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Digital Smart Jewelry: Next Revolution of Jewelry Industry?

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Additional information is available at the end of the chapter

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Abstract

The purpose of this article is to examine business potential of digital smart jewelry. When jewelry has tens of thousands of years of history, it is interesting to find out what people think of jewelry that contains technology. The study was conducted as an action research, in which researchers acted as main innovators of smart jewelry. The smart jewelry can be divided into two main product groups: the esthetic light jewelry and the functional jewelry. Six different jewelry prototypes were manufactured—three pieces for both product groups, after which they were tested by potential and nonpotential users. According to study, the smart jewelry seems to have business potential, but as often with radical products and new markets, it will take time. Forty percent of potential users saw the smart jewelry as fun, cool, fantastic, and an inevitable future. On the other hand, 25% kept them as obnoxious. The functional jewelry seems to have much more potential target groups and users than the light jewelry. As wearable technology and the Internet of things become more common, the smart jewelry market will probably grow as well. The healthcare and wellness industry is a particular force for growth.

Keywords: smart jewelry, digital jewelry, wearable technology, prototype, revolution, radical innovation, user-centered innovation, user experience, user-study method, user data

1. Introduction

Wearable technology is one of the megatrends. One of its branches is the digital smart jewelry (later in text ‘smart jewelry’) that are esthetic and jewel-like smart electronic devices, which provide different kinds of value for their user. The smart jewelry is a new product group without an established market. Therefore, the uncertainty in demand is very high. Smart jewels are already on the market, but the sales volume is still modest. Why do not people buy smart

jewelry? What people think the jewelry that contains technology? On the other hand, because of the current movement toward digitalization is everywhere, it may be only a matter of time before digital technology will emerge in jewelry. The aim of this study is to find out whether the smart jewelry has the potential to break through widely and even revolutionize the jewelry industry. In order to reach a holistic view to research problem, the study seeks answers to the following questions:

- What kind of smart jewelry has the most business potential?
- What value people expect to experience from the smart jewelry?
- Who are the most potential users of the smart jewelry?
- How and in what circumstances the smart jewelry would be used?
- What can prevent people from buying and using the smart jewelry?

Therefore, the objective was to create new information on demand and thus reduce uncertainty in demand. It was important to understand what potential and nonpotential users think of smart jewelry. Nonpotential users were defined as a group that does not use even traditional jewelry. Uncertainty of innovation, user-centered innovation, and user-study methods were utilized as theoretical themes. Users were participated in innovation in different ways, and user data was collected with various user-study methods. The smart jewelry was divided into two product groups: the LED technology-based light jewelry and the functional jewelry that can contain different kinds of technologies. Jewels in the light jewelry group do not create functional value for their users, but esthetic, status, emotional, and symbolic value. Three different kinds of smart jewel prototypes were manufactured for both the product groups to obtain user feedback concerning five questions presented above. The light jewelry prototypes included light jewelry for consumers, light jewelry for pets, and effect jewelry for a movie and its fans. The functional jewelry prototypes included bola jewelry, lifesaving jewelry, and access control key jewelry.

Next section presents the methodology of the study, after which Section 3 focuses theoretically on uncertainty of innovation, user-centered innovation, and user-study methods. Section 4 presents the action research and its results, and the article ends with conclusions.

2. Research methodology

The purpose of an action research is to develop new skills or a new approach to a specific matter and to solve problems that have connection to some practical activity. Action researchers have an active role in this. Action research helps to examine reality in order to change it, but also to change reality in order to examine it. Action research is suitable for situations where action is taken to change something and at the same time increase both understanding and knowledge about change. The action study proceeds cyclically. During the new rounds, new efforts are made to increase knowledge or improve something.

The objectives and problems of an action research are formulated together with researchers and practitioners. Often, it is somewhat difficult to determine what a customer needs for results. The customer may also be unknown when the research is executed. The purpose of this research was not to influence a specific company but rather to provide with information on the potential of smart jewelry to inspire and prompt some companies to develop smart jewelry in the future. The research was positioned in the first phase of market design, the mental model design such as market definitions for smart jewelry. The action researchers were in the role of an activist by encouraging companies to move forward.

Reflection is an essential part of action research. It is defined as a conscious, systematic, and critical assessment of events, with the aim to learn something new. It is a matter of distancing oneself from the phenomenon under consideration—by watching it from the outside. Action research proceeds as follows:

1. Definition of problem or setting of goals
2. State of art: what is already known about the problem or solutions
3. Planning of study and interventions
4. Action: Doing interventions
5. Gathering data from interventions; for example by observing
6. Reflection: Assessment of interventions; what was learned [1–4]

The study was conducted as an action research of two researchers. Adapting the above process, this study proceeded as follows:

1. Definition of problem: What is the business potential of the smart jewelry. Research questions were set based on uncertainties – in other words, what information is needed to understand the business potential.
2. State of art: Preliminary understanding about the uncertainty of innovation, user-centered innovation, user-study methods, and smart jewelry was created.
3. Planning: Interventions were recognized and planned to create new knowledge on research questions.
4. Action. Part 1: Hundreds of different smart jewels were brainstormed by potential and nonpotential users, after which the best 30 ideas were conceptualized. Prototypes were designed and manufactured for six different smart jewelry groups. Part 2: Implementation of interventions to get feedback from potential and nonpotential smart jewelry users.
5. Gathering data: Prototypes, surveys, trial runs, design probes, observation, interviews, conceptualizing workshops, and storytelling were used as methods to gather user data.
6. Reflection: The action researchers conducted a critical reflection of the user data and created understanding how people relate to smart jewelry.

3. Preliminary theoretical understanding through literature review

Theoretical themes included uncertainty of innovation, user-centered innovation, and user-study methods. In addition, it was examined what kind of smart jewelry is already on the market. In 2013, there were still very few jewelry for sale, but innovation and development work seemed to be in quite a many places in progress.

