Smart products

An introduction for design students

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ABSTRACT

In recent years there has been a rapid development of sensor- and semantic technologies, which enables a new type of products. “Smart products” make use of the information these new technologies offers, which gives them a set of unique properties like being; context-aware, adaptive, self-organized, pro-active and the ability to support the whole life-cycle. This paper is meant as an introduction to the field of smart products for design students, with a goal to inspire further research and development. It gives a basic overview of smart products, important areas of focus as well as new opportunities that this may offer, seen from a designer’s perspective. Smart products are very interesting as this introduces new ways to relate to users and new sets of challenges and opportunities. Most interesting is the amount of data and context-aware information the smart product is able to collect and analyze. This may result in entirely new use patterns, how users interact with their products and eventually a new way of thinking when designing products. There is however much R&D needed to fully take advantage of the capabilities that smart products offer. Much of this is however on how to achieve this through technology, but there is also needed research on how this technology can be used for something useful.

KEYWORDS: Smart Products, industrial designer, intelligent products, semantic technologies, context-aware, pro-active, self-organized, adaptiveness, life-cycle support, user centered design, interaction design, TPD4505

1. INTRODUCTION

The word “smart” is something that in the last few years commonly can be seen put in front of new consumer products. Such as: smart watch, smart phone, smart door lock, smart water bottle and so on. But what are really smart products? What implications does these kinds of products have for the industrial designer? And what will be the main area of focus when developing them?

Recent innovations in microchips, sensor technology and semantic technologies are changing today’s consumer products. This technology enables physical products to be filled with intelligence, sensing- and communication abilities. This creates a new product category called “Smart Products.” They have a set of properties that makes them unique; like being context-aware, pro-activity and self-organized. This makes them able to make decisions based on different contexts, and even try to anticipate the user’s activities and choices. All this is enabled with information from different sensor embedded into the product, but also from a so-called smart environment. Even though development in this area is moving fast, there is still needed more development and research

before it is possible to fully utilize these capabilities.

This paper is meant as an introduction for industrial designer into the resent fields of smart products. It gives an overview of the field by comparing definitions and by looking into important key-areas of smart products. Furthermore it looks at how the industrial designer can contribute when developing smart products, and new opportunities that this field enables.

1.1 Background

The field of industrial design is changing together with user needs. The basis of design has always been to fulfill needs, both manufacturers and users. Despite the lack of a coherent definition, [1]states that "Industrial design can, for example, be seen as creating tangible propositions for the mutual benefit of both user and manufacturer; as creating design solutions for a broad market by integrating aspects such as form, usability, technology and business into a coherent whole; as problem finding, making sense and developing something to a preferred state; or as a mixture of making, thinking, contextualizing and envisioning."

In the early days of industrial design, products usually had to fulfill their main purpose of the product to be classified as a good product. E.g. A teapot had to be able to boil water, have the ability to pour tea into cups and keep the tea warm. Today we live in the information age and dataflow and advanced technology becomes more usual. This enables products to take advantage of the increasing amount of information available. The problem with today's products that try to benefit from all this information is that they are usually not able to understand the context. Hence make wrong choices and/or give the user a lot of unimportant information. Smart products combine sensing and semantic technologies[2] with the goal sift all this information and put it together with a context, and might therefore be are able to make smarter choices. The teapot could e.g. Make tea by itself, right before the user wakes up in the morning because it got the information from a motion sensor in the bedroom that the user just woke up, have the ability to turn itself off because it realized that the user went to work. It is therefore easy to imagine that the process of developing smart products would be complex and involve different elements that ordinary products do not have to think about. To illustrate this complexity, Den Brauman, R. [3] states "the design of smart products can no longer be done properly by a single individual, no matter how gifted and well trained that person is. Good design involves a multidisciplinary team". It is therefore interesting to look at how an industrial designer can get involved in the research and development of smart products and what should be the areas of focus as well as opportunities that emerge with this new product category.

