Trend and Strategy of Wearable Devices Design

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A bstract

Focusing on the development trend of wearable devices, based on the existing references and information from the market, this research combines concepts and thoughts from product design with a focus on the core of user needs. This research analyzes the ongoing development of wearable devices. Further, it discusses the reason for the growth of the wearable devices market, thus finding that sports and health-related wearable devices have become the primary focus for brand manufacturers. The paper analyses standard features and interfaces between sports and health product categories as the categories of significant development in the wearable industry. We additionally argue that the wearable industry has become more robust as sports and health wearable products play a crucial role in users' daily life. We reveal the creative trend for wearable devices by analysis the development of the industrial practice. As high-tech and user-centered design strategies gradually develop to discover the real user needs, the wise wearable devices union will evolve into a "smart space" phase in the future.

K eywords
Design, Wearable, Interaction, Sports, Health.

Introduction

Sports and exercise are significant ways for human beings to maintain health. Nowadays, the quality of design of sports products is continuously developing and benefitting the quality of our lives. Thanks to the progressive development of digital technology, devices have become smaller and portable. They are increasingly being integrated into garments and other body accessories. We call them *wearable devices*, which are worn on the human body or clothing (Xie et al., 2020). From a product design perspective, it is interesting to study the evolution and integration of such products in the sports industry and discuss upcoming development opportunities.

Scopes and Features of Wearable Devices and Health Products

1. *Major Trends in Product Design*

From the production of basic lifestyle facilities in the past to the contemporary evolution of intelligent technology, human-centered design is an established concept that affected the entire development of innovative product design. Especially for those unclear design directions and challenging to find the way of commercialization, like intelligent clothing, the human-centered approach can help designers understand the consumers better (Ariyatum et al., 2005). Moreover, we are also experiencing a multiplication of products due to the advancement of technology. About 30,000 new products are launched yearly (NielsenIQ, 2019). We argue that HCD and considering the user needs influence product development and innovation. The general developing pattern of technology has proved this. Let's take computers as an example. The first electronic computer was created in the 1940s, occupying 150 square meters and weighing 30 tons. Whereas in the 1980s, despite the screens' size increasing, the computer's size was significantly reduced and would fit on a table. Consequently, computers could become individual consumer goods (Liang, 2013). Moreover, with the innovation of portable devices and the diffusion of wireless connectivity, smaller and more compact wearable devices have become increasingly common, often used in sports and health, fashion, and lifestyle (Berglund et al., 2016).

This is the convergence of technology trends and the demands of users seeking product innovation and simplicity in their lives. We could argue that, in a long-term scenario, people would support the possibility of the products becoming *none* (Xin, 2011). The concept of *none products* refers to the possibility of not carrying any device along, yet enjoying ubiquitous services. For this to happen, the products we would need in our daily life would be translated into public and shared spaces with the no-material device, which would integrate into a *smart space*. In the long term, the human-centered design would reach a condition with *None* products (Chen, 2000).

2. *Differences and Similarities between Sports and Health Products*

Nowadays, we are experiencing the integration between garments and equipment. Sports and health are two connected dimensions. Regular participation in physical activities benefits both physical and mental health (Leavitt, 2008). On the other hand, a healthy body can perform physical activities. So we can say that sports is the method, and health is the ultimate goal.

Sports products in the market appear mostly as garments and accessories. By discovering new typologies of sports activities and specifying existing sports categories, the product design is transferred from garments to equipment. More and more professional sports equipment strived to bring customers better experiences.

On the other hand, health products firstly encompass medical equipment. Those products are evolved and popularised based on medical science and human health study requirements. Looking at the current health product market, we learn that health products are transferring from the design of equipment to the design of garments. Moreover, more and more, health products have become user-friendly (Chen, 2007).

3. *Design Intersection Triggered by User Experience*

Although sports products are conducted after people's living condition reaches a certain level and those products tend to be specified as developing, the developing process of sports product design is still similar to industrial product design.

Traditionally, humans intentionally and spontaneously engage in sports and physical activities; therefore, the primary purpose of sports products is not to motivate people to move, but to provide better and more comfortable sports conditions. For instance, sports garments provide functions such as better breathability of fabric and lighter weight, so that users can enjoy exercise without being bothered by wet or heavy outfits.