3.1. Uncertainty of innovation

Innovations can be parsed with the product-market matrix (Figure 1). Uncertainty is greatest when creating a new product for new markets. This is called a suicide quadrant of innovation. In fact, entrepreneurs or innovators do not see this as a suicide quadrant, but as a vital possibility to create new business [5, 6].

Uncertainty can be divided into uncertainty in demand (whether customers buy a solution) and supply/technology (can we build the desired solution). Uncertainty is related to a lack of knowledge. The more unknown things are in customer preferences and behaviors, the greater is the uncertainty in demand. If there are already existing products and market, then forecasting is easier, for example by analyzing competitors’ sales and actions. Technological uncertainty is associated with, what new technologies emerge, and when or what kind of new technology the company can itself develop. Experimental innovation with users has been seen as a key tool to reduce uncertainty [7–9].

3.2. User-centered innovation

User-centered innovation means that persons in the company and its value network are included in the innovation. Especially the end users of products and services play an important part in this. Users can also come from outside the current value system, in which case the issue deals with extreme type of open innovation [10, 11].

Users may have different roles during the innovation process, such as idea creator, evaluator, idea refiner, designer, and manufacturer of prototypes. At most, they may participate in

	Current market	New market
Current product		
New product		Suicide quadrant

Figure 1. Product-market matrix [5, 6].

innovation throughout the innovation process. On the other hand, users can be grouped to three groups according to how active they are:

- for the user: company creates a solution based on knowledge about users' needs,
- with the user: company and users co-design a solution, and
- by the user: users innovate a solution on their own initiative [12–16].

Innovation is born when a company meets the conscious or unconscious needs of the customers. Majority of the customers cannot say what they need before seeing and even experiencing a solution. Unconscious needs often come up only through product or service experiences. This may take place, for example, by providing a prototype for the customers to test use. Customers can be divided into innovators, early adopters, early majority, late majority, and skeptics. Innovators and early adopters are called lead users. Compared to the designers who are good at solving defined problems, the lead users or fans are need experts who have insider knowledge. They can identify previously unknown customer needs. When they bring their need expertise in order to connect it with a designer's solution expertise, new solutions can become blockbusters. Lead users often help designers further customize and fit a product into users' everyday life. The innovators are the kind of lead users who innovate on their own initiative. The early adopters, on the other hand, are more like codesigners. Critical point is between the early adopters and the early majority. Most innovations die in this chasm [9, 12, 15–20].

3.3. User-study methods

The essential thing in creating new products for new markets is to challenge the current market definition and create a new one; in this case, challenge the definition of traditional jewelry and create a new one for smart jewelry. Creating a new market definition is based on an in-depth understanding of the users. For this reason, it is necessary to consider what designers know in advance, and which questions can only be answered through collaboration with customers and other partners. For this, variety of user-study methods can be utilized such as user participation, prototypes, experiments, observation, and interviews (**Figure 2**). On the basis of the user research problem, the most suitable method classes and single methods within them are utilized. The use of different methods may take place simultaneously (e.g. observation and interview) or sequentially, such as making first prototypes and then testing them. Choosing the method and knowing how to use it are essential skills when carrying out user research [17, 21–23].

In the user-centered innovation, qualitative research methods are utilized instead of or in addition to traditional market surveys. The aim is to get caught up on the users' experiential relationship to a product. This approach is a key to getting an idea of a variety of product use cases and finding the core value of product. It is critical to understand user goals and motives through the meanings. User understanding can be structured through user profiles that refer to a variety of ways to use the product, as well as attitudes toward the product. Users can be placed in different categories, such as doubtful, familiar, seeker, etc. Creation of a user profile can start from only one customer by understanding his life profoundly. After this, the profile may reflect a larger crowd [9, 17, 24].

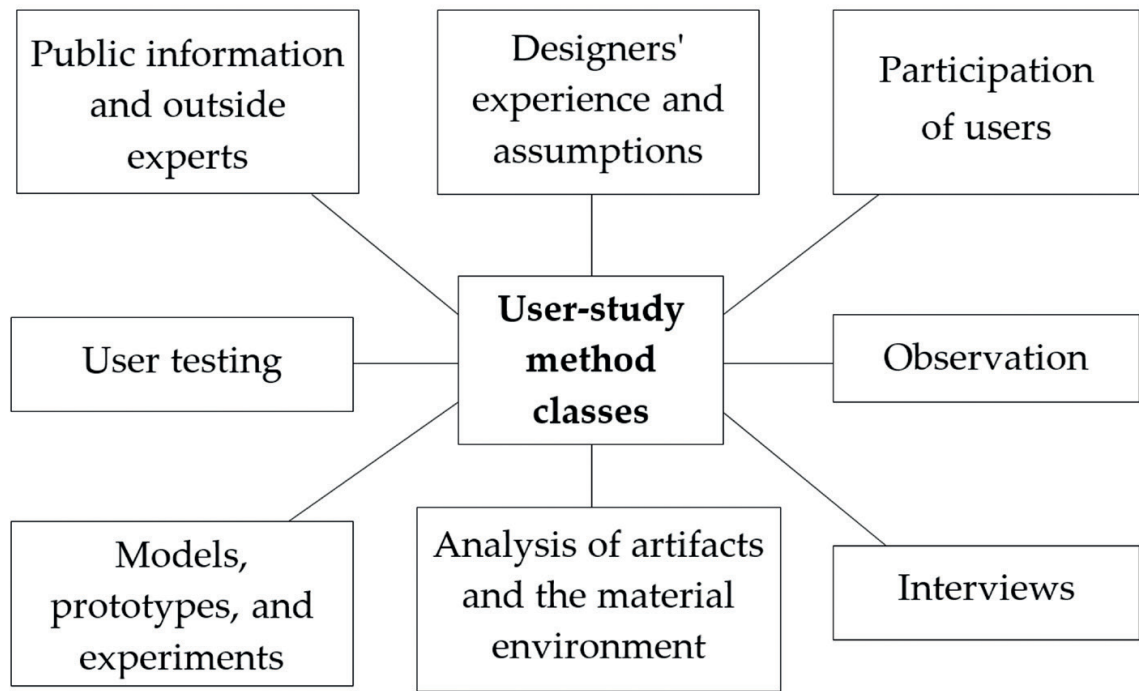


Figure 2. User-study method classes [21].

