an explosive demand for higher capacity batteries and its current offering is a major limiting factor for wearables' potential. In addition, manufacturers must balance battery life with size restrictions of the device's dimensions.

- **Integration into back end systems:** Integration of new devices into existing back-end systems is another issue. Incompatibility of software has already been seen with Android Wear and Apple iOS 8. As already witnessed in the smartphone and music device markets, major corporations will launch devices and consumers will consolidate depending on which brand of mobile or computer

they already have in order to continue compatibility of devices. The market will polarise and this could hinder innovation. If a consumer base is guaranteed then developers might be tempted to focus on software rather than hardware, and this is a problem already visible in the current wearables landscape; guaranteed custom will only make it worse. Rather than just overcoming technological limitations, developers must innovate.

- **Designing for a wide range of operating environments:** At the risk of stating the obvious, wearables are only useful if you wear them. Asking the user to remove the device when they go swimming or to discard the data when they are doing particular activities, for example, will make it less useful and will limit its uptake. This can be extremely challenging and result in undesirable technical trade-offs. For example, an entirely waterproof device is difficult to achieve if a USB cable is needed for charging it.

- **Biocompatibility:** Devices worn on the skin can cause allergies, or can promote physiological changes (e.g. sweating/immune response) that can interfere with the sensor measurements. For example, Fitbit had a recent problem with its Surge wristband whereby within four months of launch consumers were complaining of skin rashes. The lifetime (and accuracy) of body-worn glucose sensors is severely limited by the bio-fouling of the sensor caused by the tissue trauma resulting from the insertion of the sensor probe into the skin. These problems will become more prominent as devices shift from being attached to patients to being miniaturised and implanted into the body. In addition to problems associated with sensor performance and allergies, developers often forget that the human body is 70% water and that wireless signal range (particularly at the frequencies that Bluetooth Low Energy operates at) can be dramatically reduced as a result of the transmitter being placed onto or within the body. This can make it very difficult to extract the data reliably. If such biological effects such as these are not considered, the device will not be useful.

Beyond these technical challenges, thought must also be given to regulations and the impact of different legislative frameworks across territories. Without due consideration, regulations can make it difficult for companies to shift from a local product to a global user base, especially between the US and the EU. For example, measurements using Ultra Wide Band (UWB) technology can be used to measure respiratory rate and heart rate, but the allowable bands differ between the US and EU. In addition, Europe's regulations tend to be more conservative and concerned about data security. These considerations must be factored in as early as possible in a new wearable system development, or the ability to roll out a new product in several territories will be severely limited.

Differentiation will come from technical innovation

Wearable technologies have created a highly competitive market that is rapidly evolving. Until now companies have been constrained both by the market and by available technology and have developed wearable products by focusing on repackaging versions of existing technologies that simply monitor, transmit and report specific data from relatively basic sensors such as pulse rate.

No matter how pretty a device looks – consider Fitbit Flex's collaboration with accessories designer Tory Burch last year – if the hardware isn't innovative then the outcome will be the same regardless of software applications or design packaging.

As the market evolves, however, we are sure to see the advancement of wearables and an expanding set of capabilities and promises that they can deliver to consumers and the healthcare sector at large. We are already seeing signs of this, but we're really only just at the beginning of understanding the full potential. Success will be shaped by timing, innovation and approach. But what is clear, is that through the innovative application of front end technologies and by combining medical scientific and technological innovation, companies can use novel sensors in order to develop more intuitive and accessible devices, with more sophisticated integrated functionality. This will allow for real differentiation and a revolution in terms of what consumers and patients can expect from the wearables market.

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