White paper

Value change and technological design

The **aim** of this white paper is to present engineers and designers with the most recent insights on value change in technology and how this might affect technological design, particularly when one aims to embed relevant social and moral values in technological design.

Contributors to the text:
Freek van der Weij
Steffen Steinert
Ibo van de Poel
Joost Alleblas
Anna Melnyk
Tristan de Wildt

Illustrations:
Ilse Oosterlaken

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Contents

1. Introduction

Technology helps to solve problems, but it may also lead to unintended consequences. For example, biofuels may help to overcome disadvantages of fossil fuels, but their production might compete with food production and lead to higher food prices and hunger. Therefore, in recent decades, the societal impact of technology has come to the center of attention. To deal with potential ethical issues related to technology, many scholars have emphasized the importance of addressing values already during the design phase of new technology. Values are here understood as beliefs about what is good or desirable, like human autonomy, safety, sustainability, or privacy. Researchers in ethics and philosophy of technology have developed a variety of approaches, like value sensitive design and responsible research and innovation, to help engineers embed values in technological design (e.g., Van den Hoven et al., 2015).

In this white paper, we address a challenge that existing approaches for dealing with values in technological design face. This challenge is that existing approaches tend to assume that values are static: at one point in the design process, the relevant values and their meaning are established. However, real-world examples show that values change over time. For example, sustainability was not always a relevant value in the design of energy technologies. Only in the wake of the energy transition did sustainability emerge as a core value in the design of energy technologies.

New values emerge all the time. As an example, consider wind turbines: these have primarily been designed for sustainability. However, studies have found that noise of these turbines can cause nuisance and (mental) health problems for people living nearby (e.g., Poulsen et al., 2019). Due to such new insights, (mental) health has emerged as a new value relevant for the design of wind turbines.

Social media is another example that illustrates why we should take value change seriously. Initially, many people believed that platforms like Twitter and Facebook should largely be left unregulated to facilitate the value of freedom of speech. However, due to the rise of fake news and political polarization on these platforms, ‘truth’ and ‘harm prevention’ emerged as new values guiding decisions about what messages to allow on these platforms (Iosifidis & Nicoli, 2020). Social media may also facilitate societal value change that has political implications (Steinert, 2021). For instance, by fostering a negative emotional climate, social media can increase the importance of values related to preservation of security and the avoidance of threat. Political attitudes are related to personal values, and a change in values will facilitate a change towards preference for policies that focus on security, conformity and social stability.

These examples indicate that designers and engineers should take values as dynamic and take seriously value change in the design and development of new technologies. This white paper provides guidance and introduces the issue of value change to engineers and designers. The paper is based on the outcomes of the ERC-funded research project ‘Design for Value Change’. After describing some approaches to design for values, we explain value

change and introduce different ways it can affect technology design. In the final section, we propose some approaches for dealing with value change in design.

2. Background: Design for Values

In the last decades, various approaches have been developed that aim to proactively address societal and ethical issues during the early development and design phases of new technology. Examples of such approaches are Constructive Technology Assessment (CTA) (Rip et al., 1995) and, more recently, approaches such as responsible research and innovation (RRI), often simply called responsible innovation (Owen et al., 2013).

Here we will focus on approaches that focus on *values* and on the *design* of new (technological) products, services or systems. We will use *Design for Values* as an umbrella term for approaches that pay *systematic* attention to social and moral *values* throughout the *entire* design process. (For more on Design for Values, see the handbook by Van den Hoven et al., 2015.) Considering values in design is not just relevant for improving the moral acceptability of technology, but also for increasing its acceptance by stakeholders. There are various more specific approaches that share the general outlook on design and values that is characteristic of Design for Values.

Design for Values: systematic approach for embedding values in engineering design

One approach is Value Sensitive Design (VSD) (Friedman & Hendry, 2019). The approach of Value Sensitive Design consists of three types of investigations: empirical, conceptual and technical. During the empirical investigations, the designers identify relevant stakeholders and their values. The conceptual investigations focus on giving conceptualizations of the relevant values and they help to identify possible trade-offs and conflicts between these values, as well as possible ways to deal with such value conflicts. During the technical investigations, it is investigated whether and how technical features support or impact values and how values can be implemented in design.