However, more recently, and particularly in urban settings, sedentary lifestyles have increased. Therefore, the challenge to encourage people to engage in physical activities is back on the table and even becomes a necessary goal in designing sports products.

If compared to sports products, the definition of health products is broader. To support the continuous aspiration of a high-quality lifestyle, health products, especially products designed as medical equipment, pay more attention to patients and doctors as users. Not only limited to the functional design, but such products also embed the concern for their users' psychological and emotional feelings, i.e. they are designed with beautiful shapes that can enhance a relaxing mood or provide a stronger pleasurability to the users.

In conclusion, the development trends in sports and healthcare products industries suggest that user-centered design concepts could contribute to integrating such domains, with the benefit of providing better services for their users. In such a scenario, both of the product's typologies will require a redesign or more attention to details in order to meet the requirements of the user-experience design.

This convergence between sports and healthcare product design is supported by different technological trends such as;
1. integration of human-machine interaction
2. Parameterization, collection, and sensing of user data.

On the other hand, they still maintain different scopes: sports products emphasize digitalization and performance and involve gamification incentives; the design of healthcare products focuses instead on safety, privacy, and companionship (Chen & Liu, 2008).

Figure 1: *HUMAPEN® SAVVIO insulin pens designed in partnership with IDEO (2013).*

I will demonstrate this concept with an example. The design of the insulin pen is a typical example of centralizing the companion and privacy aspects. Figure 1 is a HUMAPEN® SAVVIO insulin injector that was designed by IDEO (Watterson et al., 2022). From only their appearance, it is difficult to tell the difference between this injector and a regular pen. This is also why people call it an *insulin pen*, and this name confirms how the product is equally portable and discreet.
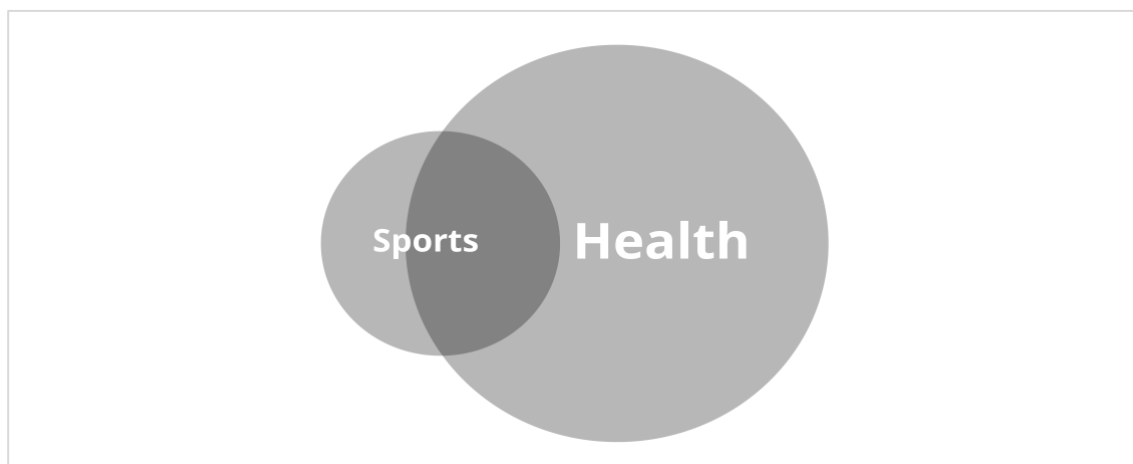

Figure 2: *Conceptual relationship between sports and health products.*

In conclusion, as schematized in Figure 2, I believe there is a significant intersection between sports and health products despite the differences in the industry. The scale of healthcare products is more extensive, yet wearable devices will fall at the meeting of these domains and will be designed and developed according to the pattern and requirements.

The Boom of Wearable Devices in Sports and Health

As shown by the market of technical products in recent years, there was a massive number of brands launching wearable products in the sport and healthcare fields (Xin, 2011). After sorting out the time line of the products of mainstream wearable device brands in the market (Table 1), Citing Xin's investigation is also verified, so we will discuss further the current aspect of the wearable devices market.