4. Action research

Smart jewelry is a new product group without an established market. An initial market definition was named concisely “smart and digitalization comes to jewelry.” Smart jewelry is a category of wearable technology, and therefore the market definition of wearable technology [25] was applied to the second market definition: *Smart jewelries are esthetic electronic devices (electronic devices with microcontrollers), which provide value for their user through esthetic and different functions and features.*

4.1. Background of smart jewelry innovation

The idea of smart jewelry was conceived in 2012, in a technology company’s innovation workshop, where different applications for the company’s display technologies were created. One of the ideas related to the smart jewelry. One of the researchers was involved in the workshop, and through this, innovation of smart jewelry started. Initially, seven smart jewelry brainstorming and conceptualizing workshops were held, which produced hundreds of ideas of 30 concepts. The best 100 ideas were described briefly in text format, through which a common understanding of smart jewelry was formed. For example, a reminder necklace was described as follows: *The necklace reminds a person when to take the medicine.* In the brainstorming stage, the smart jewelries were divided into two product groups: the esthetic light jewelry and the functional jewelry.

Smart light jewelry was defined as follows: *Light jewelry provides users esthetic, symbolic, social, and emotional value, and differs from traditional jewelry by using internal light as additive design element.*

Smart functional jewelry was defined as follows: *Functional jewelry provides users just only aesthetic, social, symbolic and emotional value but also functional value, in other words concrete benefits.*

The best 30 smart jewelry ideas were conceptualized. **Figure 3** shows pictures from conceptualizing workshop and the first rapid prototypes of smart jewelry. Rapid prototypes were important in making the ideas more concrete as well as in forming a common understanding what smart jewelry means. They also inspired to innovate more.

The best smart jewelry ideas were conceptualized, after which prototypes were manufactured from the best concepts. By utilizing readily available electronics, some of the prototypes became bulky and heavy compared to many traditional jewelries. Solar cells were utilized in some prototypes as renewable energy source.

Action researchers were the main innovators of smart jewelry and potential jewelry users themselves. Numerous other potential and nonpotential users participated in innovation work as innovators, early adopters, and other users of smart jewelry. Less than 5% of them had previous knowledge of smart jewelry and no one had any previous user experience. Sixty-eight percent of users were Finnish and the remaining 32% came from other nationalities, emphasizing on Europeans. Totally 14 different nationalities were presented. The proportion of women to men was 61 vs. 39%, and the age varied from 16 to 62 years, the average age being 25 years. One-fourth of the test group people did not use even traditional jewelry at all. They were chosen to study as the laggards or the late majority groups. It was immediately obvious that the smart jewelry was “high concept,” which attracted people’s attention and pulled free resources to participate in innovation. To get answers to the five research questions, different kinds of user-study methods were used (**Table 1**). The manufactured prototypes were utilized with all the methods.



Figure 3. The concepts and first rapid prototypes of smart jewelry.

Research method	Objective
Public information and outside expert	Examine, what kind of smart jewelry is on the market and how much they sell.
Designers' experience and assumptions and user participation	To create smart jewelry ideas and concepts. Eight designers created hundreds of ideas and 30 concepts in seven brainstorming and conceptualization workshops with Finnish people.
Rapid prototypes and prototypes	To recognize technological challenges, to inspire, and to help obtaining user feedback, two designers (action researchers) designed and manufactured 15 rapid prototypes and after this prototypes for six different kinds of smart jewelry.
Survey	To obtain views from a wide range of people from different nationalities about smart jewelry value, use cases, main target groups, and jewelry design. The surveys were carried out in Finland and Germany in international events. N = 186.
User testing and interviews	To find the emerging experiences and meanings from smart jewelry use in real-life situations. Information was collected through design probes and interviews. The trial use was carried out by Finnish users. N = 21.
Passive observation	To get information about smart jewelry users' preliminary reactions and how other people react the users with jewelry. This observation was carried out in Finland and Germany in international events. N = 85.
Participatory observation and interviews	To get information about smart jewelry user's preliminary reactions and how other people react the users with jewelry. Action researchers put the smart jewelry on themselves. Third of the people were also interviewed. The observation was carried out in Finland in international and domestic events. N = 57.
User stories	To obtain feelings toward smart jewelry. User stories were written by Finnish users. N = 12.

Table 1. User-study methods used in mental model design.

In the following, six different smart jewelry prototypes are presented and how users experienced them. The light jewelry prototypes included jewelry for consumers, jewelry for pets, and effect jewelry for a movie and its fans. The functional jewelry prototypes included life-saving jewelry, access control key jewelry, and bola jewelry.

Taking into account all prototypes, almost all people interested also in traditional jewelry reacted to smart jewelry with a strong or fairly strong emotion – positively or negatively. Forty percent of these people saw smart jewelry as fun, ‘cool,’ fantastic, and an inevitable future. About half of them loved the smart jewelry. On the other hand, 25% of “traditional jewelry people” could not tolerate the smart jewelry. The remaining 35% were unable to form a clear opinion. One fourth of the participating test users were not “jewelry people.” Eighty-five percent of them were not either interested in the smart jewelry. With the functional jewelry, the potential user base is remarkably larger than the light jewelry.

