The Design and Styling of Technology-based Innovations

Theory and Practical cases.

Wouter Eggink*, Angèle Reinders**

** University of Twente, w.eggink@utwente.nl*
*** University of Twente and Delft University of Technology, a.h.m.e.reinders@utwente.nl*

Abstract: This paper addresses the design and styling of future products that are based on innovative technologies. So how should a future electric personal mobility device look like? Or how will an electric vehicle charging station look and work with integrated photovoltaic solar cells? In general we wonder how we can create such designs that people are willing to incorporate new technologies in their daily lives. Because the way that new technologies are embodied in tangible products can have a lot of influence on the perception and adaptation of innovative technology-based products by the intended users. In this paper we propose guidance for the contemporary designer, in order to improve and facilitate the acceptance and domestication of such new technology. At least three complementing design principles play a role in this process; level of complexity, the combination of novelty and typicality, and the framing of meanings with associations and metaphors. This combination of design theories, called "innovative design & styling", was implemented and tested within an IDE students' master course "Sources of Innovation". The initial results that we present here, show that the explicit application of the three design principles had a positive effect on the quality of the proposed design concepts.

Key words: Design and Innovation, Design and Esthetic, Novelty, Typicality, Domestication

1. Introduction

How should a self-diagnosis device for the early detection of breast cancer look like? How should we shape a possible product that controls the daily calorie-intake of people with overweight, in order to have it accepted by the intended users? How will a new sunshade look and work with integrated photovoltaic solar cells? In general we wonder how we can create such designs for innovative technology-based products that people are willing to incorporate these new technologies in their daily lives. The communication function of design and styling can provide metaphors and associations that comforts or appeals to future users. However, little guidance is provided on how this should look like and especially theory of form that does justice to the complexity of the problem is lacking [1: p.25-29]. So at this time, often the only thing we can do, is look back and see what not to do. For instance the 'DaVinci' surgeon robot (Figure 1) shows how shapes can unintentionally invoke disturbing reactions of the intended users. The visual association with the villain "Sentinel" of the popular 'Matrix' SciFi movie trilogy, will not comfort the patient, especially when in a foreseeable future the human operator might be unnecessary.

2. Design and Styling

Design and styling of new products used to be easy. Modernism depicted that the product should be designed to fit the utility function of the object efficiently, and that the shape should be geometric and clean [2].

Postmodernism of the 1980s however, re-introduced the idea of cultural reference and moral values in product design [3]. Increased interest in the perception of these products by the intended users prepared a role for psychology in product design in the late 1990s [4]. Finally, the idea of product experience added an important context for the use of products [5], which should be pleasurable and provide a memorable experience [6]. For the future, product design can, and will, have to play a role in solving societal issues like obesity, increasing health-expenditures, the proliferation of environmental awareness or the avoidance of social isolation [7].

A lot of work has been done on mastering this increasing complexity. However, most work in the field of design research deals with *how* one should design; very little guidance is provided on *what* to design, in particular how the designed objects could look like if they are to incorporate all the aforementioned qualities and values.

Figure.1 The 'DaVinci' surgical robot unintentionally looks like the 'Sentinel' from the Matrix trilogy.

2. The Challenge

The design and styling of innovations is complicated. Especially in case of breakthrough innovations, the intended new objects have no real 'predecessor' in their existence, in other words, there is no reference to determine how they should look like. This is problematic, because in our 21st century postmodern society, the image of products has sometimes become more important than the products themselves [8, 9] and the perception by the user determines their existence [10]. At the same time, the functionalist idea of 'form-follows-function' cannot play its central role in the development of aesthetics anymore, because of the increased importance of "visually anonymous" electronics and information technology [11]. These simply do not have a particular shape, like steam-engines or bicycles used to have. This abstract nature even increases with developments in bio- and nano-technology [12]. And on the other hand, the developments in materials and computerized production techniques like 3D-printing, enables us to make nearly any shape we want. In this context, the communication function of aesthetics [3] - telling the user what the product is and how to use it - is therefore of utmost importance. Moreover, it burdens the designer with a lot of influence on the acceptance and domestication [13, 14] of new technology.

