Value-sensitive design practices for frugal innovations

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Abstract

This chapter focuses on technological innovation and how insights from technological design can be used to address the challenges associated with the setting in which frugal innovation operates. The resource-constrained setting of frugal innovation puts high demands the design requirements of frugal innovation technologies and the possible conflicts between these requirements. Within the ethics of technology, there is a growing literature that explicitly focuses on how to make technological design more sensitive to important moral values, commonly referred to as value-sensitive design or design for values. However, despite strong commonalities, frugal innovation does not feature as a strong application domain in the literature on value-sensitive design practices. Since frugal innovation takes place in and/or for a resource-constrained context, focusing on just one value could easily lead to other relevant values not being appropriately embedded in the design. For value-sensitive design practices to contribute to frugal innovation, it seems better to think in terms of 'design for *context* X' rather than 'design for *value* X', as the latter may be too narrowly focused on one specific value. Systematic research on design practices is necessary to gain more insight in which values are particularly relevant, both in terms of internal values and in terms of external values, but also in the relevant operationalisations, which may differ substantially in different contexts and which may make value conflicts both more complicated but also more easily solvable.

1. Introduction

Frugal innovation is sometimes described as involving three types of innovation: technological innovation to address resource constraints, social innovation to address affordability constraints and institutional innovation to address institutional voids (Bhatti et al. 2018). Although the three types of innovation could not easily be separated, the main focus in this chapter is on the technological innovation and how insights from technological design can be used to address the challenges associated with the setting in which frugal innovation operates.

The resource-constrained setting of frugal innovation puts high demands the design requirements of frugal innovation technologies and the possible conflicts between these requirements. Since the formulation of design requirements and any trade-off between these requirements is inherently value-laden and ultimately a matter of ethics, the literature on ethics of technology is a good starting point for exploring the link between frugal innovation, technology and ways to responsibly address resource constraints.

Within the ethics of technology, there is a growing literature that explicitly focuses on how to make technological design more sensitive to important moral values. However, despite strong commonalities, frugal innovation does not feature as a strong application domain in the literature on value-sensitive design practices. Since there is no well-established literature on value-sensitive design applied to frugal innovation, this chapter is exploratory in nature, presenting the state-of-the-art of the value-sensitive design literature in order to sketch some tentative ideas on where this literature could contribute to the literature on frugal innovation and vice versa. It will be shown that values play a role in both the process and the product of frugal innovation and that value-sensitive design approaches are relevant for both. It will also be shown that the heuristic of frugal

innovation, which can be characterised by adaptability, may be relevant for value-sensitive design more generally.

The outline of this chapter is as follows. Section 2 briefly describes the design turn in applied ethics and how this also led to a new view on the ethics of technology, followed by Section 2, which provides a general discussion of the concept of values. Focusing on the existing literature on value-sensitive design practices, Section 3 describes the two main approaches to value-sensitive design. Section 4 presents some tentative ideas about what the insights and methodologies developed within the value-sensitive design literature could add to context of frugal innovation and the bottom of the pyramid. The concluding Section 5 identifies some research avenues that could be explored to bring value-sensitive design approaches closer to the context of frugal innovation.

2. The design turn in applied ethics and the role of ethics in design[1]

The moral nature of technologies has long been an important topic in the philosophy of technology. A key contribution here is the work of Langdon Winner, who was one of the first to provide a systematic account of how technological artefacts and design choices may be value-laden (Winner 1980). His most famous example concerns the design of 200 low-hanging overpasses over the parkways to Long Island, New York, by the influential urban planner Robert Moses in the mid-20th century. Winner explains how the specifications to which the overpasses were built reflect deliberate value-laden choices to achieve a specific social effect. By constructing very low overpasses, public busses would be kept off the roads to Long Island. As a result, people who would generally use public transport were not able were to access Long Island Beach. According

[1] This section is largely based on Chapter 7 of Doorn (2019).

to Moses' biographer Robert Caro, there was an racial motive behind this, as the white people from the upper and middle-class generally owned a car and were thereby able to reach the beach. People who were dependent on public transport, usually the poorer people, often of racial minorities, would not be able to reach the beach. Although the accuracy of the example has been debated, Moses' low overpasses have become the paradigmatic example how seemingly neutral technological artefacts, may be politically or morally charged. Today, the view that technologies are value-laden through their inherent function is widely supported, although philosophers disagree on how this value-ladenness can best be understood and different philosophical accounts have been proposed (Kroes and Verbeek 2014).