1.2 Method

Literature from a wide set of research areas and sources has been reviewed. Since this is a new field with a lot of development, only recent publications was taken into account. Many of the scientific articles written about smart products have been focused on defining the characteristics, exploring what smart products are, and the technological aspect. But not so much on the opportunities that smart products offers, and how to deal with them. It was therefore gathered literature from different areas. The goal was to connect the dots for all of these to find new opportunities, interesting areas of focus, and an overall understanding of the field.

1.3 Paper outline

After this introduction the paper will continue with an overview of the most used definitions of smart products found in literature and explain their major characteristics. Furthermore in section 3, a brief overview of the different technologies that enables smart products. Section 4 gives an overview of notion of smart

products, to find important areas of focus. Section 5 looks at areas where the industrial designer can use its expertise in R&D of smart products. Furthermore, section 6 discusses the different opportunities this field might enable for the industrial designer, followed by a discussion and conclusion in section 7 and 8.

2. WHAT ARE SMART PRODUCTS?

This section provides an overview of what smart products are as well as insight into different definitions and key characteristics of smart products.

First off there are a lot of different terms related to smart products, such as "Intelligent Products" "Smart Things" and "Smart Objects". "Intelligent Products" is the term that is closest related to smart products. In fact Kiritsis, et al. [4] and Gerben, et al. says that intelligent products and smart products can be used interchangeability. Gutiérrez, C., et al.[6] also introduced an umbrella team called "Smart Things", and says that smart products and intelligent products are specializations within this term. I will in this article however use the term smart product, since this is the most well-known and –used[1], and most often misused.

2.1 Definitions and Major characteristics

While the term "smart product" is widely used, there is no agreed upon definition of this concept. Some different definitions and characteristics can however found in literature. The most commonly used are: Maass and Janzen[7] and Mühlhäuser [8].

Maass and Janzen [7] introduced in 2007 three core requirements for smart products:

- (R1) adaptation to situational contexts,
- (R2) adaptation to actors that interact with products or product bundles, and
- (R3) adaptation to underlying business constraints.

In the same article they [7] also split these requirements into six characteristics for a fully implemented smart product:

1. *Situated*: recognition of situational and community contexts (R1)
2. *Personalized*: tailoring of products according to buyer's and consumer's needs and affects (R2)
3. *Adaptive*: change product behavior according to buyer's and consumer's responses and tasks (R2)
4. *Pro-active*: anticipation of user's plans and intentions (R2)
5. *Business-aware*: consideration of business and legal constraints (R3)
6. *Network capable*: ability to communicate and bundle with other products (R3)

Mühlhäuser [8] defines a smart product as:
"A Smart Product is an entity (tangible object, software, or service) designed and made for self-organized embedding into different (smart) environments in the course of its lifecycle, providing improved simplicity and openness through improved p2u and p2p interaction by means of context-awareness, semantic self-description, proactive behavior, multimodal natural interfaces, AI planning, and machine learning."

There are also a handful of more or less similar definitions out there. And in 2013 Gutierrez, C. et al [6] compared the three most used definitions of smart products together with the three most used definitions for intelligent products (since these concepts can be seen as equivalent). The goal was to find a consensus definition and major characteristics of the term smart products. The findings were:

- Life cycle support (4)
- Context-aware (4)
- Pro-activity (4)
- Self-organized (5)

[1] Based on google serch results

- Adaptiveness (2)

Where the number tells how many of the reviewed definitions that uses the same characteristics. E.g. Five (5) out of six (6) definitions reviewed agreed upon the characteristic: Self-organized. Since this is the latest attempt to define the overall characteristics of smart products and a result of comparing the most used definitions, this article will use these characteristics further when talking about smart products.