This is for instance visible in a regrettably common Dutch practice: the violence against speeding camera's [15] (Figure 2). The work of Verbeek [16] shows that when technology is involved in mediating moral issues, acceptance can be extremely low. The negative feelings about the implicit morality incorporated in the technology is projected on the object [17], and the impersonal and neutral shaping of the camera boxes does not help. Because the styling of the boxes represents anonymous technology rather than a personalized authority, the user is not

inclined to withhold his or her aggression. In other words; it is easier to molest a 'thing', rather than a 'personality'.

Figure.2 Molested speeding camera's in the Netherlands (left and mid) and their typical design (right).

3. Theory

Innovation will be considered as changes of product-market-technology combinations. So within the potential success of innovative technology-based products, design and styling can be an asset. A market for these new products can be promoted by studying the image that potential users wish, and designing products such that they meet those aesthetic requirements [18, 19]. So it is not only necessary to know the potential user and their preferences, fears and desires, but it is also necessary to provide the designer with a strategy to implement these into the design and styling of the new product. Within our research we developed such a strategy, based on a mix of three complementing design principles. The application of these principles was developed and tested within more than five years of experience with Master student design projects in the courses *Sources of Innovation* [20] and *Create the Future* [21] of our Industrial Design Engineering Curriculum. These three principles are (1) level of complexity, (2) the combination of novelty and typicality, and (3) the framing of meanings with associations and metaphors.

Basis for these three styling principles is the communication function of design [10], where the messages that are transferred can be functional (where to hold your hands when manipulating a product) or mental. The last category can be rather straightforward, for instance when a product is perceived as "new" or "masculine" or "engaging" [22], or more complex, when a product is perceived as "something that is going to cure me" or "something that is controlling me" in for instance the case of the speeding camera's in Figure 2, or camera surveillance systems in general. Figure 3 shows an example of both categories. The object in the left does clearly communicate the message about functionality; where to hold your hand when operating the device. However the more complex mental information that this is a device that can save you when you are in danger is not so clear. The smooth and fluent shaping of the device reminds more of a vase or another interior product, rather than the fire extinguisher that it is actually meant to be.

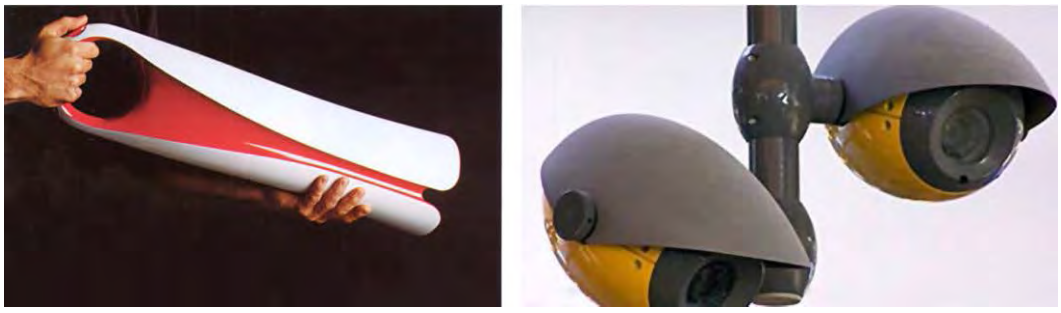

Figure 3. (Left) Anonymous fire extinguisher concept (2006) and (Right) Camera surveillance system, designed by WeArePerspective for NS Prorail (2007).

The object in the right is a surveillance camera system designed for the Dutch railways. The simple mental message that is communicated is that it is not “masculine” or “technical”, but rather “human”. There is also a more complex mental message that is communicated; that this is not a system that is controlling you when passing by, but rather “kindly keeping an eye on you”. These cameras were tested at Duivendrecht station in Amsterdam, where the “Big Brother feeling” among travellers decreased from 34% (old situation) to 12% [23].