Another approach is value-based engineering (Spiekerman & Winkler, 2022). This approach aims at systematically and in a traceable way translating values into technical design choices and features. This approach is also the basis for the IEEE 7000 standard that aims at addressing ethical concerns during systems design.

In recent years, Design for Values approaches have been developed for specific values; examples are approaches like privacy-by-design, safety-by-design, or design for well-being (e.g., Brown, 2014; Van Gelder et al., 2021; Van de Poel, 2012). Some of these approaches do not only apply to engineering design, but also to other forms of design like for example architectural design, the design of sociotechnical systems and institutional design.

More specific values, and approaches, have also been formulated for specific technological domains. An example is the report of the EU High-Level Expert Group on AI (2019) that

formulates 4 ethical principles (respect for human autonomy, prevention of harm, fairness, explicability) and seven key requirements for trustworthy AI.

Despite their successes, scholars have criticized these approaches for assuming that values are static (for example Boenink and Kudina (2020) on RRI and van de Poel (2021) on VSD). Because values can change, as we illustrated in the introduction, engineers and designers should take value change seriously. In the next section, we will focus on value change and why it is important that designers and engineers consider it.

3. What is value change and why is it relevant for designers and engineers?

To explain value change, we first have to make clear what we mean with the term 'value'.

Values: relatively stable beliefs about what is good or desirable.

In this white paper, we consider values to be relatively stable beliefs about what is good or desirable. We can take different perspectives to understand values, and disciplines, like psychology and sociology, reflect these different perspectives. A psychological understanding of values considers values to be mental structures and an integral part of an individual's personality (Schwartz, 2012). Values influence individuals' attitudes, opinions, and actions. A sociological perspective on values understands values as abstract and shared principles that actors in society use to orient and legitimize their behavior (van de Poel, 2022; Martin & Lembo, 2020; Miles, 2015). So understood, values are often unarticulated guides of social evaluation and shape social action.

Psychologists and sociologists usually study values from a descriptive point of view; i.e., their aim is to adequately describe what values individuals have, or what values exist in society, and they may want to understand how and why these values change. Such descriptive studies are possible without making judgments about what is normatively or morally desirable. In designing for values, we are interested in values that are also morally important, i.e. values that are supported by moral reasons. Such *moral values* are often said to be independent from people's subjective beliefs (Korsgaard, 2015). How can moral values change? One way is through new information or new (moral) experiences. For example, when we learn that technology has unexpectedly negative health effects, it is reason to consider health a relevant value for the design of that technology, while before we weren't aware of that.

Value change may also occur through new moral experiences. For example, people experienced the wearing of Google Glass - when it was experimentally used on a small scale - as a privacy intrusion, even when it did not collect information (Kudina & Verbeek, 2019; Van de Poel, 2018). This suggests that in such a context, privacy cannot just be understood in informational terms, but also has a spatial component. The potential privacy intrusion through Google Glass affects how people experience shared spaces. For example,

people might feel uncomfortable at their dinner table when the dining partner is wearing Google Glass even when it is not recording.

Another way to understand how moral values may change, is to understand such moral values as being helpful for recognizing and addressing moral problems (Van de Poel & Kudina, 2022). Moral values then might need to change, or new moral values might be required, if we are confronted with new moral problems. On this reasoning, the emergence of sustainability as a value in the 20th century might be interpreted as a response to the growth of environmental problems, which in turn is caused by technical, social and economic developments.