Since the 1980s, Winner's example of the low overpasses is often used to illustrate the moral importance of technological design (cf. Albrechtslund 2007, Shilton et al. 2013). Accordingly, technological systems are increasingly evaluated in terms of how or to what extent they fulfil certain values. The idea that technologies are value-laden not only means that technologies reflect negative values, for example racist values in the case of the low overpasses, but also that technologies are capable of endorsing positive values, such as sustainability, health, justice. This has led to a so-called design turn in applied ethics and ethics of technology specifically (Van den Hoven 2017).

Relevant in this development is not only understanding how technologies and values are related, but also actively influencing this relation via design choices, as in several stages of the design process, value-laden choices need to be made that allow for the inclusion or exclusion of ethical considerations (Van de Poel 2009). In the design process, the functions that an engineered system should be able to fulfil are translated into technical specifications, which are embodied in a physical structure. In this process, crucial decisions are made that affect how a technology or

technological system will be produced or constructed, how it will be used, what maintenance will be required and how the technology or technological system will be deconstructed, disposed or recycled after it has finished its functional lifetime.

With this design-turn in ethics, the role of ethicists of technology also changed (Doorn and Nihlén Fahlquist 2010). While philosophers working on the ethics of technology traditionally focused on preventing negative outcomes of technology, the value-ladenness of technology has inspired some philosophers to address value conflicts by technical means (Van den Hoven et al. 2012), where the role of ethicists and philosophers changed from a reactive role of 'policing' to a more proactive role of thinking which values are relevant and how they could be adequately embedded in a technological design.

This new approach to ethics of technology was also reflected in funding schemes and research policies. For instance, in 2007, the most important Dutch public research financer, the Netherlands Organization for Scientific Research (NWO), launched the "Maatschappelijk Verantwoord Innoveren" (MVI; usually translated as Responsible Innovation) funding scheme (Van den Hoven et al. 2014). Similar funding schemes were present under the European Horizon 2020 scheme, here usually referred to as Responsible Research and Innovation (RRI), and in the United States under the Nanotechnology Research and Development Act (Schuurbiers et al. 2013). The projects funded in these programmes are explicitly aimed at integrated humanities-social sciences-engineering research, where ethical investigations are carried out parallel to, and in close cooperation with, the social and engineering sciences. The ethicists interact with the technological researchers, allowing the ethicists to co-shape new technological developments (Doorn 2014).

3. Values[2]

Above the notion of 'values' was introduced without further detailing what values are and how we could categorise different types of value. Before discussing how to include values in design and what it could mean for frugal innovation, more clarity on the concept of value itself is needed.

Value is one of the central concepts in ethics. Although there is no unique definition of the concept of value, in philosophy values generally refer to lasting convictions or matters that people feel should be strived for to be able to lead a good life or to realise a good society. This philosophical notion of value is different from how 'value' is used in sociology and psychology, where values are often taken as personal preferences, interests or attitudes (cf. Cheng and Fleischmann 2010, Schwartz 1994, Rokeach 1973) or in economics, where the term is used to refer to monetary value. In the remainder of this chapter, we will use the term 'value' to refer to the philosophical concept of value.

In the context of technology, values are often seen as criteria to make statements about the ethical goodness of technologies or the consequences thereof (Milchram et al. 2018). They help us to determine which goals or states of affairs we consider worth striving for. They are considered to be applicable generally and not just be valid for individual persons (Van de Poel 2009). If a person says that justice is a value, this person does not mean to say that justice is only important to him or her, but that justice is an important value that should be strived for by all people. This does not mean, however, that all people agree on which values are important, let alone that they hold the same interpretation of some value. To stick to the example of justice, whereas people may agree that justice is an important value, they may disagree on how to interpret or conceptualise this value.

[2] This section uses excerpts from Chapters 1 and 7 of Doorn (2019).

People may also disagree about the relation between different values and whether there is a hierarchy between different values. An important distinction in this regard is that between intrinsic and instrumental values. Intrinsic values relate to those goals we consider valuable in and of themselves. By contrast, we consider some goals valuable because they are instrumental to achieving something else. These instrumental goals are valuable to the extent that they contribute to some higher goal that is, ultimately, intrinsically valuable.