3.1 Level of Complexity

The first design principle is illustrated in the iPod in Figure 4. The central idea of ‘simplicity’ stressed the problem that often occurred when introducing new consumer electronics: people being afraid they cannot cope with the complexity of new technology.

Figure 4. The iPod Nano from 2005 successfully communicates ‘simplicity’ (left), the music device on the right communicates the opposite.

This shows that complex psychological issues can be supported by design decisions. Insights derived from historic and/or canonical examples can help to understand the proper implementation. The iPod was inspired by the rather graphic modernist style of German design icon Dieter Rams [24], in spite of the more contemporary postmodernist style at the time of introduction in 2001 (Figure 5).

Figure 5. (Left) Braun T3 Transistor-Taschenempfänger by Dieter Rams (1958) and (Right) Apple iPod by Jonathan Ive (2001)

3.2 Novelty and Typicality

The second principle has its origin in the MAYA-principle (Most Advanced Yet Acceptable), originally coined by American star-designer Raymond Loewy more than half a century ago. This suggests that things should look new, but not too much, or as Loewy put it: ‘A lot of people are open to new things, as long as they look like the old ones’ [25] This principle is however backed-up by social studies on aesthetic preferences, that also argue that people both long for ease of recognition on the one hand, and the excitement of newness on the other [26]. Moreover, Hekkert, Snelders and van Wieringen [27] conclude that people have aesthetic preference for objects

that are both typical *and* novel. They conclude that this is not very easy to achieve because novelty and typicality show a highly negative correlation. Our research shows that this combination of newness and recognition is typically achieved when something that is widely known, is presented or applied in a new, unfamiliar context [28]. This principle can be implemented in many different ways. In the Gina concept car that was presented in 2008 by German car manufacturer BMW for example, the bodywork was innovatively executed in fabric, covering a tubular frame (Figure 6, right). Because the fabric was made in one continuous piece covering the whole body, this solution resulted in a form of wrinkling of the bodywork when the doors were opened. This is new within the styling of cars, but also recognizable because it associates with skin. The Formula Zero concept (Figure 6, left) uses the typical shapes of windsurfing sails within a non-conventional product architecture.

Figure 6. Mercedes Formula Zero racer (left) and BMW Gina concept (right).
Both designs from 2008 combine novelty and typicality.

Industrial Design Engineering Ma-student Jan Willem Peters explored this principle in his graduation project and showed that this works either way around [29]. Amongst others he designed a lampshade-fireplace (Figure 7). The lampshade-slash-fireplace looks very familiar in a living room context, but is new because of the gel burner that is providing a real fire, situated somewhere one does not expect. The familiar lampshade styling explains the functionality of the object and thereby facilitates the acceptance of the innovative concept.

Figure 7. Lampshade-Fireplace concept by Jan Willem Peters (2010)

Summarizing, innovative products need to be *both* novel to express their innovativeness *and* typical, to facilitate recognition and acceptance from the user. We called this deliberate combination of new and familiar aspects within one design the ‘extended MAYA principle’.

3.3 Associations and Metaphors

Thirdly, the communication function has to be regarded as a cultural phenomenon, in which design history is also important because the response of users is determined by their so called cultural capital [3]. So a red car connotes ‘danger’, because people learn that red depicts danger as in the traffic lights (Figure 8) [30].

Figure 8. Metaphors and associations; the 'dangerous' car is red and the 'friendly' example is green.

This example is very straightforward, but the surgical robot (Figure 1) illustrated already that this might easily go wrong when complex technology is involved. However, nicely styled in a non-obtrusive form language, the complexity of the overall-shape *does* invite for the wrong metaphor.