Smart products can therefore be seen as products that contain information technology (IT) in the form of, for example, micro- chips, software, and sensors that are able to collect, process, and produce information[9]. This enables this kind of product to have smartness and intelligence in comparison to regular non-smart products. Furthermore a main requirement for smart products is the capability to adapt to situations and in particular to users and other products[10]. To determine in what situation the product is in, it must have the ability to be context-aware. It then uses data obtained from sensors and the environment to analyze and determine the current situation. (E.g. If the user is in a meeting, the smart cell phone is able to understand this situation, it might therefore be able to react. In this particular situation it could be to mute the sound.) Therefore it is not only the smart product that is important, but also the environment it exists in. To fully take advantage of the smart product capabilities it need to be able to be self-organized[8] to efficiently communicate with other products, users, services, and process this data into useful information for the users. It is important to note that the users do not have to be the end user, but every user in the product life cycle. Maass, W., et al. [10] says that "a smart environment should have the intelligence to download, process and store information on individual customers, their prior interactions with products, and the ability to create pleasant experiences for the customers." If we go back to the last example, where the smart product would turn off the sound because it knew that the user was in a meeting. This reaction is what is called a pro-active reaction. The user had not told the smart product to mute the sound, but it tried to anticipate the users intentions and needs[7] based out of the particular context.

3. TECHNOLOGIES ENABLING SMART PRODUCTS

Smart products highly rely on advanced technology, and it would be impossible to build what we today associate with smart products without the focus on IT (information technology). Smart products are basically IT embedded into a tangible product [7]. Some of the most important key enablers for smart products are sensors, computer chips wireless- and semantic technology.

Smart products can use a lot of different technologies combined. The most usual sensing technologies are [10]:

- *Global sensing technologies:* E.g. satellite-based technologies like GPS.
- *Local optical sensing technologies:* E.g. barcodes, QR-codes and video-based sensing.
- *Short-range sensing technologies:* E.g. RFID.
- *Wireless communication technologies:* E.g. WLAN, Bluetooth Zigbee and NFC.
- *Rich context representations:* Context data.
- *Semantic technologies:* Get computers to understand the meaning and context behind all the data.

Since smart products often use a lot of these technologies combined, it is not hard to imagine that this is the most important and complex research area this field. Knowledge technologies like "semantic technologies" play a crucial role in smart products, as this can be seen as the brain of the product. Semantic technologies try to understand the meaning, contexts and situations

behind the obtained data, and can therefore be seen as the element that makes the product smart. As this is a reasonable new field of study, there are also a lot of challenges and things that might go wrong. E.g dealing with incomplete data/information and hardware limitations [2]. Therefore, if it is poorly implemented, functions like context–aware and pro-activity might have the opposite result; instead of making the users life easier it results in poor usability and irritation.

A smart product uses a different of well-known and developed technologies like; GPS, QR-codes, RFID, WLAN and NFC. This is mainly to connect to other smart environments and to get context information. Context information from GPS can e.g. be where the product or user I located. RFID have the ability to send more precise context information, like states of items and wherever a user is in e.g. a car or not. This is managed with so-called *beacons,* which are placed around in the environment. The smart product's ability to obtain relevant context information is therefore dependent on the development on smart environment infrastructure.

Though the focus of this paper is not on the technology itself, but more about how designers can use this technology, it is important to have and overall understanding of what they are and what they do, as this will give the designer a more realistic image of what is possible and what is not. It will also make it easier to talk and discuss to people from other background disciplines.

4. NOTION OF SMART PRODUCTS

As described earlier in this article, smart products have a lot of abilities that differs them from other non-smart products. This can cause consumers to have another notion of smart products, which again can be seen as important areas of focus from a designer's perspective. This section highlights the areas that can be seen as most interesting for designers. The information is based on available smart product literature.

It is not difficult to find an overall user perception of smart products since this concept still lies in the future. Rijsdijk and Hultink [11] did however conduct a study on consumer perceptions of what they addresses as tomorrows smart products. They do however use another definition of smart products than this paper does. The definition is more low-tech, and do not use characteristic's like context-aware and pro-active. It is still relevant, as many of the fundamental elements are the same. They found that consumers perceive products with higher levels of autonomy (product self-control) as more difficult to understand and use than products with lower levels of autonomy. In addition, consumers perceived products with higher levels of autonomy as more likely to malfunction. In another paper [9] they also concluded that product smartness has its advantages, but important disadvantages are increased levels of complexity and perceived risk. Multifunctionality and the ability to cooperate with other products are also problematic, as consumers may have trouble operating products that fulfill many different functions and there is a complexity issue involved when bundling with other products. It may also have its advantages if the user fully understands how to use these functions. Even though this also can increase product functionality, these functions must be seen in context with its importance and the target group's technical insight. Han , S.H., et. al [12] says "some functions become untouched until the end of the product life. It is partly because there are too many functions. Some users do not even recognize those functions exist. In many cases, however, the main reason is that he/she gives up using them after a few trials because they are difficult to learn and use." Han, S.H., et. al. [12] says "the users are becoming more and more intolerant of a difficult-to-use product. Since user interaction with the controls is of primary importance from a user performance viewpoint, efforts should be taken to make products easy to use and easy to learn, not to mention aesthetically satisfactory"