A further distinction sometimes made in the context of technologies is that between internal and external values, where internal values are those values belong to technology itself and that are perceived by engineers as internal to engineering and engineering practice (Van de Poel 2015). External values, by contrast, are exogenous insofar as they are related to the *context* of technology, such as the legal, social, cultural, political, ecological, or aesthetical aspects (Gonzalez 2015). Internal values may be values such as efficiency, reliability, or maintainability; typical external values are health and safety, human well-being, sustainability, and justice (Van de Poel 2015). This distinction between internal and external values in engineering comes back in the conceptual distinction between functional and non-functional design requirements in design methodology. The functional design requirements express what a technology or technological system to be designed should be able to do. For example, a functional design requirement of a bridge may be that the bridge is able to carry traffic from one side of a river to the other. The non-functional requirements are those requirements that are not necessary for the proper functioning of the technology or technological system itself, but that express *how* a technology or technical system performs a certain function (Glinz 2007). Aesthetic values are a common example, but in the example of the road mentioned above, one could for example also think of a design requirement that reflects the desire to keep noise levels as low as possible (thereby expressing the value silence).

With these conceptual distinctions in mind, we can now turn to methodologies that aim to account for values in design.

4. Value-sensitive design methodologies

The design turn in applied ethics has led to a variety of approaches that all aim in one way or the other to account for values in the design. Two research groups have played a major role in developing methodology: the group of Batya Friedman and colleagues at the Information School of University of Washington, Seattle, whose methodology is usually referred to as Value-Sensitive Design (VSD), and the philosophy group at Delft University of Technology, the Netherlands, that introduced the term Design for Values (DfV) and together with several design groups within the university launched the Delft Design for Values Institute (DDfV).[3] In the remainder of this chapter, I use the abbreviations VSD and DfV when referring to the approaches developed by these two groups specifically, and I use the unabbreviated words 'value-sensitive design' and 'design for values' when referring to approaches that aim to account for values generally.

Developed in the context of Information and Communication Technology (ICT), VSD is a "theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process" (Friedman et al. 2013: p. 56). It has originally been introduced as a tripartite methodology that consists of conceptual, empirical, and technical investigations.

The conceptual investigations identify the relevant stakeholders and values that are relevant for the design at hand. This part of the VSD methodology aims to answer questions like: Who are

[3] The Delft school switched to the term 'design for values' only with the publication of the Handbook of Ethics, Values, and Technological Design (Van den Hoven et al. 2015b). In earlier publications of this research group, the term VSD is still used.

the direct and indirect stakeholders affected by the design at hand? What values are implicated? How should we engage in trade-offs among competing values in the design, implementation, and use of the systems we are designing? (Friedman and Kahn 2003). These conceptual investigations not only aim to clarify fundamental issue raised by the to-be-designed artefact or system, they also aim to gain insight in different conceptualisations of the relevant values. In online systems, for example, trust is often mentioned as an important value but trust can be interpreted roughly similar to concepts like reliability and 'performance as expected', but it could also interpreted as something that fundamentally takes place between humans, where the role of the technology is only seen as mediating this relationship (Friedman et al. 2013). The conceptual investigations aim to clarify these different ways of looking at values and to make the differences interpretations explicit.

While the conceptual investigations may remain rather abstract, the empirical investigations bring in the human component and to provide context. That is, these investigations look at how an artefact is situated in the human context, also to evaluate the success of a particular design. The institutional, organisation and economic context in which an artefact or system is also topic of these empirical investigations, for example in terms of different business models that are possible to create and capture value with the particular design at hand (cross-reference to Chapter 'Frugal innovation: balancing between value capture and value creation'; Rachel Howell). Additionally, the empirical investigations look at how intended users will prioritise different values, which may also affect future adoption of the design.

Lastly, technical investigations focus on the technology itself, looking at how technological properties may allow or not allow for inclusion of relevant values identified in the conceptual and empirical investigations. Due to certain physical properties, some design options are not possible.

However, the technical investigations go further than simply describing these physical constraints, they also include more pro-active investigations focusing on how the design should be changed so that the values identified in the conceptual and empirical investigations can be included in the design (Friedman et al. 2013). Friedman et al. mention the example of a collaborative ICT working environment, where the value of privacy was implemented by allowing individual users to override group settings about what data would be visible in the collective working environment and what data would be kept private to the individual user.