4. Application

To illustrate the application of the design principles in practice we shall present some examples from industrial design engineering projects. The first one comes from an IDE master course named 'Create the Future', where student groups first have to create a future context for their designs through systematic scenario development [21]. Within this future context the groups have to develop a product concept, and in this particular example, the group created a future electric mobility concept named 'Amplified Walking'. The central idea is that the electrically driven device amplifies the movements that you normally make when you are walking, stepping or running (Figure 9). Ingenious electronic feedback will keep the user stabilized in the same manner as the two-wheeled Segway does.

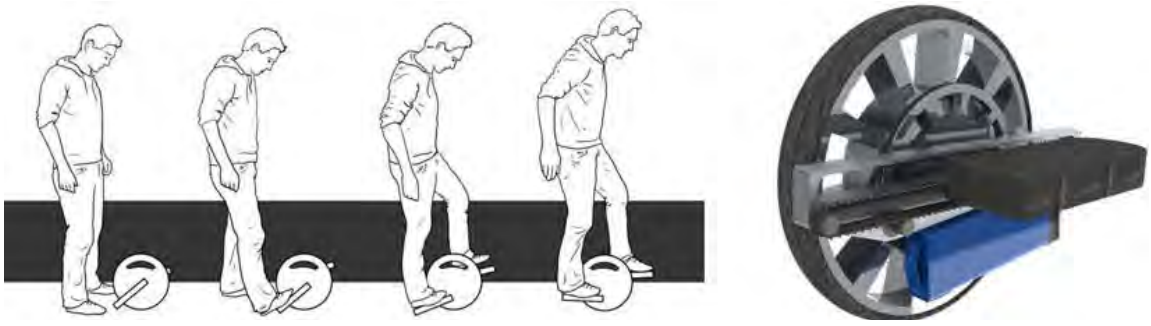

Figure 9. The Amplified walking concept, by Alfred Doppenberg, Ronald van Galen, Mark Grob and Elias van Hoek.

The amplified walking concept was developed for a future scenario context where consumer involvement with new developments was very high. This resulted in a product architecture based on building blocks that should be possible to construct in endless combinations, like a form of mass-customization. The group presented three different product architectures, likely to be built by different user groups. All three models make use of the second design principle with a combination of the novelty of the innovative technology and the recognition of the typical features of the user group's main inspiration sources (Figure 10). The first one combines the appearance of a unicycle with the styling of a white iPad. The second one is a mix of a skateboard and a mountain bike. The third concept resembles a typical fitness device, targeted on elderly people.

Figure 10. Three possible implementations of the Amplified walking concept.

The second example is from a student project on the development of an innovative product or system using a solar energy technology called CPV -Concentrating Photovoltaic. This project was executed for the master course 'Sources of Innovation'. The set-up of this course is explained in the paragraph about testing the methodology. The student couple designed a sustainable charging point for electric cars (Figure 11). The concept was named 'Tulip' due to the shape and to strengthen the sustainable character in the build environment.

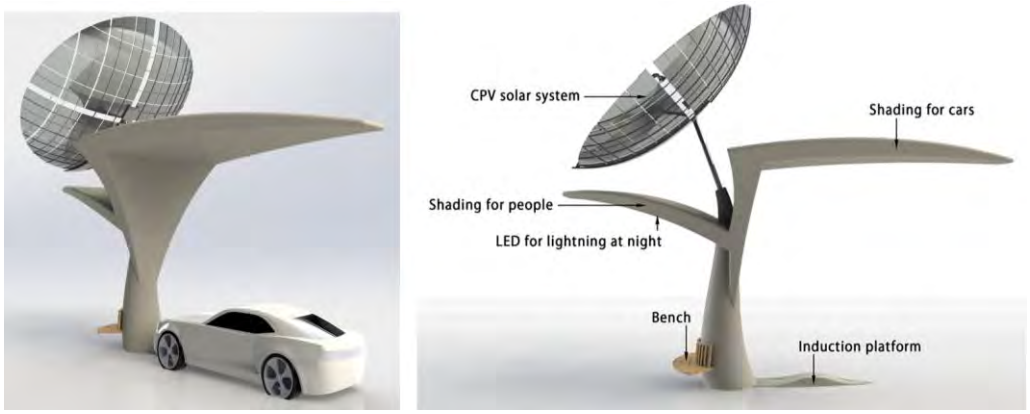

Figure 11. 'Tulip' concept for an electric vehicle charger station, developed by Jorien Bootsveld and Katja Schuitemaker.