4.2. Prototypes and user tests of light jewelry

4.2.1. Light jewelry for consumers

Three different light jewelry prototypes were manufactured (**Figure 4**) to help people to find the most preferred design for themselves. The jewelry on the left was a favorite for test users

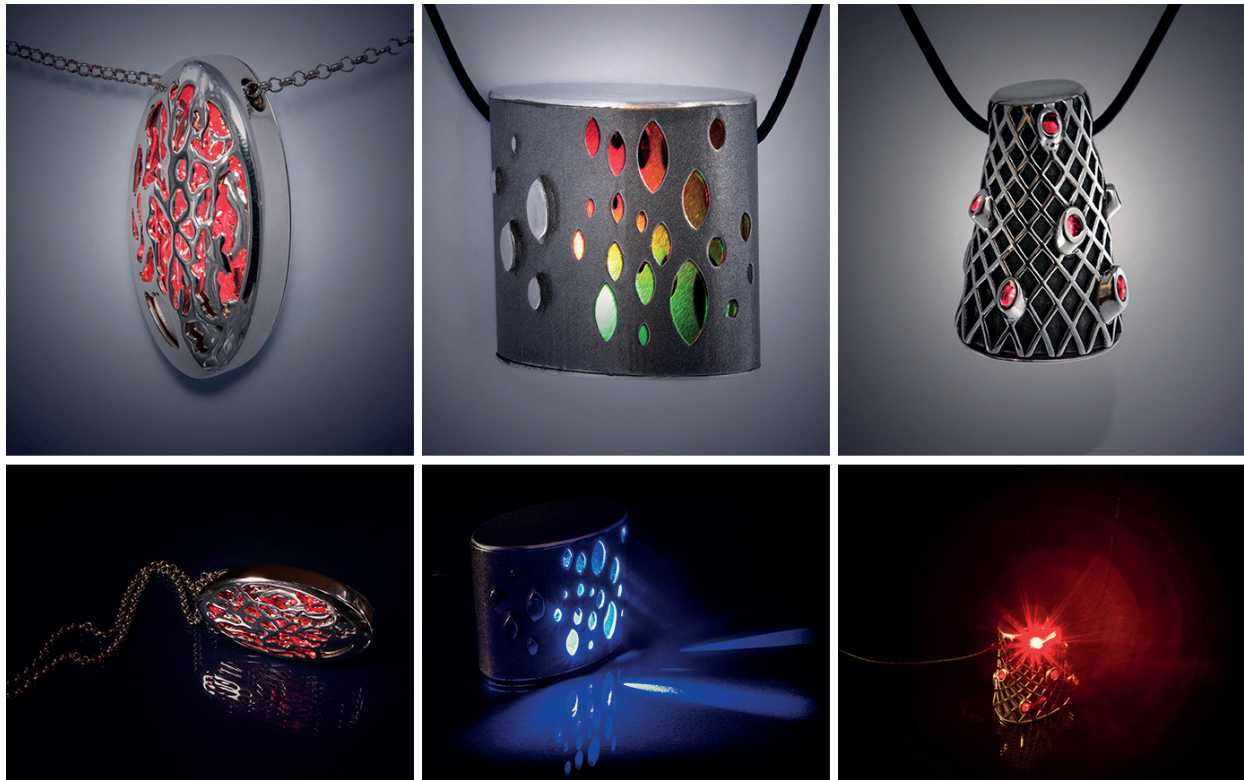


Figure 4. Light jewelry prototypes for consumers.

because of its pleasant design. The light effect worked best in it as an additional design element. For the test users, the light jewelry produced esthetic, emotional, symbolic, and social value. Middle jewelry in the figure was able to charge with solar energy while the other two were charged electrically. From test users' point of view, this was a good feature that produces ecological value.

The light jewelry was considered most likely to be used in evening parties, parties for young people, and at Christmas or pre-Christmas, but also in everyday use (**Figure 5**). As user studies progressed, it was realized that the original assessment of young adults as the main target group of light jewelry was wrong. Young people quickly began to ask whether the light jewelry incorporated additional features, such as a music player and sensors—in other words, functional value. They wished to challenge jewelry more holistically with regard to design. On the contrary, many 35–50-year-old women born in 1960s and 1970s fell in love with the light jewelry. More precisely defined, they have a positive attitude to life and were extrovert, courage, tolerant, being trendsetters, and 'nutty.' Also men who have same kinds of characteristics were seen as potential target group. Other potential target groups were communities, guides, and tourists. Also, pets were found to be one new potential user group—*"I could also buy a collar with light jewelry for my dog."*

Light jewelry was seen more as a work of art than an electronic device. Silver or other high-quality material was seen as a clear added value. Jewelry design had a significant impact. Test users wanted to find their preferred model from the model options. None of the test users expected personal customization, but the personal product relationship appeared strong.