Where the original VSD methodology is still primarily focused on making sure that ICT systems are value-sensitive, the DfV approach explicitly takes the challenges and dilemmas stemming from conflicting values as a driver for innovative design, thereby not only extending the application of value-sensitive approaches beyond the domain of ICT, but also giving design a much more prominent role in actually solving potential value conflicts. In DfV, the design process is recognised as:

> "(…) a far richer process since it can now be seen not only realizing our functional requirements but also our moral values. It recognizes designers as far more important professionals since they not only can provide us with technical means but can also address the values of people and society and think about expressing them in material culture and technology" (Van den Hoven et al. 2015a: p. 3).

Hence, with DfV, design is given an explicitly positive role in solving societal challenges. In the DfV approach innovative design strategies can open up new possibilities so that certain trade-offs between conflicting values no longer need to be made. The aspect of design is relevant here in the

sense that it allows for creating new opportunities and "making the impossible possible" (Van den Hoven et al. 2012: p. 150). In other words, through innovative design, certain state-of-affairs that have hitherto been impossible now become 'feasible' or 'physically realisable'. DfV has been applied to a range of domains other than ICT, including biotechnology (Van den Belt 2015), architecture (Schrijver 2015), healthcare (Van der Wilt et al. 2015) and the water sector (Ravesteijn and Kroesen 2015).

Much of the literature on value-sensitive design practices seems to have a somewhat unsubstantiated optimistic tone, where value-sensitive design practices will be able to solve situations of conflicting moral demands (Van den Hoven et al. 2012). However, empirical evidence and concrete guidelines on how to do so is still scarce. Although the tripartite VSD methodology was developed to ensure that a technology's design requirements adequately reflect the values in the design at hand, it does not provide explicit guidelines for the implementation of values within the design process (Harbers and Neerincx 2014). The DfV Handbook compiled by members of the DDfV Institute lists some explicit DfV strategies to design for specific values, for example 'design for the value of inclusiveness' (Keates 2015), 'design for the value of responsibility' (Fahlquist et al. 2015), 'design for the value of safety' (Doorn and Hansson 2015), 'design for the value of trust' (Nickel 2015), et cetera, but it does not present a systematic approach for balancing different values in one and the same design.

The first systematic attempt to provide such guidelines was developed by DfV scholar Van de Poel, who introduced the concept of a 'values hierarchy' to describe how abstract values and more concrete norms translate into tangible design requirements such that the design sufficiently reflects the moral values at stake (Van de Poel 2013). The values hierarchy is a coherence structure, consisting of three layers, that shows how context-independent values in the top layer, can be

translated into more contextualised norms (that is, prescriptions or restrictions on certain actions) and further specified into concrete design requirements in the bottom layer. In this structure, the conceptual distinction between intrinsic and instrumental values is also important, as the instrumental values are only important to the extent that they contribute to intrinsic values.

While VSD can be seen to fit this top-down approach of specification, starting with conceptual investigations and moving towards concrete design requirements, the values hierarchy can also be constructed bottom-up. Here, the concrete design requirements are taken as point of departure and from this, one tries to derive more general norms and lastly the underlying values on which the requirements may be based or to which they may contribute. As design is most often seen as an iterative process, the construction of a values hierarchy for a particular design will therefore most often be a combination of both top-down and bottom-up approaches.

The conceptual distinction between intrinsic and instrumental values may be helpful for alleviating some potential value conflicts. In the case of conflicting values, instrumental values could sometimes be replaced by other values contributing to the same intrinsic value, as visualised in the values hierarchy.

Van de Poel explains how the bottom-up construction of the values hierarchy is also helpful for checking whether the ultimate design does indeed adequately reflect the values that are identified as relevant. He provides as an example the design of a chicken husbandry system based on the European Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens (see Figure 8.1). In the design of such a system, at least three values play an important role: animal welfare, human wellbeing and environmental sustainability, which form the top layer of the values hierarchy. In the preamble of the Directive, animal welfare is explicitly mentioned to include the provision of housing, food, water and care appropriate to the

physiological and ethological needs of the animals. Elaborating the values hierarchy based on shows a different picture though. The abstract value 'animal welfare' can be translated in norms, such as 'enough living space', 'presence of laying nests, 'enough littered area per hen', and 'availability of perches'. Lastly, these norms can be operationalised into concrete design requirements. Although it is beyond the scope of the present chapter to have an in-depth of this this example, elaboration of the values hierarchy for this chicken husbandry system reveals that the design requirements do not adequately capture all the relevant norms that pertaining to the value of animal welfare as described in the preamble of the Directive itself (Van de Poel 2013: p. 264).

