Future Aesthetics of Technology; context specific theories from design and philosophy of technology

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Abstract: Since Postmodernism, presenting universal guidelines for aesthetics is highly suspect. However, aesthetics can play a significant role in the acceptance of technology and its success in society, so this paper argues for the generating of specific aesthetic guidelines, based on a general perspective. The goal of the research was to find a method of generating guidelines for the design of a technology to improve the diffusion of that technology in society. Aesthetic theories were generated by comparison of factors with historic precedents (the automobile, the television and the personal computer) The theories were then tested for the design of a social companion robot and a vacuum cleaner robot. From these two design cases it became apparent that the acceptance of both devices can be improved by, respectively, improving their conformity to contemporary design (the social companion robot), or improving their conformity to contemporary philosophy of technology (the vacuum robot).

Keywords: Aesthetics, Technology, Diffusion, Philosophy of Technology, Design History

1. Introduction

Defining the appearance of newly designed artefacts used to be easy. Modernism depicted that the new item should be designed to fit the utility function of the object efficiently, and that the shape should be geometric and clean. Postmodernism of the 1980’s however, re-introduced the idea of cultural reference and emotion in product design (Krippendorff, 2007). Increased interest in the perception and acceptance of products by the intended users added a role for psychology and emotion in the late 1990’s (Desmet, 2002). Finally, the idea of product experience (Green, 2002), introduced in the beginning of the 21\textsuperscript{st} century made it even more complex (Eggink & Bijl-Brouwer, 2010). From then on, using products should also be pleasurable and memorable (Schifferstein & Hekkert, 2007). Now that new production processes, electronics, and interactive technology on the other hand made it possible to make any shape we want (Eggink, 2012), a unified theory of how things should look like seems to be far away.
One solution to this problem can be found in making Aesthetics Theory specific for every new context (whether cultural, social, emotional or local). With which we mean that one can adapt a general theoretic aesthetic perspective and make it into a specific aesthetic theory, tailored to the design context at hand. In the research that we present in this paper, we developed a method to generate such context specific theories for the aesthetics of new technologies. The general perspective adopted was a combination of design aesthetics and philosophy of technology, and the specific context was the improvement of the acceptance of (household) robot technology.

2. Technologies and Aesthetics

This work on the aesthetics of technology is part of the “Where’s my Robot?” research strand that addresses the design aesthetics of robot technology (Eggink, 2014). Robot technology develops rapidly, and there are high expectations for the application of especially social robots in the lessening of future societal needs. Think of healthcare and safety, in the light of an aging population. Despite all the effort in robot technology research, the actual large-scale diffusion of robots in the domestic and social environment is still awaiting. The only domestic robot product with significant market penetration is the relatively simple automated vacuum cleaner. Key objective of the research program is to provide design strategies for the appearance of social robots that increase the acceptance of robot technology by the public.

How products are shaped can have lot of influence on the perception of these products by the intended user. This is not only a matter of nice curves and colors, but also a matter of culture, context and intentions of the designer (Crilly et al., 2009; Dorrestijn & Verbeek, 2013). Van Wynsberghe (2012) researched ethical issues of human-robot interaction in a healthcare environment, and concludes that these are largely defined by the actual shaping of the devices.

3. Research Approach

Basis for the search for new theories of aesthetics is the notion that we can learn for the future from the comparison with historic precedents. Our hypothesis is that the aesthetics of successful new technologies are determined by the relations between these technologies and the temporal views on aesthetics and technology in society. Therefore, the conformity of three successful technologies (the automobile, the television, and the personal computer) to the design movements and the philosophy of technology during the period of their diffusion was analysed. The patterns in these conformities could then be used to build an aesthetic theory for new technologies. In our specific context the conformity of household robot technology was compared with contemporary views on design and philosophy of technology (Snippert, 2016).

4. Historic Precedents

Issues with acceptance of new technologies in society are affected by a large variety of factors, making it difficult to gain a comprehensive overview of the current situation. Therefore, it is useful to look for analogies of the current situation; similar cases in which technologies had to deal with user acceptance. Analogies such as these can grant insight on the timeframe of the problem and on the influence of external factors and developments in the technology itself on user acceptance.

For such an analogy to work, it is essential to determine which technologies and contexts are relatively comparable to the current situation. In addition, the timeframe of the analogy should be
situated as such that it is sufficiently long ago to have a clear overview of both the context of the problem as well as the consequences of the offered solutions, and that it is recent enough to be documented properly.

Eventually, three successful technologies were chosen for their resemblance with robot technologies: the automobile (technical complexity), the television (social influence) and the personal computer (combination of hardware and software). The timeframes of the diffusion period for these three technologies are nicely spread over the previous century, what makes that the prevailing design styles and contemporary views on philosophy of technology at these timeframes are also significantly different.