Table 1: *Wearable devices in the market and released timeline (2008~2014).*

Company	Released Time	Product	Note
Fitbit	2008	Tracker	First wearable product
	Oct. 3rd, 2011	Fitbit Ultra	Updated product
	Sep. 17th, 2012	Fitbit One, Fitbit Zip	Updated product
	May, 2013	Fitbit Flex	Updated product
	Oct. 10th, 2013	Fitbit Force	Updated product
Nike	Jan. 19th, 2012	Nike+ Fuelband	Sale on web
	Nov. 27th, 2013	Nike+ Fuelband SE	Updated product
Google	Sep. 18th, 2013	Calico Company	New company focusing on health and medical products
	May 14th, 2014	Google Glass	Sale in the US
Samsung	Sep. 5th, 2013	Gear fit	
	2013	Gear fit, Gear2, Gear2 neo	Updated product
	Jun. 26th, 2014	Gear live	Four products in brand
Sony	Feb. 26th, 2014	SmartBand	New product
Huawei	Feb. 24th, 2014	TalkBand	New product
OPPO	Mar 19th, 2014	O-Band	New product

1. *Volume*

The volume of wearable devices is satisfying not only for sports products but also for health products. The comfortable way of wear and the cute diminutive size could quickly reduce its disturbance to users' physical activities, and at the same time, meet users' requirements of privacy as a health product (Jing-Can et al., 2008).

2. *Hardware Difficulties*

Internal Component

All the internal components of wearable devices are attempting to reduce their own volume, as well as their energy consumption. This could allow them to support more functions of wearable devices from a long-term view.

However, as of the status quo, we cannot determine that they will be over-functional (Lin et al., 2009).

Figure 3: *Fitbit Force.*   **Figure 4:** *Jawbone UP.*

Material

Wearable devices need to have a seamless relationship with human bodies, so there is a critical requirement for the materials. In early 2014, *Force band*, a wearable product from Fitbit, had to be recalled by the brand due to its material, which is likely to cause skin allergies in its users (Park, 2014).

Assembling

Wearable devices are primarily used when users swim, run, or hike. Thus, humidity or even wet conditions require products with high-quality assembling. For example, Jawbone Up band (Figure 4) once made a public apology for the high failure rate of its hardware during the early stage of its product design.

In order to overlook these difficulties, a leading mindset and workforce are needed from design throughout the entire supply chain, which now only a few large international corporations would be able to achieve. Based on the current situation, investing in launching a sports and health product with relatively simple functions certainly will become a business strategy that will create high ROI.

3. *Knowledge Accumulation*

Along with the longstanding R&D for sports and health products, designers in the industry accumulated plenty of design research and production experience. Among that accumulated knowledge, relationships between humans and machines are incredibly restricted and detailed (CaoXin, 2011). For instance, as most product designers now know, when designing a waistband, human waists should no longer be considered as a simple circle. There should be different sizes and shapes based on human-centric research statistics in order to meet the requirements of varying gender and human species. This could also explain why so many technology companies could be able to turn into the wearable device market with their sports and health products.

