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**DOI**

[10.1109/MTS.2023.3302406](https://doi.org/10.1109/MTS.2023.3302406)

**Publication date**

2023

**Document Version**

Final published version

**Published in**

IEEE Technology and Society Magazine

**Citation (APA)**

Van Der Weij, F., Steinert, S., Van De Poel, I., Alleblas, J., Melnyk, A., & De Wildt, T. (2023). Value Change and Technological Design. *IEEE Technology and Society Magazine*, 42(3), 25-32.  
<https://doi.org/10.1109/MTS.2023.3302406>

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## Value Change and Technological Design

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■ **TECHNOLOGY HELPS TO** solve problems, but it may also lead to unintended consequences. For example, biofuels may help to overcome the disadvantages of fossil fuels, but their production might compete with food production leading 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 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 (VSD) and responsible research and innovation, to help engineers embed values in technological design (e.g., [32]).

In this commentary, 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 instance, 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., [20]). Due to such new insights, (mental) health has emerged as a new value relevant to the design of wind turbines.

Social media is another example that illustrates why value change should be taken 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 [12]. Social media may also facilitate societal value change that has political implications [24]. For instance, by fostering a negative emotional climate, social media can increase the importance of values related to the preservation of security and the avoidance of threats. Political attitudes are related to personal values, and a change in values will facilitate a change toward a 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

Digital Object Identifier 10.1109/MTS.2023.3302406  
Date of current version: 21 September 2023.

seriously value change in the design and development of new technologies. This commentary is based on a white paper that we wrote for the 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.

## Design for values

In the last decades, various approaches have been developed to proactively address societal and ethical issues during the early development and design phases of new technology. Here, we focus on approaches that focus on *values* and 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. This includes approaches such as VSD [10] and value-based engineering [23]. 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., [4], [26], and [33]). Some of these approaches apply not only to engineering design, but also to other forms of design like architectural design, the design of sociotechnical systems, and institutional design. More specific values and approaches have also been formulated for specific technological domains.

Despite their successes, scholars have criticized these approaches for assuming that values are static (e.g., [1] and [30]).<sup>1</sup> Because values can change, as we illustrated in the introduction, engineers and designers should take value change seriously. In the following section, we will focus on value change and why it is important that designers and engineers consider it.

## What is value change, and why is it relevant for designers and engineers?

Psychologists and sociologists usually study values from a descriptive point of view, that is, they aim to adequately describe what values individuals

<sup>1</sup>These approaches have also been criticized for other reasons, for example, for the assumption that values, or at least some of them, are universal [3] or for lacking a proper grounding in moral theory [16].

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 judging what is normatively or morally desirable. In designing for values, the focus is on values that are also morally important, that is, values that are supported by moral reasons. Such *moral values* are often said to be independent of people’s subjective beliefs [14]. Obviously, this does not mean that people necessarily agree about moral values and—in designing for values—it is crucial to take into account the views of (direct and indirect) stakeholders about moral values.

Value change is to be distinguished from conflicting values in design. Design often needs to meet different values, such as safety and sustainability, that may not be fully realized simultaneously. This lack of simultaneous realizability of values in design may lead to tradeoffs between values.<sup>2</sup> Value change is different from value conflict because it relates to how values change *over time*. This may be a change in the relative importance of values, so changing acceptable value tradeoffs. But it may also be the emergence of a new value or a change in how a value is understood or specified, as we explain below.

How can moral values change? One way is through new information. For example, when designers or users learn that technology has unexpectedly negative health effects, it is reasonable to consider health a relevant value for the design of that technology, while before designers and users were not 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 [15], [29]. This suggests that in such a context, privacy should not only 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

<sup>2</sup>There are various methods for dealing with such conflicting values in design [28], including value dams and value flows [18].

as helping recognize and address moral problems [31]. Moral values then might need to change, or new moral values might be required if people 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 to the design of technology, and in what follows, we identify types of value change concerning technology [30] (see Figure 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 redesigned. Similarly, there is a social demand to take into account sustainability in the design of new technology.

### Emergence of the 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.

### Changes in the priority of values

Besides the emergence of new values and irrelevant values becoming relevant for 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 toward the protection of other vulnerable traffic participants [22].