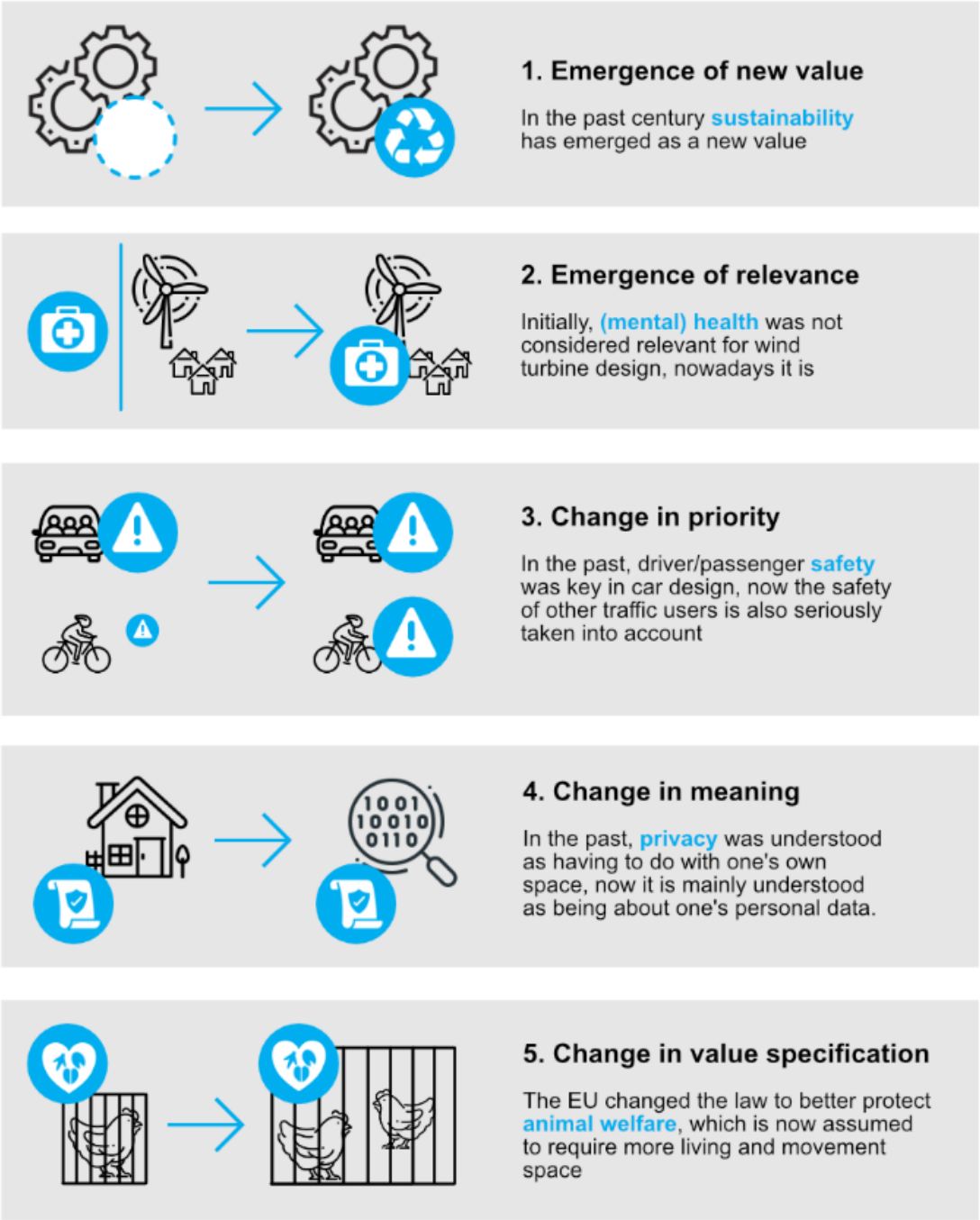
Value change is relevant for the design of technology and in what follows we identify types of value change concerning technology (Van de Poel, 2021):

1. Emergence of new values

New values can emerge over time because of technological or social developments, or a combination of these two. As mentioned earlier, the value of sustainability emerged in the wake of the energy transition, which was facilitated by new technology. The emergence of new values is relevant for design because established technology may not align with new values and needs to be re-designed. Similarly, there is a social demand to take into account sustainability in the design of new technology.