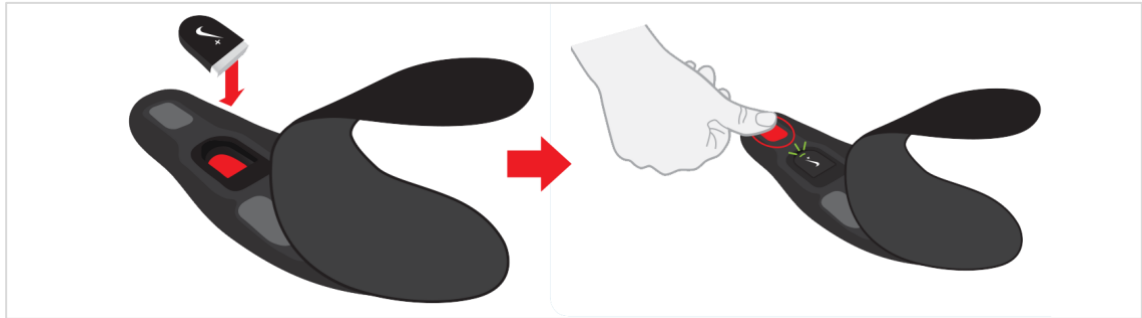**4.** *Updating Requirement*

Figure 5: *Nike+ training shoes set up.*

Sports products are consumable and quick-updating, and wearable devices are in the experimental design phase. So that keeps updating comes to be a requirement for both. Sight on those wearable device companies in the past, most of them will update their products in around two years, or some of them even stop the old product lines. The embedded sensor in Nike+ is a collaborated product designed by Nike and Apple Company. Shoes that support Nike+ modules will have a Nike+ sensor in them, and in the meantime, connected Apple products will be able to display all of the activity information collected by the sensor (NikePlus Support, 2016). This sensor was claimed to work correctly for two years on a daily wearing circumstance and needed to be abandoned after that. However, considering the lifespan of a pair of running shoes, even though the sensor is fully sealed and not rechargeable, I believe it is still enough to satisfy customers.

To sum up, all stated above caused a situation where most wearable devices are designed as sports and health products, as sports has become their entry points.

Creative Trends for Wearable Devices

1. *Started from Sports Products, and Then Infiltrate into the Health Industry*

As proved earlier in this research, sports product innovation is the most accessible entry point to the wearable device market. However, creating health-related wearable devices is the ultimate goal. In order to be successful in the routine, it requires not only an understanding of sports product design but also massive research and data related to human health and medical science.

It is being said that it will need an even more extended period of time for R&D than it for sports products. Google founded Calico Company with a business focus on health, and it was disclosed in their official statement that this is a long-term investment; ROI could possibly be expected in more than ten years.

Recent advancements in healthcare wearable devices (HWDS) include Textile-based HWDS, E-skin or tattoo-based HWDs, Sweat-based HWDs, and Tears-based HWDs to be used for physiological and psychological monitoring essential for the treatment of different diseases in various professional fields (Iqbal et al., 2021). Once technology and cost are controllable, these professional test products will be available for large-scale application and commercialized.

2. *Diverse Sources of Data Collection*

By far, wearable devices are able to record essential data like people's heart rate, electrocardiogram (ECG), blood glucose, sleeping quality, activity path, etc. For example, Apple released the flagship model Apple Watch Series 1 in 2015, which had functions with high and low heart rate notifications and irregular rhythm notifications. With the upgrade of sensors, health detection is becoming more accurate and functional, such as fall detection, blood oxygen test, crash detection, and body temperature (Table 2).

Table 2: *Apple Watch series change in healthcare.*

Series	Year	Health Check Function	Senior
Apple Watch Series 1	2015	High and low heart rate notifications and irregular rhythm notifications.	Optical heart sensor
Apple Watch Series 4	2018	High and low heart rate notifications, irregular rhythm notifications, ECG app; Emergency SOS and Fall Detection.	Electrical heart sensor and second-generation optical heart sensor
Apple Watch Series 6	2020	High and low heart rate notifications, irregular rhythm notification, and ECG app; International emergency calling, Emergency SOS, and Fall Detection.	Blood oxygen sensor; electrical heart sensor, and third-generation optical heart sensor
Apple Watch Series 8	2022	High and low heart rate notifications, irregular rhythm notification, and ECG app; International emergency calling, Emergency SOS, Crash Detection, and Fall Detection; Temperature sensing, Cycle tracking.	Temperature sensor, blood oxygen sensor; electrical heart sensor and third-generation optical heart sensor

So we can firmly believe that with the advance in sensor technology and new materials, wearable products could possibly collect more complex data such as breathing patterns, the amount of platelet, the operation of muscles and organs, or even precisely detect your mood switches (Liang, 2013). Furthermore, all this data could combine into *The Big data* system and become good resources for further development.