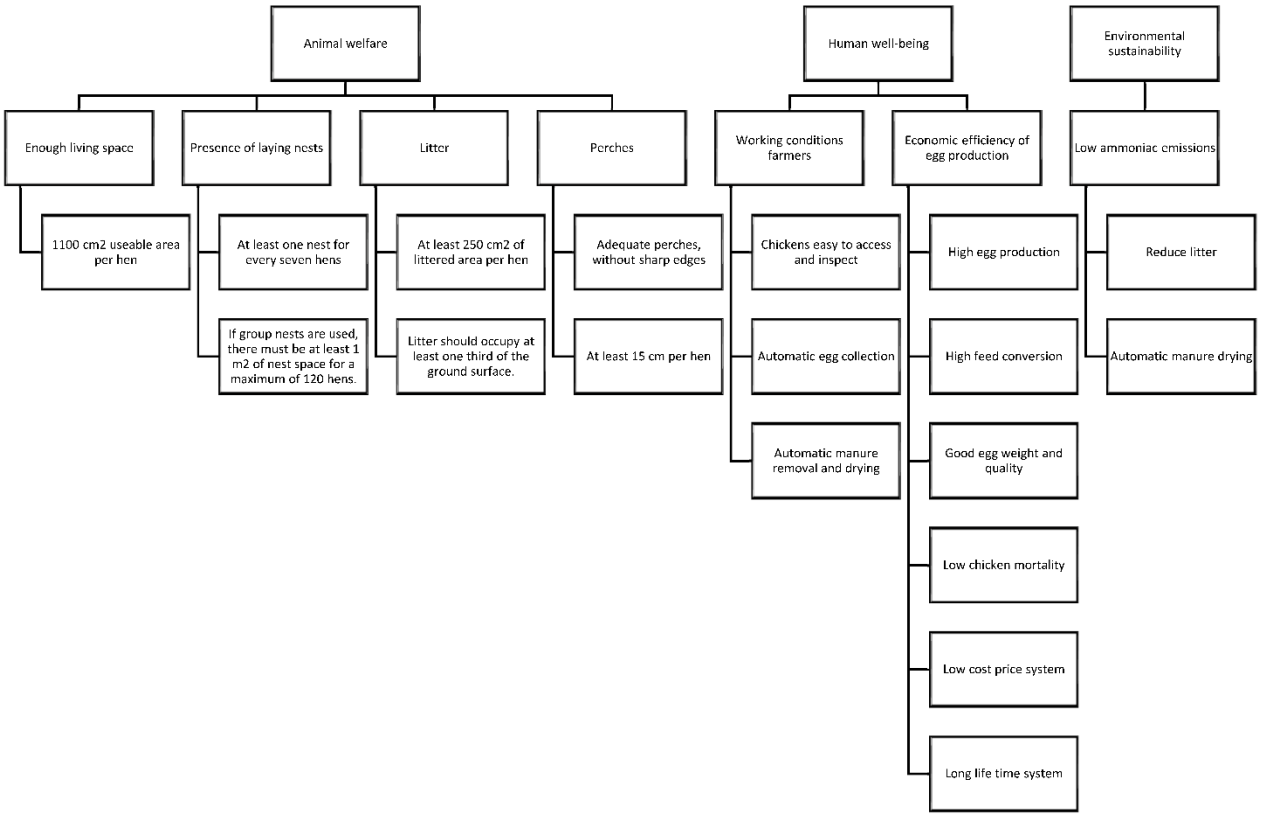

Figure 8.1: A partial values hierarchy for the design of aviaries, a specific type of chicken husbandry systems. The design requirements for animal welfare are based on EU Council Directive 1999/74/EC (Source: reproduction of Figure 201.1 in Van de Poel 2013)

While primarily developed with a *design* purpose, the values hierarchy can also be used as an analytical framework and as a tool for structuring discussion and participation (Mouter et al. 2018). Empirical studies on technology-based controversies indicate the need to address values early in the design and implementation of technologies and their governing institutions because unresolved ethical issues can exacerbate conflicts and undermine resolution efforts (Glenna 2010). Furthermore, addressing moral values may secure commitment from relevant stakeholders whose involvement is needed to successfully implement these technologies (Doorn 2016). The values hierarchy could play an important role here, for instance, in facilitating structured dialogue in which stakeholders better understand each other's argumentation lines.