2. Emergence of relevance of values for technological design

Changes in the relevance of values for a specific technology is another kind of value change. Recall the example of the wind turbine. The continued use of wind turbines has provided new information about their impact on (mental) health. As a consequence, (mental) health, which was previously not considered relevant for wind turbine design, became relevant and should be an important consideration in the design and implementation of wind turbines. The design of social media platforms is another example that illustrates that values that previously were not relevant, can become relevant for the design of technology. In the beginning, the moderation of social media content was often guided by the value of 'free speech'. However, over time, the rise of disinformation, harmful online behavior, and political polarization led the values of 'truth' and 'prevention of violence' to become relevant .



3. Changes in priority of values

Besides the emergence of new values and irrelevant values becoming relevant for a technology, values can change in priority. That means the same values remain relevant for technology design but their relative importance changes. The change in value priority can be illustrated with car design and the relative importance of the safety of drivers and passengers compared to the safety of other traffic participants, like cyclists or pedestrians. Originally, car design focused on protecting drivers and passengers, but this emphasis has gradually shifted towards the protection of other vulnerable traffic participants (Simms & Wood, 2009).

4. Changes in meaning of values

Values are often expressed as abstract ideals or principles that people need to interpret to make them meaningful. For instance, the value of justice is rather abstract and people often provide different interpretations of it. Justice may, for example, be understood in terms of equal outcomes for different people, but also in terms of equal opportunities, which may lead to unequal outcomes for different people.

Technological and social change can lead to changes in how values are conceptualized, with potential consequences for technology design. Consider the value of privacy (e.g. Koops et al., 2017). Arguably, facilitated by the widespread use of communication and media technology, people commonly define privacy nowadays in terms of information and data (informational privacy). In the past, privacy was more often understood in spatial terms (e.g. a 'room for one's own'), and arguably such spatial understanding of privacy is still relevant for some technologies today.

Change in the meaning of a value has implications for technology design because to design for values you need to know how people clarify the meaning of a value and how this meaning may have changed over time. Otherwise you may design a technology that does not align with the new value conceptualization. For example, if people understand privacy in spatial terms, designing for informational privacy might not be good enough.

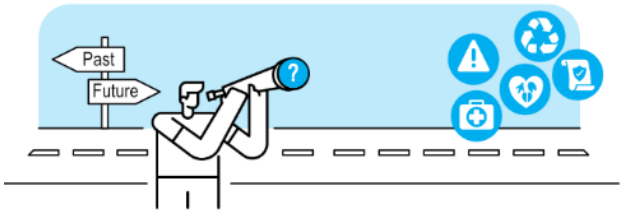
5. Changes in value specification

Finally, changes in value specification is another kind of value change relevant for the design of technology. Specification is the translation of values into design requirements. That means, value specification is usually context-dependent and focuses on a specific technology. For example, the EU changed the law regarding animal welfare and outlawed battery cages. Thus, the value of animal welfare needs to be translated into design requirements for housing animals that meet these new regulatory requirements (Van de Poel, 2013). This does not necessarily mean that animal welfare emerged as a new value or that the understanding or priority of animal welfare has changed. It merely means that an aspect of it is respecified, leading to different norms and design requirements. If we consider values at a higher level of abstraction we could also consider the aforementioned example of car design as a respecification of the value 'safety', with bystander and occupant safety becoming part of how safety is specified.

We believe that the kinds of value change we have outlined are important for the design and development of technologies. Taking value change into account will improve technology's normative desirability and will increase the likelihood that technologies are taken up by relevant societal stakeholders. In the next section, we discuss methods that engineers and designers can use to deal with value change.

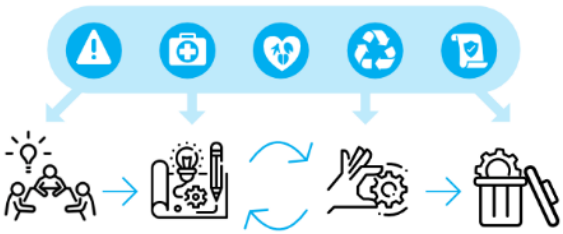
4. Dealing with value change in design and engineering

The possibility of value change has implications for Design for Values approaches that focus on values during the design phase of new technologies. We suggest three ways in which value change can be accounted for in the design of new technology: 1) Improving the anticipation of possible future value change; 2) Expanding Design for Values approaches to the full life cycle of new technologies; 3) Applying certain design strategies that make it easier to deal with future value change.