This is also what Mühlhäuser [8] focused on, and he identified two major goals for smart products. First off there is a need for increased *simplicity*. (Increased product-to-user interaction.) As smart products become more and more complex. Increased product smartness needs to hide irrelevant features and rather assist the user with respect to the actual relevant features. It is also important to simplify the product user interaction. Product interaction is usually something that requires the user to concentrate on that specific task. [8] E.g. While driving a car and trying to adjust the volume of the stereo, hands-and-eye interaction are not adequate, since it forces the user to take his/her eyes off the road. Speech based interaction would in this scenario be a safer and better way to adjust the volume. This is of course if the voice recognition software is smart enough. Otherwise it would just cause irritation, and causes the driver to lose focus on the road. This is a common result of when new technology is implemented before it is matured and well tested. Many products have a smart way of interacting on paper, but when it is poorly implemented it fast becomes an annoyance. E.g. early hand-to-camera gesture-control. The other goal Mühlhäuser identified was increased *openness*. (Increased product-to-product interaction.) He states that it is fair to say that in a given situation, the actual usefulness and pertinence of a product can only be exploited in the context of its environment. A p2p focus and an infrastructure that enables the product to communicate efficiently with a smart environment will therefore give the smart product a lot of advantages in the context of usability.

Security is another important issue that is closely related to usability and openness. A common saying is “if it is secure, then it is not usable”[13]. E.g. as different and complex passwords increase security, but make it more difficult for the user to remember each password. For smart products, security is extremely important, as they share information about themselves and the user. That is some of what makes them great, but is also something that can be scary from a user’s privacy perspective, as sensitive data may end up astray. Openness can therefore result in better usability, but also lower safety, or perceived safety.

Another implication that may occur when products uses advanced technology that are meant to increase their intelligence or smartness, are that users can feel that they lose control of the product or tasks that they want to do. As the product is able to “think” and “act” for itself the user might feel that the he or she does not have the ability to fully control it. There might therefore be a limit of how smart a product should be, and how autonomous it should be. Meyer, G.G., et al sais: “for the moment, it seems like humans would not be ready or interested in interacting with or being taken care of by human-like robots; however, people do accept autonomous grass-cutters, vacuum cleaners and other everyday devices that make their lives easier.” The human versus artificial intelligence aspect is therefore something to take into account when designing smart products.

Based on this literature there were a number of arguments that suggested that the new abilities that smart products enable both have negative and positive effects. This effect mainly depends on how well implemented these features are and if they are relevant for the user in the particular situation. E.g. well-implemented pro-activity has advantages when being able to correct anticipate user needs, but if this is not the result, it will cause a negative effect. And for this to work, it is dependent on other features and products from a smart environment. It can therefore be concluded that the notion of smart products is not only based on the smart product itself, but also other systems and products in the environment.

Other important findings were that intuitive user interface is a critical element. It is believed that this is especially important for smart products, as they tend to have a lot of different functions, both visible and invisible for the user. There is however an opportunity to use the added product smartness to hide irrelevant features for

the users in different situations, or/and find new ways of interacting with the user. But before doing this it is crucial to look deeper into how these new interaction methods are perceived by the user, then just get the technology to work. E.g. a problem with voice recognition is that the user does not know how much the product he or she is talking to understand. Some products just understand simple commands, but other have the ability to process sentences, contexts, different languages and dialects. (E.g. apple's Siri software.)