5. Design, values and frugal innovation

So far, neither VSD nor DfV has systematically been applied to the context of frugal innovation. To date, there has not been any attempt to develop concrete "design for frugality" guidelines. Yet, the commonalities between value-sensitive design practices and frugal innovation seem quite strong. Indeed, both the literature on interdisciplinary research engagements and the literature on values and design recognise their roots in, amongst others, the frugal innovation literature. Schuurbiers et al., for example, link the current paradigm of interdisciplinary research efforts to "movements that aim to include minority views in design and technology development, like the appropriate technology movement (e.g., Nieusma 2004), *frugal design* (e.g., Bhatti et al. 2013), and inclusive or universal design (e.g., Connell and Sanford 1999)" (Schuurbiers et al. 2013: pp. 6-7; emphasis added). Similarly, in the introduction to the DfV Handbook, Van den Hoven et al. mention that, although the DfV approach originally stems from ethics of technology, designers

themselves "think about incorporating sustainability, democracy, global development, and social improvement to their design requirements, as in *design for the base of the pyramid*" (Van den Hoven et al. 2015a: p. 3; emphasis added). In this section, I will therefore explore what a VSD or DfV approach *could* add to the frugal innovation literature. In order to do so, it is important to distinguish between the frugal innovation as a product and frugal innovation as a process. Both the process or procedure by which a certain innovation comes about can be value-laden and the product that is the result of this process may be value-laden, which partly (though not fully!) overlaps with the distinction between internal and external values discussed in Section 3. The internal values often apply to the *process* of frugal innovation. In the context of engineering generally, Van de Poel mentions effectiveness and efficiency, robustness, rationality as examples of internal engineering values but he also mentions inclusive design. Although inclusiveness is probably not a value that will be recognised by all engineers as "internal to engineering practice" (Van de Poel 2015: p. 32), it does at least suggest that the design process can be more and less inclusive, where an inclusive design process could for instance mean that all relevant stakeholders and users should be able to decide to which requirements and specifications an object should be designed and how potential values conflicts are to be dealt with or resolved. Likewise, the process of frugal innovation could also be assessed in terms of how inclusive it is: Who has a saying in the decisions that are made during the innovation process? Other examples of such internal values that apply to the process of frugal innovation are transparency and participation: If choices need to be made regarding the use of scarce resources, how transparent is process by which the choice is made? Is it made by the people whose resources are used for commercial purposes or are they made by multinationals who would like to explore a new market? The example of the cook stove in Chapter XXX of this Handbook shows that lack of participation by end users may lead to

innovations that will ultimately not be adopted by its intended users (cross reference to Chapter "Frugal Innovation: a Gender Perspective" by Solange Hai & Saskia Vossenberg).

External values mostly apply to the *product* of innovation. In the context of frugal innovation, examples of external values are justice and sustainability (see, for example, Chapter 23 "Frugal Innovation and Sustainability: Bringing Together Polarised Views from the State of the Art" by Julia Bendul and Knizkov). Bendul and Knizkov mention the electrocardiogram (ECG) machine of General Electric (GE), which "utilises less plastic, as well as cheaper and commercially available screens, chips, printers and software, all of which reduce the costs and subsequent end price from 10,000 USD to 1,500 USD" (Sharma and Iyer 2012). Here, the value of sustainability is embedded in the product through low resource use in its construction.

Some values may apply both to the technology itself and to the process and the value of frugality itself is probably the best example. As explained in Chapter 2 (cross-reference to Chapter "Frugality in innovation process: insights from the informal economy"; Saradindu Bhaduri et al.), frugality is "not only *what* is achieved, but also (perhaps more importantly) *how* it is achieved" (emphasis added). The 'what' applies to the end product, which should ideally be produced with minimal resource use. The 'how' applies to the process of innovation, which the authors link to the heuristics through which innovations come about in the informal sector and this could be seen as a value internal to the process of innovation. Also the value of inclusiveness, presented above as an example of an internal value, could also be taken as an external value as well. It could then be taken to mean that the designed product should be useable by a large group of people and not put too high demands on, for instance, the literacy or physical abilities of the user.