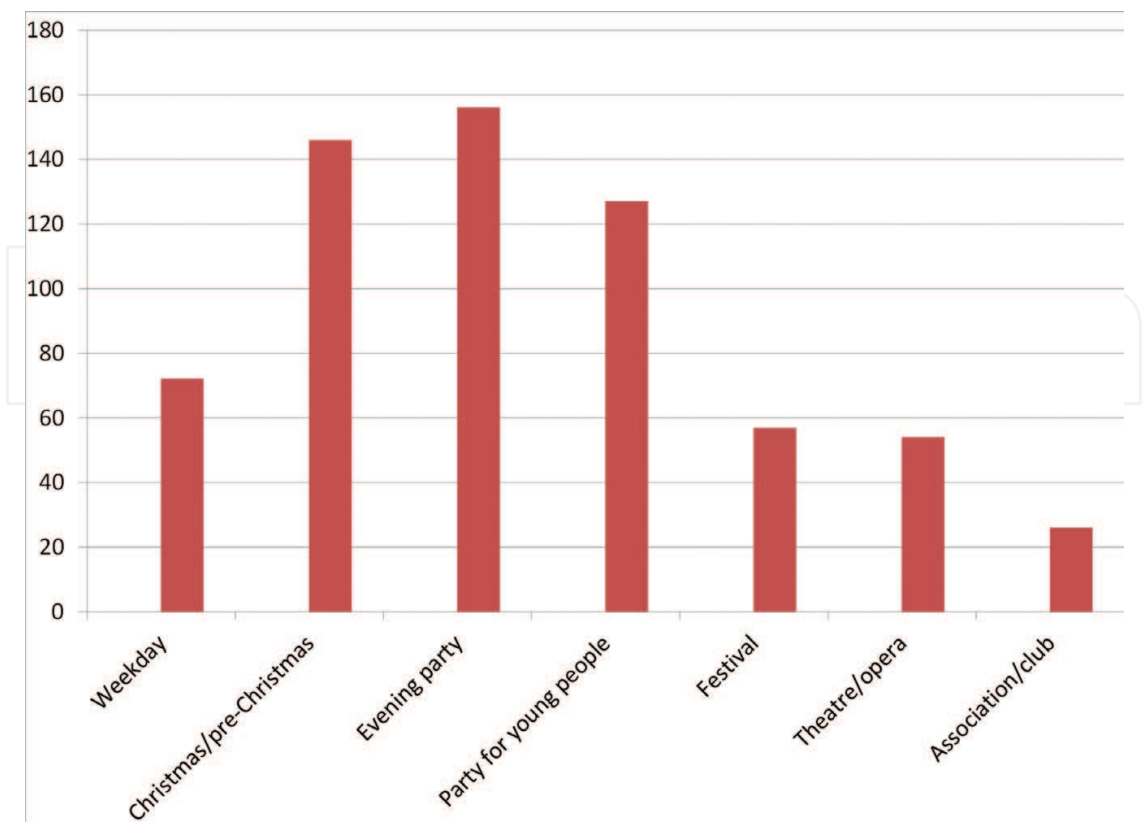


Figure 5. Use cases of light jewelry.

Color options for lights in the same piece of jewelry were important. Most quickly found their favorite color and said they could also change the color depending on the situation and their clothes. Light jewelry aroused curiosity and interest in people. Strangers watched the jewelry cautiously and whispered, *“Is there a light?”*. Users felt it was important that the jewelry was impressive even without light. Jewelry with light is not suitable for all situations; for example, a funeral or when someone else is the center of attention. In everyday use, jewelry also received some disapproving views, such as *“Why are you trying to show off.”*

During the test use, it obtained usable bits of story such as *“Light jewelry brings joy to my and others’ lives,”*, *“I would proudly wear light jewelry,”* *“Light jewelry looks impressively grand,”* *“I would want one right away,”* and *“I would buy it as a Christmas present for my wife.”* People also wanted to give their own names such as *“Twinkle,”* *“Aurora borealis,”* and *“Fairy of Light”* for the jewelry.

Battery life, the need for maintenance, price, and market position raised questions. Most of the respondents estimated the price range as or would be willing to pay 200€ for designed light jewelry. On the other hand, if light jewelry is perceived as bauble, the price should be max 20€. Some did not like the large size of the jewelry, while others appreciated it for that same reason. Quite many, however, thought the jewelry prototypes were too heavy. People wished for more compact and lighter models as well as more details. **Table 2** summarizes contents from stories that test users wrote about the light jewelry.

Why would I buy them?	<ul style="list-style-type: none">- They stand out from the crowd, they are different- They are modern and innovative, they have a novelty value- They are wonderful, esthetically pleasing/attractive, fun, interesting, youthful, impressive, playful, intriguing, surprising, and personal- They are striking- They are versatile—they adapt to different situations and clothes
Whom I would buy light jewelry?	<ul style="list-style-type: none">- For myself- For family members – for a spouse and/or children- For friends or acquaintances- As gifts or business gifts- My pet
What would I tell about light jewelry to others?	<ul style="list-style-type: none">- They are great gifts- They are fun, beautiful, and unique- The color of the jewelry can be changed- They have received recognition on television news and other media- They are jewelry containing electronics/new technology- They make for good costume jewelry and also work for bar nights- They are a different and a thing for pioneers- The jewelry comes in various models that can be adapted- They are unique and handcrafted
What may be troublesome?	<ul style="list-style-type: none">- Adequacy of power- Changing the battery—could energy be produced ecologically?- Frost durability- Lifetime/duration of technology- Big size, palette is too colorful- Price

Table 2. Summary of results from user stories.

4.2.2. *Light jewelry for pets*

When it comes to pets, the reactions of the animals to light jewelry were observed. The prototype was tried on cats and dogs (**Figure 6**). When the cord was adjusted appropriately, so that it did not meddle with walking, it did not bother dog at all, seeing as dogs are used to collars to begin with. It was more challenging with cat, but it also got used to the collar in ca. 5 minutes. The cat got used to collar more quickly the next time it used jewelry. A solution that would be lighter than the prototype would be more suitable to smaller animals. The test pets weighted 7 and 4.5 kg. The potential purchasers are naturally pet owners and their animal friendly friends. The pets themselves do not obviously be esthetically pleased with the jewelry. Pet owners saw two crucial values of the pet jewelry: they decorate the pet and act as a substitute to a traditional reflector for safety, later of which is a functional feature. Ca. 30% thought that the idea of jewelry for pets was good, but an equal amount was of a different opinion. Mostly the pet jewelry was interesting to those pet owners, who themselves wanted to own a light jewelry. The idea for further design work was that more user friendly solution would be a design collar with integrated jewelry. The collar would be more practical because it lets the pet move freely, and poses no imminent threat of choking. As an additional functional feature, a locating or tracking system was wished for, in case the pet goes astray.



Figure 6. Light jewelry prototype for pets.

Too high a price can be a hindrance when buying light jewelry for your pet. On the other hand, the jewels are possible to be made more cheaply for pets because of more affordable materials, for example, plastic, rubber/latex, etc. The need for maintenance was also seen as a possible hindrance. However, nowadays there are LED collars, where the change of batteries is made easy. Furthermore, there was a speculation about the jewelry's durability and safety in wet conditions, but the solutions are possible to be made waterproof. The whole idea of pet jewelry is part of the trend of people using more their time and money on their pets.