4.1 Qualitative analysis

First the timeframe of the diffusion of the three technologies was established. Next, the society’s views on design and technology were studied and compared to the actual design of, and popular media about, these technologies during the time of diffusion.

The diffusion timeframes were determined by using data on the amount of products that were produced. It was chosen to focus on the diffusion in the United States, because the diffusion of both the automobile and the television in the United States is better documented and was less disrupted by the World Wars than in Europe. The first automobiles in the United States appeared in the 1890s, which was relatively late. However, both the production as well as the total number of automobiles in use quickly surpassed that of European countries (Nakicenovic, 1986). The total number of cars, buses and trucks that were registered in the United States shows an immense expansion up until 1930s and a steady growth after the 1930s, when over 50 percent of U.S. households owned an automobile. So the timeframe for the diffusion of the automobile was set from 1890 to 1930. The timeframes were defined in a similar manner for the television (1938-1954) and the personal computer (1975-2000).

To accurately map a society’s views on design and technology over a period of time is a task far outside the scope of our research, if possible at all. Instead, in this research, design movements are taken as representative of a society’s views on design in the time of that design movement’s popularity. While this supposition might be inaccurate, it is expected that different popular design movements deviate from the society’s view on design in a similar fashion. As such, if used consistently, design movements are considered a proper substitute for a society’s views on design. Similarly, for the society’s views on technology, the respected philosophy of technology from that time is considered a proper substitute.

For example, during the diffusion period of the automobile, two design movements were specifically influential: the Arts & Crafts movement, which was simply called ‘craftsman’ in the United States in the first period, and later on Art Deco (Danahay, 2015; Dell, 1999; Giedion, 1948). First we mapped these design movements and then compared them visually to popular automobile designs during the years. Then we did the same with the other technologies. See figure 1 and 2 for examples of the footage that was used to compare the design of technology with the prevalent design movements.
Up until the mid-nineteenth century, technology had little impact in everyday life and was mostly regarded as a novel way of using nature to make certain tasks easier. Ernst Kapp’s book *Grundlinien einer Philosophie der Technik* (1877), is generally considered the first work on the philosophy of technology. In this book, Kapp relates technological artifacts to human organs. The goal of technology was to ‘replace’ the human organs and improve upon them. And as the organs are already shaped as the standard of their function, the technological artifacts that replace these organs should also be based on these forms and should focus on increasing their utility and power (Reydon, 2015). This human oriented view on technology fits the human oriented craftsman style. However in the mean time during the diffusion period of the automobile, a lot was written on the dissatisfaction of craftsmen with regard to machines for mass production. So the remaining view on technology was both positive and negative, or rather ambivalent.
The qualitative comparison of all three technologies with the respective design movements and prevailing views on technology in philosophy and society resulted in the summarizing overview, presented in table 1. For more accuracy, it was decided to make a distinction between a first and a second timeframe within the diffusion period of all three technologies.

Table 1. overview of views on technology and design and the conformity to these views for the three technologies: the automobile, the television and the personal computer (Snippert, 2016).

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* these evaluations are specifically for game consoles

Aim of the comparisons was to find correlations between design movements, the view on technology and the appearance of the successful technologies. Most notable in all three cases, is that there is a clear rise in the conformity of the technology to the contemporary philosophy of technology from the start of the diffusion period to the end of the diffusion period (row 5; all three going from ‘ambivalent’ or ‘neutral’ to ‘good’). There is also a weak correlation between the conformity of the technology to the contemporary philosophy of technology and the personal views on technology (rows 5 and 1). Regarding the conformity of the technology to the contemporary design movements (row 6), there is a stark difference between the PC, and the automobile and television. For example Art Deco has a positive view on technology, which is in accordance with the personal view on technology from that time. Only for the Personal Computer there is a large discrepancy between the design movements’ appraisal towards technology and the personal views on technology. As such, it can be stated that there is a correlation between the conformity of a design movement’s appraisal of technology to the personal view on technology from that time and the conformity of technology to that design movement. In other words, when the personal views on technology are not in line with the views of a design movement, the conformity of the appearance of technology to that design movement is low.
4.2 Quantitative analysis

Due to the nature of qualitative research, the results that were gained from the descriptive data were mostly impressionistic. To improve the reliability of the results and to find more nuanced correlations, it was decided to perform a complementary quantitative research, comprising of a deeper analysis of the data that was previously gathered. Instead of analysing the technologies in their entirety, the individual designs of each of the technologies were now rated separately on their conformity to the relevant design movements and philosophies of technology.

A selection was made of 131 automobiles, 50 televisions and 99 PCs that were relevant in the United States in their respective periods of diffusion. See Figure 3 for an example of the data set.