This project used the extended MAYA principle in full. The division between aspects that should be typical and aspects that could be novel were visualized separately, before implementing them in the final design. Figure 11 shows this process. First, the design problem was visualized with aid of the disruptive images technique [31] (left).

Figure 11. The disruptive image technique is used to visualize the design problems (left). The Typicality-Novelty aspects are explicitly assigned and visualized (right).

The depicted problems were: the typical shape of the filling station does not fit in the futuristic surroundings; waiting for the actual charging process is boring, and; the wires that have to be connected-disconnected. In the

typicality-novelty analysis (Figure 5, right), the aspects that should stay familiar to the user were the parking spot, paying at a terminal and signing. Novelty could be achieved with different ways of shelter, energy provision (CPV), filling/connecting and lighting.

Figure 12. Disruptive images that were made to determine the right metaphor for the framing of the concept, similar to the way in which framing with themes is used in Design Thinking [32].

For the third design principle, the framing with metaphors, the students again used the Disruptive Images technique. Amongst others, the charging point was depicted in the context of a beach resort, a zoo, and the North Pole (Figure 12). The students argued that the first one was the most applicable: “The created atmosphere in the image of the beach is relaxed, comfortable and safe. This can be translated to a charging point with a bench, lightings, heaters or coolers, shadows, and etcetera. The translation makes sense because the charging of an electrical car is a different activity then the reloading of a regular car at a gas station. It takes an average of six hours to recharge an electrical car so a place to relax is maybe an option to make the use of electrical cars more attractive”. Besides this metaphor of a beach as a pleasant surrounding for the user of the charging point, the name tulip is also a cultural metaphor.

5. Test

As mentioned before, the theory and associated practical approach was implemented within the IDE master course Sources of Innovation. The particular set-up of the course allowed us to test the effectiveness of the proposed Innovative Design & Styling method, consisting of the three design principles that we described in this paper. Between September and November 2012 a total of 34 students attended the course and executed a design project in couples.

The course is laid out as project based learning [33], where the students have to develop an innovative concept, based on a given new technology. For 2012, the student teams were invited to design an innovative product or system using a solar energy technology called CPV (Concentrating Photovoltaic), fit for use in the built environment and/or energy landscapes. The students worked in teams of two, during ten weeks (one quartile) with a total workload of five European Credits. The course was finalized with a report and presentation of the developed design concept, accompanied by an oral exam about the design and the application of the underlying design principles and innovation methods. The students were supported in this task with a series of weekly lectures and workshops on both methodological and technological aspects. Topics that are attended are for instance: Delft innovation model, lead user study, platform driven product development, innovation journey, technology road mapping and TRIZ. Within their general design process, the student couples have to apply at least

four of the given innovation methodologies. The students are free to choose which of the methodologies is most suitable for their own project, however platform driven product design is compulsory. The other methods (totaling nine) are; constructive technology assessment, risk diagnosing methodology and innovative design & styling. Because of this set-up we were able to compare the design concepts from projects in which the Innovative Design & Styling method was explicitly applied, with the concepts from projects that did not. Earlier work showed that there are rather significant differences in the quality of the results, depending on the different methods that can be applied [20]. (For a complete reference of the setup of the course we refer to our publication *Explaining the Design & Styling of Future Products* [34]).

5.1 Results

The results of the course range from small products up to roof systems, and from the solar electric vehicle charger described in the previous chapter to an integrated sunshade and lighting system for terraces. In total, fifteen student couples finished the course with a complete product concept design and a full report describing the design process, including the four innovation methods chosen. In six projects, Innovative Design & Styling was explicitly used as an innovation method. Table 1 shows the projects and the innovation methods that were applied for all the groups that finished the course. The last column lists the scores, relative to the average grade for the conceptual designs, on a ten point scale. The average score of the six teams that used the Innovative Design & Styling method explicitly, is 0.6 point better than the average of the others.