1. Improve your anticipation of future value changes

Methods include e.g. making techno-ethical scenarios, doing case studies and running simulations



2. Extend design for values to the full technology life cycle

Make use of prototyping and experimentation, monitor value change throughout the use phase and redesign if desirable

3. Apply design strategies that make dealing with future value change easier

We recommend three design strategies: adaptable design, flexibility in use, and value robustness

A caveat is in order here: We do not propose that designers and engineers engage with all three methods for each and every design process, nor do we propose that they become experts in anticipation or modeling methods. Collaboration with experts on these methods could be beneficial. Furthermore, how extensively value change needs to be considered may depend on the design process and the kind of technology that is developed.
Below we describe the three approaches in general terms. Relevant sources are listed at the bottom of this document for further details.

4.1 Anticipating value change

Anticipation of potential future developments is one approach to deal with value change. As far as it is possible to anticipate value changes, this is a very good approach. However, not all value changes can be anticipated. Moreover, anticipating value change will often require

considerable time as well as specialized expertise (depending on the exact approach applied). Of course, there are also less time intensive forms of anticipating value change, that also require less specialized expertise. For instance, one could consult works of science-fiction that often speculate about how technologies could lead to change in values. One approach that can be used for anticipating value change is the creation of techno-ethical scenarios that describe the co-evolution of technology and morality (Boenink, Swierstra, & Stemerding, 2010; Swierstra, Stemerding, & Boenink, 2009). Creating such scenarios involves three steps, namely 1) sketching the existing moral landscape, 2) anticipating new moral controversies that a novel technology may give rise to and 3) anticipating possible closure of these controversies that might result in value change.

Techno-ethical scenario (adapted from Boenink, Swierstra, & Stemerding, 2010)

(1) sketch the moral landscape:
    (a) present state of the art of technology
    (b) relevant current beliefs and practices
    (c) description of past and present controversies and how they were solved
(2) *potential moral controversies*: recurring types of moral arguments, and past controversies, are used to generate plausible ethical arguments and issues concerning technology; examination of promises and objections to anticipate possible controversies
    (a) delineate promises and expectations concerning the new technology
    (b) imagine critical objections against these promises
    (c) create argument patterns of argumentative reactions and counter-reactions
(3) *plausible resolutions of controversy:* potential (counter-)views and (counter-) arguments of step 2 are reduced by imagining plausible resolutions
    (a) Which parts of morality have proven robust in the past?
    (b) Which direction of decision-making is plausible in the light of past solutions and actual trends in morality and society?
(4) The second and third steps can be repeated to extend the analysis into the future

An important kind of value change is the change in meaning of a value. There are methods to anticipate value change as meaning change. For instance, Kudina and Verbeek (2019) investigated how people in discussions about a technology articulate new meanings and conceptions of the value ‘privacy’.

Multiple simulation tools that can be used to anticipate value change exist within the literature on social simulation and scenario analysis. Which simulation tool is most adequate depends on the simulation purpose (Edmonds, 2017) and the extent to which the system modeled can be described quantitatively (Weimer-Jehle, 2006). De Wildt & Schweizer (2022) use cross-impact balances to identify scenarios of value change for digital voice assistants and gene drive organisms. Melnyk et al. (2023) use agent-based modeling to explore how people’s moral concerns might expand to include the environment. De Wildt & Van de Poel (2022) use an agent-based model to test accounts of value change, allowing to better understand how phenomena of value change might unfold in the future. The table proposes a classification of adequate simulation tools based on the types of value change studied.