4.2.3. *Effect jewelry for a movie and its fans*

A prototype with highlighting the logo of the movie was made, which then could be used as a so-called effect jewelry in the movie—even a central part of the plot. Effect jewelry would then bring esthetic value and possibly functional value (cf. the light sabers in Star Wars). For better visibility, the piece of jewelry was made big, ca. 6 inches in diameter. In **Figure 7**, we can see the effect jewelry prototype in action, while in the lower part of the figure shows the blueprint and electronics of the jewelry. The more pivotal role the jewelry would be in the movie, the more likely also the fans would buy the consumer version of the jewelry. The size of the fan jewelry is about half of the original and it would be available also without the effect feature, that is, a regular piece of jewelry. With alternative versions, fans could have a choice of design and price. The jewelry could be numbered and thus unique.

Fan jewelry could be a subject of crowdfunding along with more traditional ones, like signed Blu-ray or DVD discs or posters. It would be a symbolic icon for fans to have been a part of a

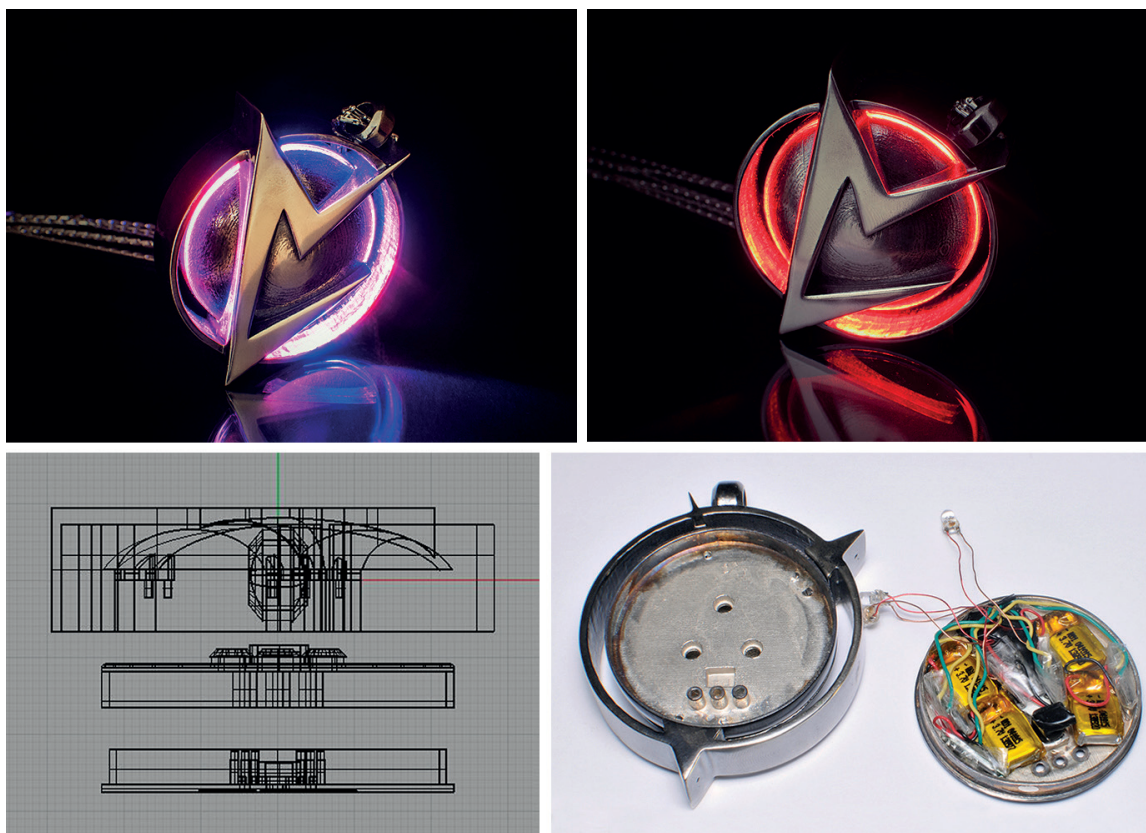


Figure 7. Effect jewelry prototype for a movie and its fans.

group making the movie possible. The jewelry would thus have a clear meaning. Furthermore, it could be a utility article for everyday and party use. Party use could be wearing the jewelry for a premiere or a fan meeting. People could be interested in jewelry of this kind even when they are not usually jewelry oriented. Effect jewelry could be an object in a showcase. The value for the moviemakers would be economical and related to getting the fans hooked; furthermore, the jewelry would have image value and marketing value. This already realized when the media got interested in the effect jewelry.

The insufficient visibility could be a hindrance in using the item in a movie. This already happened when filming the trailer for the movie. As the lights were so strong, the effect jewelry did not shine enough. On the other hand, if jewelry is not an integral part of the plot, it is a mere decoration with no larger significance. The purchase or use of the jewelry can be prevented by the fact that it does not please the fans despite the different choices, the price is too high or the fan is simply not interested.

4.3. Prototypes and user tests of functional jewelry

4.3.1. Lifesaving jewelry

Lifesaving jewelry (**Figure 8**) contains the crucial identity and health data of the person who is wearing it, readily readable in the case of a sudden seizure, which means when the person is not being able to show data or tell about it. Smart jewelry had a near field communication (NFC) tag into which the data had been recorded. In the prototype, the health information



Figure 8. Lifesaving jewelry and its field test.

was readable with mobile phone by putting it close to the jewelry. A field experiment of this was carried out with paramedics. A situation with the person having a seizure was simulated. She acted unconscious and could not communicate at all. Paramedics had ca. 20 seconds to get the health information they needed and began taking measures according to that. The paramedics saw this solution as easy and good. The piece of jewelry was easy to be found so that the information was reachable by turning the actor. The situation could be made easier if the piece of jewelry or a similar gadget could be read from afar, let us say from a five-foot distance, and then the lifesaving jewelry or gadget wouldn't even have to be found. On the other hand, this poses problems to one's privacy. The problem could be solved with a special scanner and special tag.