The security and usability contradictions can also be seen as very important to get right. Both because smart products have the potential to use a lot more of personal information than people are used to, and because this should not interfere with the usability of the product. It I natural to assume this this is even more important for users now, than it was for only some years ago as a result of widely media coverage of the NSA and other recent surveillance scandals.

5. HOW CAN THE INDUSTRIAL DESIGNER CONTRUBUTE WITH SMART PRODUCT R&D

Smart product is a new concept that involves a lot of different subject areas. It is difficult to predict how it is going to evolve in the future but this added intelligence and sensing capabilities offers advantages and possibilities that might end up changing how we interact and how we think about products. As earlier discussed in this paper, the success of such a product highly depends on the success level of implementation of this intelligence and capabilities. Based on the insight acquired in the previous sections and new literature, this section addresses key-areas where an industrial designer really can make a difference in the development of smart products and where further research is needed to realize this concept.

User centered design

A smart product involves different types of technology packed together. It is extremely important to make this product usable for all consumers and not just IT-experts. It has become evident that mastering the "simplicity paradox" is deterministic for product success. And huge efforts should be used to get better usability[8]. As smart products are made for making the life for the user easier, bad usability would be considered a failure. A key factor for success is to involve the user in the development process. This would be especially essential for smart products as this is a new field of study, the user needs must be identified as well as who the users are, demographical- and cultural differences.

A tool that industrial designers often use is the user centered design process (UCD), instead of the commonly used technology driven process. This can also be used with great results for smart products. The basic principles of user centered design are:[14],

- Know your users;
- Incorporate the current knowledge of users in the early information stage of design;
- Confront users repeatedly with early prototypes for evaluation purposes; and
- Re-design as often as necessary.

It can therefore be seen as a design philosophy where the end-user's needs are in focus at every development stage of the product. A big advantage with this model is that the product is optimized towards the users. With this in mind a system can be designed to support intended users existing attitude and behaviors, instead of forcing users to adapt to the new system[15].

There is a lot of research needed to realize the concept of smart products, and not just in technology but also in researching user needs, user behavior and to explore new applications for smart products. Other important research areas are how the user perceives smart products, as this can tell a lot about how open it should be? How much information-share that is acceptable?

How much self-control and pro-activity is acceptable? The design of smart products would rely deeply on these answers. For this research, the UCD process is a great tool.

P2U Interaction

"Interaction design is about shaping digital things for people's use"[16] and will in the context of smart products be about p2p and p2u interaction. For and industrial designer a product-to-user focus is probably the most interesting. It is important to find a way to interact with the product that is perceived as natural for the user. The smart product might also have multimodal interaction systems (e.g. voice and gesture controlled); which again increases the importance of good design and well-implemented interaction systems. Miche et. al says that "The main goal of making products smart is to facilitate interaction for the user as much as possible. This comprises automating workflows in order to avoid interaction, proactively guiding the user through non-automatable workflows, and providing natural interaction in case no workflow is followed by the user." It is therefore huge advantages in having a good way of interacting with both the user and other products. This added smartness and technology development can also result in- and may need new and better ways of p2u interaction, and are something that are needed to explore further, as this can result in huge advantages.

User experience

There has been a lot of talk about usability in this paper, and how important it is. But there is more to a product than usability and functions. Humans are not always rational; they are also derived by emotions[18]. When buying a product there are a lot of different aspects that are crucial. E.g. for a car there are not just performance and functions that counts, but also how it their budget, the desire for comfort, their need for peace of mind and aesthetics[19]. Mattheissen[18] says that "functionality and usability are expected, but the user experience goes beyond functionality. Users are also looking for pleasure in products use and emotional, experiential aspects related to appeal, aesthetics, or product image. This can be seen in how mobility devices are not just devices; they have been marketed to consumers on an emotional level." It is therefore fair to say that it is not enough to just focus on usability, specifications and functions, but that the products must be seen as a whole and an overall experience. Both on a functional and emotional level.