Extent to which the system can be formally described	Low No description of the relationship between system elements	Medium Description of the relationship between system elements by polarity (+/-)	High Description of the relationship between system elements by equations
Some suitable simulation tools	Storylines	Cross-Impact Balances	Agent-based modeling, System dynamics
Example of systems of value change	Emergence of sustainability as a new value on a global scale	Changing relative importance of privacy and sociality on future design requirements for digital voice assistants	Influence of human values on the adoption of sustainable behaviors

Case studies is another method through which we can anticipate value change. For instance, in their paper on technology and moral change, Danaher and Sætra (2022) use a case study method to investigate the mechanisms of technology-mediated value change. They show how technology changes our perception of the values of truth and trust through mechanisms like alteration of the cost-benefit balance of accessing these values.

4.2 Experimentation and monitoring

While better anticipation of value change is useful, not all value change can be foreseen or anticipated. Oftentimes, value change will be the consequence of new information, for example about unintended consequences, or of new experiences that people gather when using new technology. Such new information or new experiences may only become available after the introduction of new technology into society.

Large-scale introduction of new technology may however be risky and hard to reverse. Therefore, it is often worthwhile to first experiment with new technology on a smaller scale (Van de Poel 2018). This can, for example, be done by creating and testing prototypes during the design process (Peters, Ahmadpour & Calvo, 2020). Prototyping and experimentation can be combined with methods like questionnaires and focus groups that enable the collection of relevant information and experiences concerning potential value change.

Another possibility to better address value change is to organize the design process so that relevant new information and new experiences are collected and considered during the whole life cycle of new technologies, not just in the early phases of design and innovation. This can be done by extending the design process to the full life cycle of products (de Reuver et al., 2020), so that attention to values continues after a product has been introduced into society. This means that there is ongoing monitoring of how values related to the technology change over time, as well as continuous redesign of the relevant technology if necessary.

A tool that can be used for monitoring value change over time is ValueMonitor (De Wildt et al., 2021)[1]. By considering written sources, ValueMonitor helps to trace values in a technology domain on a frequent basis, even if these values are not explicitly mentioned in the written texts. It could also be worthwhile for designers to pay attention to large value surveys, like the World Values Survey[2] and the European Values Study[3]. These studies can provide insights into dynamics of values on a societal scale.

4.3 Design strategies

In order to deal with externally caused value change in particular, we recommend three design strategies (Van de Poel, 2021): adaptable design, flexibility in use, and value robustness.

First, because values can change, it is desirable to design **adaptable** technology (Gu, Xue, Nee, 2009). If the composition or configuration of a technological device or system can be changed, it is more likely that it will be able to perform well its current function, or perform a novel function. Adaptability allows a technology to better attune to new or changed values. An example of an adaptable technology are customizable digital apps and software, where users can change settings in accordance with their preferences and values. Open source could be another strategy that makes technology more adaptable. By opening technology to tinkering and improvement by users, technology becomes more adaptable and responsive to changing values. Design for adaptability is also recognized by architects who seek to make the built environment responsive to change (Schmidt & Austin, 2016). Another example is the modular design of smartphones allows them to be reconfigured in different ways to keep up with changing demands from users and society at large (Schischke et al., 2016).

Second, **flexibility in use** is also an important design feature of technology in dealing with (unforeseen) value change. Flexibility in use does not mean that the material product itself can be adjusted but rather that there are different possibilities for how it can be used. By increasing the number of ways in which a technology can be used, one improves the capacity to deal with value change. For instance, a thermostat that can be adjusted manually, instead of being automatically controlled, is flexible to respond to changes in users values concerning sustainability and energy consumption.

Both adaptability and flexibility, as design criteria, are relevant for an adequate response to changing values during the life cycle of artefacts. This response often takes place during moments of *maintenance and repair* of artefacts. Maintenance involves (re)design and innovation, and it requires creativity and adaptivity to keep artefacts functioning (Young, 2021). In maintenance philosophy, technological artefacts are not understood as static entities in which designers' ideas are realised and, therefore, should be carefully guarded. Rather, artefacts should be seen as processes of change, in which maintenance interferes with, reinforces, guides, or blocks these processes (Denis & Pontille, 2015; Graham & Thrift,

[1] https://valuemonitor.eu

[2] https://www.worldvaluessurvey.org/wvs.jsp

[3] https://europeanvaluesstudy.eu

2007; Young, 2021). Changes that come to the fore in maintenance practices include the aforementioned forms of value change. As such, maintenance appears as a possible strategy and locus for dealing with questions of value change."