![Figure 3. Television set designs that were used in the quantitative comparison with society’s views on design and technology during the diffusion period.](image)

Each design was then rated based on its conformity to the prevalent contemporary design movements and philosophies of technology, according to the descriptions that were made in the qualitative analysis. The rating that was used ranged from zero to six, with zero being ‘no conformity’ and six being ‘maximum conformity’. See Figure 4 for an example of the outcomes.

![Figure 4: the graph shows the yearly medians (in blue), the individual ratings (in gray) and the linear trend of the individual ratings (in dashed black) of the conformity of televisions to Modernism.](image)
To validate the individual ratings and test the ambiguousness of the interpretations, four additional subjects were asked to rate a sub-selection of 20 automobiles, 20 televisions and 20 PCs. See figure 5 for an example of the results of this validation, which confirmed the initial ratings.

![Figure 5: the graph shows the median trend of the four subjects (in black), the 95% certainty margin of the subjects (in gray) and this research’s trend (in blue), of the rated conformity of the selected televisions to Modernism.](image)

The quantitative ratings supported the findings of the qualitative analysis in most occasions, for instance that the conformity of television design to modernism was high in the second half of the diffusion period (compare Figure 4 and Table 1, row 6) and that the conformity to streamline design was high during the first half of the diffusion period. Only the weak correlation between the conformity of the technology to the contemporary philosophy of technology and the personal views on technology from the qualitative analysis was not found in the quantitative data. Instead, there is a correlation between the prevalent philosophy of technology and the technological appearance of the technology from that time.

### 4.3 Conclusions

The initially qualitative research that was complemented with quantitative data, provided several findings that might prove applicable in the design of new technologies with the aim of improving the acceptance of those technologies;

- There is a strong correlation between the popularity of a design movement and a (successful) technology’s conformity to that design movement.
- The conformity of the technology to the contemporary philosophy of technology increases from the start of the diffusion period to the end of the diffusion period.
- There is a positive correlation between the optimism of the prevalent philosophy of technology and the technological appearance of the technology from that time.

### 5. Design Cases

To test the applicability of the conclusions, a case study was performed on the design of robotics. First the contemporary design movements and philosophy of technology were investigated, followed by the current state of robotics. Then, based on the correlations found in the analysis, the desired conformity of the aesthetics of robots to the design movements and philosophy of technology was determined. Based on this desired conformity, several guidelines were derived. These guidelines were then used in the design of two personal service robots; a vacuum cleaning robot and a social companion robot.
5.1 Contemporary design movements

A design movement is a set of principles, or a school of thought, that influences the work of designers during a period of time. These principles are often in support of, or as a countermovement against, certain trends or events in politics or society in general. However, most design movements are only recognized in hindsight, making it difficult to discern what the most influential design movements in contemporary design are. Instead of finding large pre-defined contemporary design movements, it might be fruitful to investigate the overarching themes of design and design theories. One of the overarching themes in contemporary design is applying ethics to design. Instead of designing a product and giving consumers the responsibility of what to buy, designers are taking more and more responsibility themselves (Girling, 2012; Stam, 2015; Tromp et al., 2011). Another overarching theme is individualization. Nearly all consumer products that can be bought today are available in different colours, motifs, materials and sizes, or with additional accessories and added functions. Finally, contemporary design is also heavily influenced by the affordance of technology. New materials, extensive electronics, and 3d printing are providing designers the tools to make designs that could not have been created before (Eggink, 2012; Singer, 2002).

![Figure 6. Characterising contemporary appearance: the three most sold products from unique brands in 2015 on “Amazon.com” in the following categories: Cell Phones, Monitors, Irons, Desktop Computers, Printers, Laptops, Over-Ear Headphones, Refrigerators, and Home Audio Speakers.]

While these overarching themes are recognizable when looking deeper into a product’s design, they say little about the exterior design of the product. In order to find exterior design characteristics that are common or successful in contemporary design, a range of technologies was chosen and their best-selling products were analysed on exterior design characteristics (Figure 6).

5.2 Contemporary philosophy of technology

While the philosophy of technology is a relative newcomer in philosophy, it is now a well-developed and highly interdisciplinary philosophical discipline. Philosophy of technology is an inquiry into the
consequences of technology relating to the environment, society and human existence as a whole (Olsen et al., 2009). As such, it is difficult to present a comprehensive summary of the current state of philosophy of technology. Instead, the we focussed on subjects in philosophy of technology that are relevant for robotics and design.