Lifesaving jewelry is suitable for everyone who likes jewelry, but first and foremost for risk groups, such as diabetics, those with allergies and chronic illness, those who use prescription medication, and those with a heart condition. On the other hand, the solution is suitable for amnesiacs, children, or animals that may go astray or missing. For those groups, the jewelry may contain contact information of home and people near to them. Jewelry is to be worn daily—at least when the user leaves home, but depending on the user it would be good to wear at home.

As seen in the picture, the jewelry can be made with style utilizing NFC tag in the design (black element in the middle). Furthermore, there is a topaz and a jewel that was made of silver. Most of the test users liked the design very much indeed. Some were almost revolted by traditional wristbands that gave the user the stigma of being ill. Part thought that the prototype jewelry was too large (diameter of 31.50 mm), and would not wear it because of that. The design of the piece of jewelry in the picture is for females, but with different design, it could be worn by men alike.

Negative reaction on the authorities' side and bureaucracy might be hindrances to lifesaving jewelry's success. The danger of the client's health information getting abused may be seen stronger than the danger of wrong medication or medical procedure or getting them too slowly. The crucial hindrances are thus related to information security and the safety of privacy. Also, the durability and the reliability were questioned, what if the battery runs out, or the piece of jewelry gets wet? How do you update the health data? The last one is easily done with a mobile phone. Lifesaving jewelry has a passive tag, that is, it does not need a battery. Also, the tag has a waterproof coating. The version made of precious metal might be too expensive, so more affordable versions should be available. On the other hand, the data can be in a wristband or a ring along with the pendant, but we must bear in mind the size of the tag. One obstacle is that everyone does not like jewelry, so other alternatives, such as a tag in one's wallet or watch, or even a microchip under the skin, must be available. 'Selling' the jewelry to the elderly, especially for men, can be challenging. One has to also bear in mind the limited amount of data that is possible to put in a NFC tag in the jewelry. Perhaps, the best solution would be a system based on fingerprints, which enables access to personal info in a database by scanning the fingerprint.

4.3.2. Access control key jewelry

Access control key jewelry (**Figure 9**) is designed for the opening of electric locks and for monitoring working hours. Three different prototypes were made: a ring, a tie tack, and a bracelet. An access control key is inside the jewelry. It is as easy to realize as the lifesaving jewelry, it does not need a power source. The target group is enormous: production facilities, hotels, hospitals, schools, offices etc., and also homes as the electric locks become more popular. The



Figure 9. Access control key jewelry and its field test.

traditional unappealing access control key may be modified to match with the organization's brand and visual look, as well as create personal designs.

Prototypes were easy to make by taking apart traditional access control keys and changing the RFID tags to the designed ring, bracelet and tie tack. The access control system with scanner was left unaltered. In the user test ca. 25% thought that the access control key jewelry was a good idea. The ring was better than the tie tack or the bracelet in usability. The prototype of the ring was experienced as it was too large. The bracelet was deemed fit for only females. The tie tack positioning in the scanner was experienced as too difficult, unless it was detached from the tie. The people not attracted by jewelry wanted to integrate the chip with a watch, mobile phone, or wallet. On the other hand, it would have been taken to use from the pocket as does the traditional access control key. One approach was that the tag could be integrated as an already existing piece of jewelry with user, for example, wedding ring. One possible solution could be if nanotechnology "greased" into the ring surface and printed electronics, but this was seen as a possible future solution.

The price is the bad side of the idea. Access control keys that are 'jewelified' are 10–100 times as expensive as the current ones. In home usage, this could work better, as the quantities are more small, and individuals may decide on the budget themselves. On the other hand, the material choices are at least partly limited because of the weak penetration of standard signals, which in turn limits design.

4.3.3. Bola jewelry

Bola jewelry is a communication device for the pregnant lady and the unborn child, possibly also after birth. A piece of traditional Bola jewelry makes a noise of mechanical jingling, when in the smart version (**Figure 10**) you can create or upload many a voice – mother, father, and grandparents talking, music, and different kinds of voice recordings. A personal connection is made to an unborn child. Music and recordings of those nearest soothe strengthen the bond with the baby and the outside world. When the child is being born, she remembers and reacts to the sounds she has heard in the uterus, and that creates feelings of safety and calms the baby. Smart Bola jewelry could be worn elsewhere than the neck, for example, the wrist.

A designed and even tailor-made piece of Bola jewelry becomes an object for everyday use and a memento for the kid and the mother, or both. Why not for the whole family. After the birth, even the father can use the jewelry with the child. The prototype was built by creating

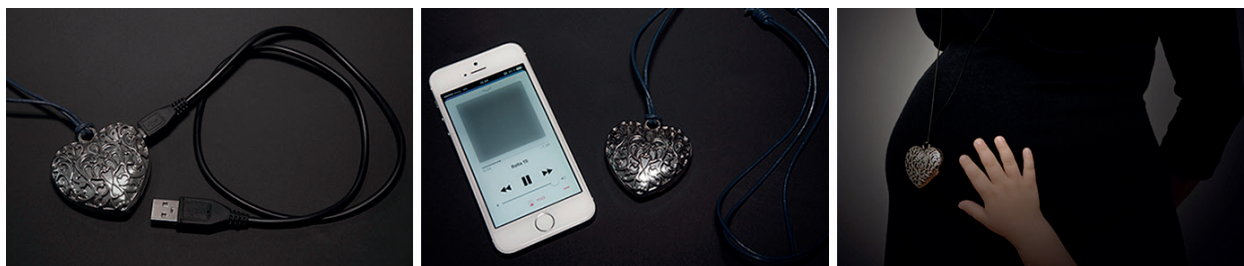


Figure 10. Smart bola jewelry.

a streaming from mobile phone to the Bola jewelry via Bluetooth. A hands-free receiver and a loudspeaker were installed to the jewelry. The source of the sound of Bola jewelry was a mobile phone. Optionally, the contents could be downloaded inside the jewelry. Ideas for further development: could the fetus or the baby communicate back to the parents—possibly including heart sounds. Vibration and light could be added to Bola jewelry, as well as auto-timer so it would not be on all the time.