Table 1. List of projects and the innovation methods that were applied

Project	IDS applied	Methods applied	Concept Grade
1. CPV roofing System	yes	**IDS**, DIM, PDPD, RDM	+1
2. CPV Vehicle Charging Station	yes	**IDS**, DIM, PDPD, RDM	+1
3. CPV Spring toy	no	IJ, DIM, PDPD, RDM	+1
4. Shade providing Electric Charger	no	DIM, TRIZ, PDPD, RDM	+1
5. High-Tech Sightseeing spot	yes	**IDS**, DIM, TRIZ, PDPD	+0,5
6. Sustainable Parasol	yes	**IDS**, DIM, PDPD, RDM	0
7. 'Tulip' Vehicle Charger (example)	yes	**IDS**, DIM, PDPD,TRIZ	0
8. Mobile CPV Fridge	yes	**IDS**, IJ, DIM, PDPD	0
9. Rural application for the 3rd world	no	LUS, TRIZ, PDPD, CTA	0
10. Sustainable Bus Info System	no	DIM, TRIZ, PDPD, CTA	0
11. Park Lounge Reader	no	DIM, TRIZ, PDPD, CTA	-0,5
12. The Solar Balloon	no	DIM, TRIZ, PDPD, RDM	-0,5
13. Very Large CPV dish	no	DIM, PDPD TRIZ, RDM	-1
14. Solar Powered LED screen for Festivals	no	DIM, TRIZ, PDPD, CTA	-1
15. Self-sustainable Park	no	LUS, PDPD, TRM, TRIZ	-1

IJ = Innovation Journey; DIM = Delft Innovation Model; PDPD = Platform Driven Product Development; RDM = Risk Diagnosing Methodology; **IDS = Innovative Design & Styling**; CTA = Constructive Technology Assessment; LUS = Lead User Study; TRM = Technology Road Mapping [35].

5.2 Discussion

In the end-results, the particular design and styling principles are in ten of the fifteen projects clearly discernible, even if the method is not explicitly mentioned in the reports. This somewhat blurs the outcome of the test. The difference of 0.6 points on a ten point scale seems not very significant, but when is considered that in the 10 point system everything below 5.5 does not pass, which in practice means that all groups received between 6.0 and 9.0, the difference is remarkable. On the other hand, the teams that did not use the theory methodically were also able to develop viable and sometimes very attractive solutions. That the results of the groups that explicitly applied IDS score better can of course be due to the preferences of the examiner, but this was not the same person as the design & styling expert that executed the workshop. Also the differences may be explained by the combinations with other innovation methodologies, which is an interesting topic for continued research [20]. Last but not least the sample is still of limited size, but we will continue to develop the workshop and monitor the results of upcoming cohorts of students.

Another point of concern is the applicability of the proposed theory on innovative technological product categories other than Concentrated Photovoltaic Energy systems. The diversity of the generated concepts indicates that this is promising, but to fully answer the question “how should we shape future technology, so that people are willing to incorporate new products containing these technologies in their daily lives?” more diverse example projects are desirable. Also a more thorough evaluation of the design results, including the opinion of the intended target users, should be considered.

6. Conclusion

Our impression so far is that design & styling can have an effect on the perception of technology-based products. Not only the designs become more attractive and are perceived as less hostile, also they will better fit in peoples lives and give intended users more control over these technologies, so that they will become meaningful.

We have also shown that the “innovative design & styling” approach can provide guidance for designers with the complex task of the development of such meaningful technological artefacts. In other words, it makes sense to succeed to shape technology in such a way that it corresponds with the (supposed) desires of people in society. According to our opinion this will be more significant than making things just look ‘friendly’.

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