Contemporary philosophy of technology recognizes that human lives are mediated through technology and acknowledges that we cannot abandon technology nor stop research on technology from being done. Therefore, the best way to deal with risks of new technologies is to educate ourselves and promote research on risk reducing technologies. In De grens van de mens (Verbeek, 2011a), contemporary philosopher of technology Peter-Paul Verbeek describes how he thinks we should handle the ethics of technology. He first shows we cannot discriminate where humans and technology separated. He then argues for an ethics system where we do not attempt to determine if technology is good or bad, but rather how we should deal with technology to reach the ‘good life’ of classical ethics. “Ethics, then, was about excellence in living, or mastering the art of living. In a technological culture, an ethics of the good life is about developing forms of excellence in living with technology” (Verbeek, 2011b, p. 156). In conclusion, human lives are inescapably interwoven with technology, so instead of giving a value judgement about technology itself, we should think critically about what the best way is to embed new technologies into our society. This means designing technology in such a way that the strengths of both the human and the technology in the interaction are supported on an individual, social, and society level (Dorrestijn & Verbeek, 2013; Eggink, 2014).

5.3 Robot concepts

Current social companion robots are clearly designed with considerations of ethics, integration into society and supporting different lifestyles. However, the exterior design does not correspond with the most successful designs at this time (Figure 6). For the vacuum robots, it is the opposite. The exterior design of vacuum robots corresponds well with contemporary views on design, but the designers have payed less attention to the philosophical questions relating technology.

In the analysis, the three successful technologies were found to have a high conformity to design movements for the entire diffusion period. The conformity to the philosophy of technology only became significant in the later part of the diffusion periods. In the current situation of personal service robots, the vacuum robots are in line with this pattern, while the social companion robots diverge strongly. It is therefore expected that, in their current state, vacuum robots are more successful, which is confirmed by the individual sales numbers.

Recommendations based on these observations, for promoting the rate of diffusion, are to design social companion robots with a higher conformity to contemporary design. Further developments for vacuum robots should be aimed at improving the conformity to the philosophy of technology while maintaining the current conformity to design.

Based on these insights, a vacuum robot design was developed with an improved interface that supports the user and the robot to perform the cleaning task ‘together’ (Figure 7). Instead of just hoovering around anonymously, the robot can provide the user with a sense of control through a programming option and communication about the cleaning options, progress, and achievements.
The social robot companion was redesigned to match the dominant contemporary design aesthetics, depicted in figure 6. Clearly displaying an alternative for the humanoid design aesthetic that is dominant in contemporary social robot design (Figure 8).

6. Discussion

The guidelines for the design of a technology, which are generated by the method described in Section 4, can be interpreted as causing an improved acceptance of the technology. However, this claim is not necessarily supported by this research. In this research, the notion of causality is avoided. So, for example, conformity to design movements and philosophy of technology does not necessarily cause an increased rate of diffusion or a higher acceptance by society. Instead, the fact that three successful technologies had certain conformities to design movements and philosophies of technologies indicates that these conformities do not prevent the diffusion of a technology. Therefore, the conformities can be considered ‘safe’. Consequently, the guidelines that are generated lead to a ‘safe’ design space, instead of a ‘good’ design space. By regarding the design space of a technology in the context of a society’s views on design and technology, a designer is guided towards a design that fits within that society.

Furthermore, the assumption that the successful diffusion of a new technology is largely defined by its appearance is also questionable. We also found that the integration of new technologies is easier
to accomplish in companies than it is to accomplish in households and subsequently, companies can act as a catalyst for the integration of that technology into the household (OECD, 2004, pp. 141-176; Prusak, 2005). The diffusion rate is also related to the ambiguousness of the technologies’ function; the more complex the innovation, the lower is the rate of adoption (Thompson & Higgins, 1991; Tornatzky & Klein, 1982).

On another level, there is still subjectivity in the descriptions and conformity ratings of the views on technology, society and philosophy of technology that are used. Also the amount and the appropriateness of the historic precedents is limited.

Finally, the developed robot concepts were not tested on their potential improvement on technology acceptance. However the method did provide valuable insights in the problematic diffusion of robot technology in consumer society. The design results also demonstrated a clear diversion from the current status quo in robot design.

7. Conclusion

The goal of our research was to find a method of generating guidelines for the design of a technology to improve the diffusion of that technology through society. In this paper we outlined a method to generate guidelines for the design of a technology and showed the application of the guidelines in the design of two personal service robot concepts. While applying the method requires a considerable amount of work, in situations where initial acceptance of a technology is lacking, this amount of work is justifiable. On the validity of the method, it should be noted that, while there is no causal relation between the generated guidelines and an improved diffusion, the guidelines are based on significant correlations between successful technologies.

Considering the unified theory of aesthetics, the method and associated design case showed that it is possible to generate a ‘theory of aesthetics’ for a particular context. The context in this case comprising of a combination of a specific technology within a specific society (where this society is characterised by its view on design and its view on philosophy of technology). From there, the correlations that were found within this research can be used to generate ‘theories’ for possible new contexts.

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