This is also what UX (user experience) design focus on. The designer needs to learn and understand cultural, intellectual and emotional needs, but also understand people's perceptions of value [20]. As discussed earlier, smart products are technology-heavy it therefore seems reasonable to improve the human factor, and make it more relatable for the user. On the other hand, product characteristic's like adaptiveness and pro-activity seems to have a positive effect on user-belonging[10] as it have the ability to learn and adapt to the user. The technological aspect of smart products can therefore have both positive and negative effects on the overall user experience. A suggestion to design for this is to see the virtual world and the physical world as integrated rather than separate[18]. This can in this context be seen as focusing on the overall UX for both the technology-aspect (as services and functions) and the physical object as a whole, instead of separate elements.

Other

There are of course many other areas where an industrial designer can contribute: e.g. sustainable design, product design, service design and strategic design. There are therefore a lot of areas within the smart products an industrial designer can have an impact. The listed topics of design are also overlapping. As an industrial designer, this might mean that it is just as valuable to be a hybrid, thus focus on multiple areas, rather than specialize in one.

6. OPPORTUNITIES

This section will discuss the main opportunities that smart products might enable for an industrial designer. They are based on information discussed earlier in this article.

Information flow

Industrial designers can take advantage of the life-cycle support of smart products. As smart products have the ability to learn, store and send information about the users and environment, designers and developers can use this information to improve the product[4]. This can work as the designer can obtain detailed information from every step in the product life-cycle. This information usually takes a great deal of resources to obtain (e.g. user analysis, surveys and production analysis) can with smart products be in the designer's hands continuously. For an industrial designer, interesting possibilities this provides could be detailed user information as e.g. user habits. This information can then be used as part of the user-centered design process. Information about the usage conditions can also be used when the product is at its end-of-life, for determining how to handle the product and its parts[5], and to learn about and reduce the product environmental impact[21].

Easier user interaction

As products and software gets smarter, it enables for making user interaction with the product easier and more natural. Since the product has the ability to "think" on it's own, a well-implemented system can reduce the number of interaction steps, and try to guide or help the user through the tasks. It may also feature new ways of interacting with products. E.g. voice-based interaction with a product, now feels unnatural because of its many limitations. A well design smart product with a smarter voice-based system offers huge advantages. Then the product does not only have the ability to understand the user's voice, but also contexts. E.g. the product is able to understand the context of the sentence and if he/she is speaking with an ironic tone of voice.

This added context-awareness might make the product smarter and smarter as sensors and analysis software become more widespread. E.g. a hungry user might want to get information about when the dinner is ready, but for a user that just has eaten, this information might be irrelevant. Advances in semantic and sensing technology can change the way users interact with products.

Enhanced emotional value

Another advantage of making products smarter is that people start to relate to them. Diana, C [22] gives an example of this with a autonomous vacuum cleaner: People really tend to get attached to the product. They give them names. They treat them like pets, and they don't won't to give up the one they had, because that's their special one. Especially adaptivity and pro-activity can strengthen the linkage with the users[10]. When a product adapts and learns user behavior, it is natural to feel a stronger connection to the product, than a product that do not. An Industrial designer can therefore take advantage of this, and e.g. try to add additional ways for the product to express itself, and find ways to further improve the product-user relationship. Which of course is a huge advantage.

Designing products to make life easier

A big advantage that can be exploited with smart products if designed properly are their main goal of making the user's life easier and better. This has a tremendous potential as the smart product can have the ability to do the tasks the user does not want to do. Hence the users have more time to do what they want in life. If you look at it this way, the product will need to be designed to be "invisible". It should have the ability to do tasks in the background, and only alert the user when

it is something important. Designers therefore need to look at the bigger picture. Not just the product, but also the environment (other products it is communicating with), the tasks it should perform. The biggest challenge here is maybe know where and how the product should be pro-proactive, and what kind of information is relevant for the user and what is not.