Finally, technology will generally remain better aligned with values when its design is **robust**. One might distinguish here between what we will call ‘technical robustness’ and ‘value robustness.’ *Technical robustness* here refers to a technology’s capacity to perform its function despite alterations in its technical features, use, or external circumstances. A technically robust technology is less sensitive to external sources of variability and is able to perform its function in novel and unforeseen circumstances, while still respecting a certain range of values. For instance, robust design approaches can help to design the built environment for a stable energy performance, thereby respecting the value of sustainability, despite climate change and adversarial external conditions (Moazami, et al., 2019).

Technical robustness allows a design to fulfil its function and a range of values also in new circumstances. However, it may make it harder to deal with value change. One reason is that in order to attain technical robustness, designers may choose to decrease adaptability and flexibility in use. When it comes to dealing with value change, we may understand what we call *value robustness* as the ability of a design to fulfil its function and serve relevant values even if these values are prioritized, conceptualized or specified differently. Designing for value robustness means that a design is not optimized for a specific understanding of current values, but rather is so designed that it is still ‘good enough’ if these values would be prioritized, conceptualized or specified differently. It would require the designers to articulate different sets of values for which they want the design to still perform properly and then look for the design option that scores best on average over these different sets of values rather than to optimize for current values. Such designing for value robustness may require anticipation, in order to know what other value sets, besides the current one, should be taken into account in the design.

5. Summary

New technologies are increasingly designed on the basis of social and moral values. Various approaches, such as value-sensitive design, have been developed to design for values in a systematic way. However, existing approaches for embedding values in design pay insufficient attention to value change. We identified five types of value change to illustrate the variety of ways in which value change can affect technological design. Following this, we provided a range of proposals for dealing with value change. These included methods for better anticipating value change, as well as methods that help to integrate experimentation and monitoring into design processes. Also, we recommended three design strategies: adaptable design, designing for flexible use, and designing for value robustness.

The world is ever changing, and so are values. We hope this white paper will motivate designers to proactively consider the possibility of value change in their projects.

6. Further readings

On existing approaches for designing for values

Friedman, B., & Hendry, D. G. (2019). Value sensitive design: Shaping technology with moral imagination. Mit Press.

This book focuses on Value Sensitive Design as a methodology to consider values in the design of technology.

Owen, Richard, J. R. Bessant, and Maggy Heintz. 2013. Responsible innovation: managing the responsible emergence of science and innovation in society. Chichester: John Wiley.

This book provides a comprehensive framework for responsible innovation.

Spiekermann, S. 2015. Ethical IT Innovation: A Value-Based System Design Approach. CRC Press.

This book introduces the value-based engineering approach for the design of computer systems.

Van den Hoven, J., Vermaas, P. E., & Van de Poel, I. (Eds.). (2015). *Handbook of ethics, values, and technological design: Sources, theory, values and application domains*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-6970-0

This handbook provides a helpful overview of literature on designing for values. It includes papers on specific methodologies like Value Sensitive Design as well as on how to design for particular values.

Van de Poel, I. (2020). Values and design. In *The Routledge Handbook of the Philosophy of Engineering*, 300-314. Routledge.

This encyclopedia entry gives a quick introduction to approaches and tools for design for values.

On value change

Hopster, J. K. G., Arora, C., Blunden, C., Eriksen, C., Frank, L. E., Hermann, J. S., M. B. O. T. Klenk, E. R. H. O'Neill & Steinert, S. (2022). Pistols, pills, pork and ploughs: the structure of technomoral revolutions. *Inquiry*, 1-33. https://doi.org/10.1080/0020174X.2022.2090434

This article gives a useful overview of the literature on technomoral revolutions, and suggests different ways in which values may change.