### Changes in the meaning of values

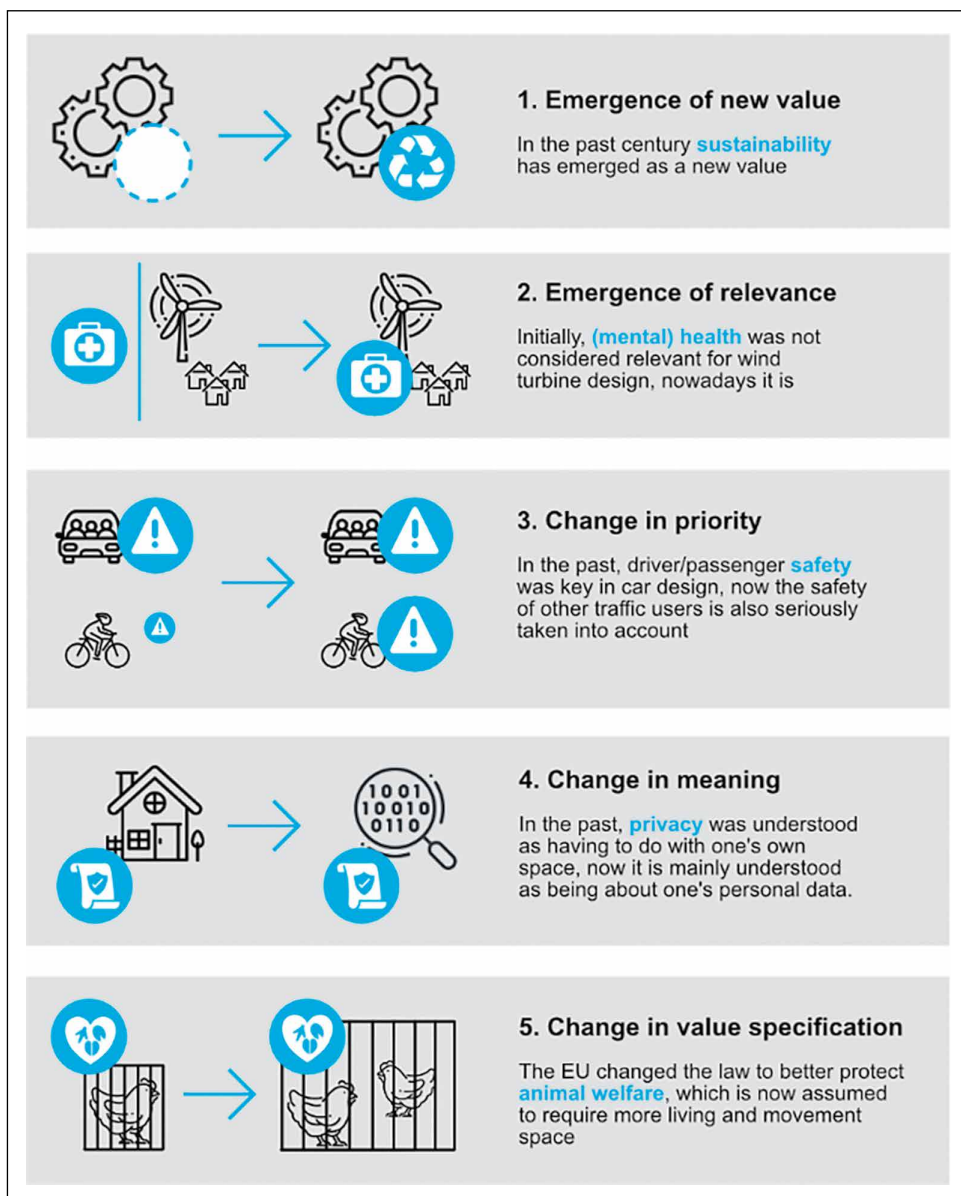
Values are often expressed as abstract ideals or principles that people need to interpret to make them meaningful. For instance, the value of justice is rather abstract, and people often provide different interpretations of it. Justice may, for example, be understood in terms of equal outcomes for different 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., [13]). 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, one needs to know how people clarify the meaning of a value and how this meaning may have changed over time. Otherwise, one 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 sufficient.

### Changes in value specification

Finally, changes in value specification are another kind of value change relevant to 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 European Union (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 [27]. 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