The fear for electronics can be a hindrance when acquiring Smart Bola jewelry. As the product is meant during pregnancy and newborn, the authorities might limit its use by legislation or the security demands are lifted so high that the price would too high for the consumer. Quality jewelry, well made, is always expensive. Furthermore, tradition is in the way of use of Smart Bola jewelry. Traditional Bola jewelry is interesting because of its design and history. Smart Bola jewelry got the least enthusiastic reception of all the smart jewelry in this study. For a certain part of the women, Smart Bola jewelry made their blood boil because they were disgusted by the idea. It might be noted though that no young mothers were a part of this user test, but mothers who have given birth 10–20 years ago.

5. Conclusions

The smart jewelry is positioned in the so-called suicide quadrant of innovation when creating new products and new markets. According to this study, the smart jewelry seems to be a so-called high concept, which arouses people's interest. On the other hand, the smart jewelry sellers are already on the market but have not yet broken through the big scale. The markets and products are still in the introduction phase of their lifecycle. In other words, the market development degree of smart jewelry is low. The technology already exists and trends also seem to be moving toward smart jewelry, but the demand is not there yet, with the exception of low cost bauble and toy jewelry.

People are especially concerned about the duration, safety, security, and maintenance of technology. The marketing message should focus on alleviating these doubts. Of course, the tradition also has great impact. Jewelry has a long history. It is a big jump to suddenly switch to jewelry with technology inside. Some people will never accept this. It would be useful if a couple of big and credible companies started to focus on smart jewelry more prominently. This would also pave the way for other entrepreneurs in the industry. So far, mainly startups and researchers have made the work of activists ("Believe me, let's move forward together") in the creation of markets, but now more powerful market builders are also needed ("You have the need and we have the solution") to develop market to the next level.

Prototypes, surveys, trial runs, design probes, participatory and passive observation, interviews, workshops, and storytelling were used as methods to increase user understanding and explore business potential of smart jewelry. Almost all people interested in traditional jewelry reacted to smart jewelry with a strong or fairly strong emotion, positively or negatively. About 40% of these people saw smart jewelry as fun, cool, fantastic, and an inevitable future. About half of them loved the smart jewelry. On the other hand, 25% of people could

not tolerate the idea of smart jewelry. The remaining 35% were unable to form a clear opinion. One-fourth of the test users were not “jewelry people.” They did not use even traditional jewelry. This group was studied to find out if smart jewelry could attract new customers as jewelry users. According to the study, however, potential buyers of smart jewelry nowadays use traditional jewelry.

People expect from the smart jewelry to experience esthetic, functional, emotional, ecological, symbolic, social, and cultural value. The weighting of these values varies among different kinds of smart jewelry. The esthetic value, however, is common and the most important to potential users. Next comes emotional and symbolic values. These three values are causes why people could use jewelry instead of other products that do functionally the same thing. That is why the smart jewelry users will mainly come from subgroup of traditional jewelry users.

As wearable technology and the Internet of things become more common on the consumer market, the smart jewelry market will also probably grow. The healthcare and wellness industry seems to be a particular force for growth. A different sensor technology has increased and become considerably cheaper. Besides functional value, people appreciate jewel-like devices rather than an engineered appearance that may also be connected to some illness and thus create sense of shame. This seems to be the only cause to tempt nonjewelry people to smart jewelry users. According to the study, there are many target groups for functional smart jewelry. Therefore, the business potential is big.

Designed light jewelry has the potential as well, but for considerably smaller target group than functional jewelry. They could be directed at five target groups: (1) for women and their spouses born in 1960s and 1970s that have a positive outlook on life, (2) for tourists as a souvenir, (3) for different kinds of communities, (4) for entertainment business, and (5) for pets. Young people were not interested in light jewelry. However, some young test users said that jewelry should be challenged more comprehensively and forget the traditional shape of jewelry.

When the market is immature, there is no even common language among people—so-called market definition. If there is no common definition of the market and a subsequent shared language, it becomes difficult to create new demand and supply. As a result, the market will grow slowly or may die completely. In this study, an initial market definition was named concisely “smart and digitalization comes to jewelry.” Later it created more specific definitions and own definitions for the light jewelry and functional jewelry. A value proposition can be considered to be a focused market definition. It connects supplier’s offering with the customers’ expectations, needs, and benefits. For example, the value proposition of light jewelry for positive women born in the 1960s and 1970s was defined as follows:

Light jewelry produces moments of joy for you, your family, and friends. It emphasizes your self-confident and bold trendsetter image—including your playful personality. Light jewelry is a vibrant mystical object. Just when you think you see something, the jewelry shapes into something else entirely. Light jewelry has adjustable color options and allows flexibility in various costumes and uses. In addition, light jewelry is distinct from traditional jewelry by being stunning also in low light. On the other hand, the jewelry is stylish in the absence of light, so that it also suits peaceful moments.

Every piece of light jewelry is unique. The jewelry combines the blacksmith's craft and technology. The jewelry is made of silver. Light jewelry has no need to be charged and is ecological because it derives its energy from body heat and solar energy. Inside a piece of jewelry containing LEDs and other electronics is a 6000-hour warranty, which means the use of over 3 hours a day through the course of 5 years. The jewelry is recommended to be serviced every five years, with regard to electronics and to replace the necessary components. You only need to send it to service center.

As a summary, the smart jewelry seems to have a business potential, but as often with radical products and new markets, there is much of uncertainty. First early adopters have been caught but there is yet miles to go. A good sign is that some people are genuinely enthusiastic about the smart jewelry. On the other hand, the smart watches can somehow equate with the smart jewelry. After the initial interest, the eagerness toward them has faded. It is uncertain; can the smart jewelry revolutionize the jewelry industry—and if it is able to do that, when will this happen? At least nowadays, the business is still quiet. Maybe, the killer application is still missing.

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