As already stated in the introduction to this Handbook, intelligence in the context of frugal innovation is about "developing a 'good enough' solution that gets the job done" (Radjou et al.

2012), where “do more with less for more people” (Prahalad and Mashelkar 2010) is one of the central tenants of frugal innovation (cross reference to Chapter 23 “Frugal Innovation and Sustainability: Bringing Together Polarised Views from the State of the Art” by Julia Bendul and Knizkov). The main contribution of the value-sensitive design literature seems that it provides guidelines and tools to help make the decision when a design has indeed reached the threshold of ‘good enough’ performance. The DfV terminology of ‘design for value X’ seems in that sense a bit unfortunate, because especially in a resource-constrained setting, focussing on value X may often come at the expense of a whole range of other, equally important, values. Exclusion of some instrumental values may be a deliberate choice and be part of the whole approach of frugal innovation. However, when the value X for which a technology is designed compromises other intrinsic values, the approach of frugal innovation becomes problematic (cf. the controversy about the compromised safety in the first Tata Nano cars; Shafiulla 2014, Tybout and Fahey 2017).

Ensuring that all relevant, intrinsic values are adequately embedded in a design up to a sufficiently high level is already a challenge in a non-resource constrained setting, but at the bottom of the pyramid, this is even more challenging. Based on existing value-sensitive design practices and currently available tools, the values hierarchy seems a promising concept to provide support here as the values hierarchy does not so much focus on one value (‘design for value X’) but rather looks at the whole range of relevant values for a specific technology in a given context. It hereby makes the translation of values into design requirements not only more systematic, it also makes values explicit, debatable and transparent (Van de Poel 2013). It could reveal instrumental values that could be replaced by other means to achieve intrinsic values, thereby resolving potential value conflicts.

The values hierarchy may create an opportunity for critical reflection on these values, not only for designers themselves but for all relevant stakeholders, for example the users of certain technologies but possibly also those people that are affected by other people's use of a technology. Although a values hierarchy can itself not solve value conflicts, it may be helpful making the conflicts explicit and, if certain design choices are made, to make these transparent to those people that have not directly been involved in the development of the product itself. While transparency in itself does not need to be a substantive value, and transparent choices are not necessarily better or more acceptable, "transparency seems a minimal condition in a democratic society that tries to protect or enhance the moral autonomy of its citizens, especially in cases that design impacts the lives of others besides the designers, as is often the case" (Van de Poel 2013: p. 265). At the bottom of the pyramid, where we see large inequalities and a large group of people deprived of power, the need for transparency may be felt even stronger.

6. Concluding remarks

Despite strong commonalities, frugal innovation does not feature as a strong application domain in the literature on value-sensitive design practices; within this literature, there is no work explicitly dedicated to design for frugality.

Since frugal innovation takes place in and/or for a resource-constrained context, focusing on just one value could easily lead to other relevant values not being appropriately embedded in the design. For value-sensitive design practices to contribute to frugal innovation, it seems better to think in terms of 'design for *context* X' rather than 'design for *value* X', as the latter may be too narrowly focused on one specific value. The values hierarchy was presented as a tool to make relevant values explicit, debatable and transparent.

The implicit assumption behind this chapter seems that value-sensitive design practices have something to offer to the context of frugal innovation, but it may very well be the other way around. In order to bring value-sensitive design practices closer to the design practice of frugal innovation and vice versa, a particularly interesting research avenue to explore is how adaptability and flexibility allows for innovative approaches to value conflicts, for example, when the relevance of certain values may change over time or when different users with very different needs may put different demands on some design. Bhaduri et al. (this volume) link the heuristics of frugal innovation to decision making within bounded rationality. Due to time and environmental constraints, frugal innovation is not so much about finding the optimal solution but more about the solution that is good enough for her and now. Especially under conditions of uncertainty, adaptability may be the defining characteristic of the heuristic of frugal innovation. This may also inspire new value-sensitive design approaches that are less static and that are able to deal with changing demands.

Systematic research on design practices is necessary to gain more insight in which values are particularly relevant, both in terms of internal values and in terms of external values, but also in the relevant operationalisations, which may differ substantially in different contexts and which may make value conflicts both more complicated but also more easily solvable.

Although the outcome of the tentative research agenda sketched above is unknown, it can at least be expected that research along these lines will provide more insight in what can realistically be expected from value-sensitive design approaches for frugal innovation.

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