**Figure 1. Different types of value change. (Credit: Ilse Oosterlaken.)**

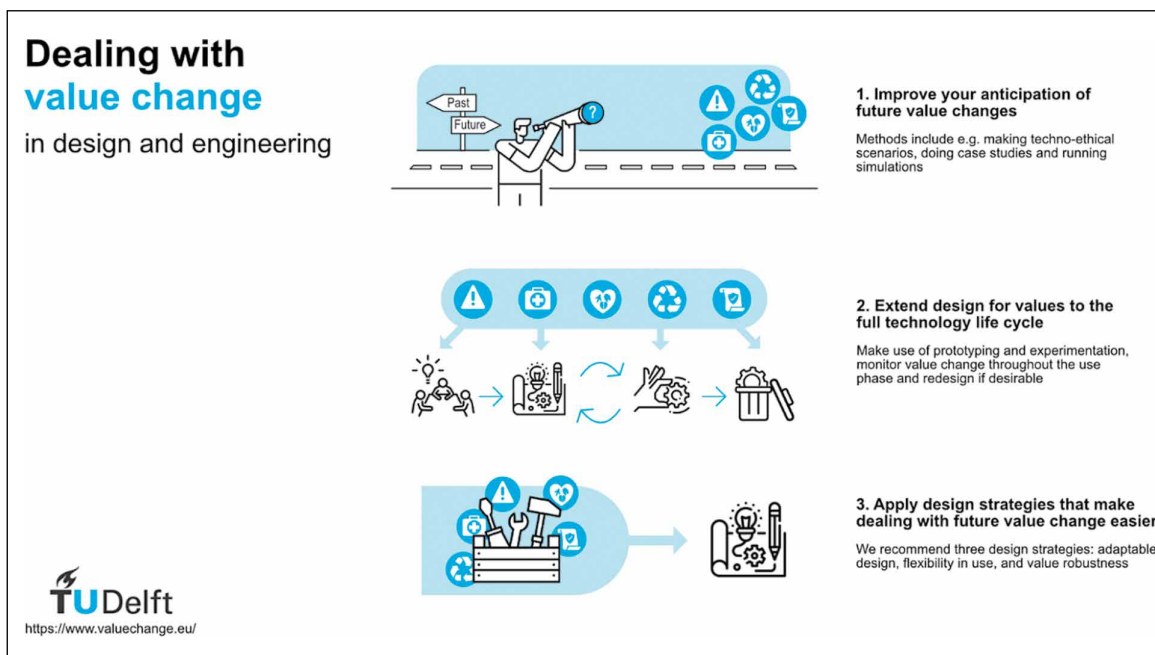
aspect of it is respecified, leading to different norms and design requirements. If we consider values at a higher level of abstraction, we could also consider the aforementioned example of car design as a respecification of the value “safety,” with bystander and occupant safety becoming part of how safety is specified.

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 relevant societal stakeholders take up technologies. In the following

section, we discuss methods that engineers and designers can use to deal with value change.

### Dealing with value change in design and engineering

The possibility of value change has implications for the 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



**Figure 2. Strategies for dealing with value change in design. (Credit: Ilse Oosterlaken.)**

to the full life cycle of new technologies; and 3) applying specific design strategies that make it easier to deal with future value change (see Figure 2).

### Anticipating value change

Anticipation of potential future developments is one approach to dealing with value change. Anticipating value change will often require considerable time as well as specialized expertise. Anticipating value change usually requires considering the larger sociotechnical system, as well as engaging with relevant stakeholders to gauge their moral values. 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 changes 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 [2], [25]. 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.

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 [9] and on the extent to which the system modeled can be described quantitatively [34]. De Wildt and Schweizer [8] use cross-impact balances to identify scenarios of value change for digital voice assistants, and gene drive organisms.

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 [5] 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.

### Experimentation and monitoring

While better anticipation of value change is useful, not all value change can be foreseen or anticipated. Often, 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.

However, the large-scale introduction of new technology may be risky and hard to reverse.

Therefore, it is often worthwhile to first experiment with new technology on a smaller scale [29]. This can, for example, be done by creating and testing prototypes during the design process [19]. 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 [6], 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 [7].<sup>3</sup> 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<sup>4</sup> and the European Values Study.<sup>5</sup> These studies can provide insights into the dynamics of values on a societal scale.

### Design strategies

To deal with externally caused value change, in particular, we recommend three design strategies [30]: 1) adaptable design, 2) flexibility in use, and 3) value robustness.

First, because values can change, it is desirable to design **adaptable** technology [11], [21]. 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 technology to be better attuned to new or changed values. An example of an adaptable technology is customizable digital apps and software, where users can change settings in accordance with their preferences and values.

<sup>3</sup><https://valuemonitor.eu>

<sup>4</sup><https://www.worldvaluessurvey.org/wvs.jsp>

<sup>5</sup><https://europeanvaluesstudy.eu>

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 that there are different possibilities for how it can be used. By increasing the number of ways in which 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 in responding to changes in users' values concerning sustainability and energy consumption.

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* refers to a technology's capacity to perform its function despite alterations in its technical features, use, or external circumstances. Technically robust technology is less sensitive to external sources of variability. It can 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 stable energy performance, thereby respecting the value of sustainability, despite climate change and adversarial external conditions [17].

**TECHNICAL ROBUSTNESS ALSO** allows a design to fulfill its function and a range of values in new circumstances. However, it may make it harder to deal with value change. One reason is that to attain technical robustness, designers may choose to decrease adaptability and flexibility in use. When dealing with value change, we may understand *value robustness* as the ability of a design to fulfill 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 be able to perform properly and then look for the design option that scores best on average over these different sets of values rather than optimize for current values. Such designing for value robustness may require anticipation, to know what other value sets, besides the current one, should be taken into account in the design. ■



## Acknowledgments

This commentary is a shortened version of a white paper that has been written as part of the project ValueChange that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 788321.

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