3. *In-Depth Data Processing Combined with Comprehensive Health Service*

As wearable device designers learn more diverse and long-term data, it will provide a vast database. For example, a study shows that they gathered the data of approximately 300 patients who wore the Apple Watch daily for three months yielding 6 million kilobytes of data (Thompson et al., 2018). Accumulating enough data tend to enhance analyzing and processing functions for their products, especially for health devices. We believe that wearable devices would complete their glorious transformation from simple data collective devices to a combination of product and service. By analyzing the constant data collected by wearable devices, more constructive health services would be provided to us. Moreover, we may expect an automatic emergency assistant service or disease prevention service based on the prediction of human bodies. In conclusion, a solid combination of comprehensive health services and wearable devices will most likely appear in the future (Liu, 2014).

Apple has built a healthcare system with its powerful products and iOS platform. On a daily basis, customers can use the watch device to monitor their everyday health and can choose to share the data with their care team.

In hospitals, doctors, nurses, and patients can see the data on health conditions and treatment stages through Apps on iPhone, Apple Watch, or iPad. And researchers can use the ResearchKit app to gather medical information more frequently because of its open-source framework. Those health records can always put patients at the center of clinicians' care (Healthcare Apple, 2022).
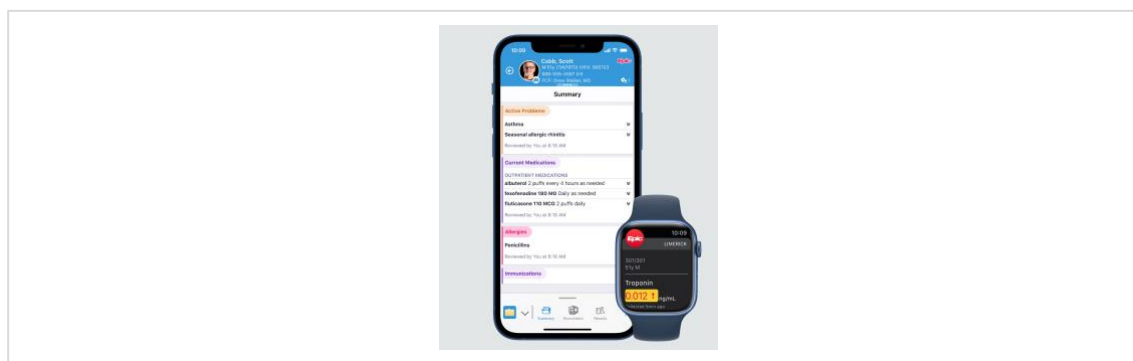

Figure 6: *Healthcare from Apple.*

4. *Multiple Operation Methods*

In the future, advanced technologies like motion capture, voice recognition, and eyeball following ought to bring up multiple interactive approaches. People have already developed some augmented reality games base on the gesture recognition algorithm and enhanced gesture detecting and tracking, which can be played in Google Glass (Lv et al., 2015).

As all kinds of approaches are being developed, it is not hard to imagine that wearable devices would be operated without physical touching. That means functions would be completed in multiple ways. However, the physical interaction will not be terminated entirely in order to make sure that users can maintain basic operations if other interaction methods accidentally lose function. Key operations such as power on and off or emergency contact should be kept with a physical operation (Xiaohua & Zexi, 2014).

The latest Apple Watch Series 8 enhanced the interaction style of international emergency calling by combining physical and non-contact operations. When users get involved in a crash accident, they can choose to press the button to call the emergency contactor immediately or wait for 10 seconds if users are not able to do any operations.

5. *Creative Wearing Design*

We have seen wearable devices created as or attached to clothes, glasses, watches, jewelry, and so on. However, those might be designed into more incredible forms, like a false tooth, attached nails, or even partly embedded in the body. It may sound unbelievable now, but maybe one day your dentist suggest you replace your rotten tooth with an intelligent false tooth, which could monitor your oral or even body health.

Conclusion

The market for wearable devices is already flourished. However, we have to say it is still on its way to growing. From a grand perspective, wearable devices are progressive products that represent a necessary milestone in human technology. Yet it is not the final outcome. The human need will eventually lead to a *smart space* phase that wearable devices melt into. In the early exploring stage, sports and health products played a role of a carrier for wearable devices to step into the market. This has become an essential breaking point in human technology and scientific discovery. In this century, boundaries in design and creation will surely be a breakout and redefined.

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