7. DISCUSSION

It has been a great upsurge of products and services related to the Internet of things (IoT) in recent years. Where new startups and crowd-funded companies can be seen as leaders in finding new applications within this category. The concept of smart products takes this slightly longer than IoT, although it relies on a lot of the fundamental elements of the IoT. There are still a lot of research, development and equipment needed to fully take advantage of the capabilities that smart products have to offer. First off the technology embedded into the product has a long way to go, but even more concerning is that it also relies on a smart environment. This means a lot of the supporting infrastructure of other products and sensors are needed.

The future of such products is therefore in the hands of the supporting infrastructure and new technologies. That being said, it is clear that there are great opportunities ahead for smart products. This is based on the benefits they offer to the user and the whole life cycle. This development is already underway. As technology and infrastructure being further developed, this kind of products will eventually follow.

It is therefore important to also research on other levels than just the technology itself. As new technological advances in this field, creates new demand for the product’s ability to deal with- and communicate with the user. This article is intended as a kick-starter for industrial design students in this field. This article introduces horizontal knowledge of the subject, as well as key focus areas and areas where designers can especially help with the development of smart products, as well as new opportunities for the industrial designer.

User-centered design is important in this field as other fields. An element that makes it particularly interesting in this field is that smart products are new and thus there is little research and results for how to do this right from a user perspective. This process can also help to find new applications for smart products. It will also be crucial to find new opportunities to optimize usability. Advances in technology may also enable new types of interaction-methods. The focus should however be as much about making this technology user-friendly and natural, as how smart and advanced the technology is. User experience also need to be addressed, as technological heavy products tend to forget about this, and it can be beneficial to have a bigger focus on appealing to the senses and the emotional aspect of the user. Smart products seem however to have a high possibility to appeal to just that, and something that designers can focus on boosting.

As a designer, there should also be a certain responsibility related to the development of smart products. Where a number of questions should be in mind: How can people's needs be better satisfied with 'smart products? How can I design the product to prevent adverse side-effects of its use? Can the product be misused and, if so, should I design it? Will the world be a better place if I design this device?[23] The main question will however be: How can this technology be used for something useful? This is what may be seen as the designer's overall task and challenge with smart products.

In my own exploratory design project: "A smarter universal remote", I explored the possibilities of developing a universal TV-remote based on the characteristics of smart products. An interesting discovery I made was that “smart products” might work better on products that solve tasks the user does not want to do themselves, rather on tasks that are seen as enjoyable or necessary.

As I had trouble finding areas where these characteristics could fully utilized by a universal remote. Controlling the TV is something that is associated with power in some situations enjoyment, and therefore not a task a user want to let the product itself control. This emphasizes the need to find useful areas where technology can actually help people, rather than to push it into products that may seem good on paper, but does not give added value in reality.

With the ability to collect and analyze loads of data and translate this into context-aware information, it is able to operate in new ways. This involves taking decisions based on contexts, hide irrelevant information for the user, predict user needs based on a number of situations and support the whole life-cycle. This may result in new user needs, a new way of interacting with products and new applications. Both for the end users, but also for the producers and suppliers. It is therefore reasonable to speculate that this eventually will change the way designers are used to develop products.

7.1 Further on

All information smart products can collect and analyze can clearly be valuable. But it is also important to address the major challenges in terms of how users will perceive this. Can it feel like monitoring? Can this information be used against the user's will, and interrupt private life? How much monitoring is allowed, and how do the relationship between monitoring, security and functionality interfere with each other? How do the users deal with the fact that the products are able to control tasks and take choices by themselves? What happens if those choices are taken on wrong terms? These are questions that have not been discussed thoroughly in this article, but that are essential for the future of smart products.

8. CONCLUSIONS

It is evident that a number of different research fields must be combined to realize the smart products. However by taking a look at the advancements in this technology in recent years, it is not hard to believe that within the near future smart products can start being utilized to its full potential. It is therefore crustal to start looking deeper into how this technology can be designed to benefit users.

This article gives design students the background theory in what smart products are, what properties it has, key aspects in relation to development, how a designer can contribute and possibilities this field enables. As other papers within this area focus on the aspect of getting the technology ready, is this paper meant as background theory and an inspiration to design students to keep up this research on other levels than just to get the technology to work, but also how to use it for something useful

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