Swierstra, T. (2013). Nanotechnology and Technomoral Change. *Etica & Politica*, *15*(1), 200-219.

This article introduces the technomoral change approach.

Van de Poel, I. (2022). Understanding value change. *Prometheus*, 38(1), 7-24. https://doi.org/10.13169/prometheus.38.1.0007

This article gives an overview of different ways of understanding value change, relating to different understanding of 'value.'

Van de Poel, I., & Kudina, O. (2022). Understanding technology-induced value change: A pragmatist proposal. *Philosophy & Technology*, *35*(2), 40. https://doi.org/10.1007/s13347-022-00520-8

This article proposes a pragmatist understanding of why and how values may change

On how to designers can deal with value change

Boenink, M., Swierstra, T., & Stemerding, D. (2010). Anticipating the interaction between technology and morality: A scenario study of experimenting with humans in bionanotechnology. *Studies in ethics, law, and technology*, *4*(2). https://doi.org/10.2202/1941-6008.1098

This article sets out how to develop techno-ethical scenarios which can help anticipate value change in design.

De Reuver, M., van Wynsberghe, A., Janssen, M., & van de Poel, I. (2020). Digital platforms and responsible innovation: expanding value sensitive design to overcome ontological uncertainty. *Ethics and Information Technology*, *22*, 257-267. https://doi.org/10.1007/s10676-020-09537-z

This article explains why better dealing with value change requires extending value-sensitive design to the full life cycle of products, and how this can be done.

De Wildt, T. E., van de Poel, I. R., & Chappin, E. J. (2022). Tracing long-term value change in (energy) technologies: Opportunities of probabilistic topic models using large data sets. *Science, Technology, & Human Values*, *47*(3), 429-458. https://doi.org/10.1177/01622439211054439

This article explains how topic modelling methods can be used to trace (and monitor) value change over time. See also www.valuemonitor.eu

Van de Poel, I. (2017). Moral experimentation with new technology. In *New Perspectives on Technology in Society*, 59-79. Routledge.

This chapter gives an overview of different ways in which designers (and others) can experiment with new technology to discover new moral issues or new values.

Van de Poel, I. (2021). Design for value change. *Ethics and Information Technology*, *23*(1), 27-31. https://doi.org/10.1007/s10676-018-9461-9

This paper provides a more in-depth description of the proposed taxonomy of value change, as well as of the design strategies (adaptability, flexibility, and robustness).

7. References

Boenink, M., & Kudina, O. (2020). Values in responsible research and innovation: from entities to practices. *Journal of Responsible Innovation*, *7*(3), 450-470. https://doi.org/10.1080/23299460.2020.1806451

Boenink, M., Swierstra, T., & Stemerding, D. (2010). Anticipating the interaction between technology and morality: A scenario study of experimenting with humans in bionanotechnology. *Studies in ethics, law, and technology*, *4*(2). https://doi.org/10.2202/1941-6008.1098

Brown, I. (2014). Britain's smart meter programme: A case study in privacy by design. *International Review of Law, Computers & Technology*, *28*(2), 172-184. https://doi.org/10.1080/13600869.2013.801580

Danaher, J. (2021). Axiological futurism: The systematic study of the future of values. *Futures*, *132*, 102780. https://doi.org/10.1016/j.futures.2021.102780

Danaher, J., & Sætra, H. S. (2022). Technology and moral change: the transformation of truth and trust. *Ethics and Information Technology*, *24*(3), 1-16. https://doi.org/10.1007/s10676-022-09661-y

Denis, Jérôme, and David Pontille. "Material ordering and the care of things." Science, Technology, & Human Values 40.3 (2015): 338-367.

De Reuver, M., van Wynsberghe, A., Janssen, M., & van de Poel, I. (2020). Digital platforms and responsible innovation: expanding value sensitive design to overcome ontological uncertainty. *Ethics and Information Technology*, *22*, 257-267. https://doi.org/10.1007/s10676-020-09537-z

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