Chapter 20
Translating Values into Design Requirements

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Abstract A crucial step in Value Sensitive Design (VSD) is the translation of values into design requirements. However, few research has been done on how this translation can be made. In this contribution, I first consider an example of this translation. I then introduce the notion of *values hierarchy*, a hierarchy structure of values, norms and design requirements. I discuss the relation of *specification*, by which values can be translated into design requirements, and the *for the sake of* relation which connects design requirements to underlying norms and values. I discuss conditions under which a certain specification of values into design requirements is adequate or at least tenable.

Keywords Value sensitive design • Value • Design • Specification • Requirements

20.1 Introduction

In recent years, various authors have argued for incorporating values of ethical importance into engineering design (Flanagan et al. 2008; Friedman and Kahn 2003; van den Hoven 2007). We want cars that are safe and sustainable. We want internet search engines that are transparent in how they gather information, that have no systematic bias towards certain information, that respect our privacy, et cetera.

In this paper I focus on one specific aspect of what has been called Value Sensitive Design (VSD), i.e. the translation of values into more tangible design requirements. I have several reasons for this focus. First, the translation of values into design requirements is a relatively neglected aspect of VSD. Second, design requirements

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specify certain properties, attributes or capabilities that the designed artefact, system or process should possess. If VSD is to be successful, the formulation of design requirements is obviously to be (partly) informed by values. Third, design requirements play an important role in guiding the design process. Again, if Value Sensitive Design is to make values bear on the design process, design requirements seem a prime target.

Translating values into design requirements not only happens in VSD, but also in 'regular' design, albeit often implicitly. I therefore start my enquiry with an example that highlights how the value of animal welfare was translated into design requirements for chicken husbandry systems such as battery cages. This example will highlight some of the general characteristics of the translation of values into requirements in design. After discussing the example I will introduce the notion of *values hierarchy*, i.e. a hierarchical structure of values, general norms and more specific design requirements. A values hierarchy is a coherence structure that is held together by two relations. *Specification* is the relation by which higher level elements are translated into lower level elements in the hierarchy. Pursuit *for the sake of* is the relation by which we can connect lower level elements, like design requirements with higher level elements, such as more general norms and values. I will discuss both relations and end with a brief conclusion about the added value of drawing a values hierarchy for translating values into design requirements.

20.2 The Design of Chicken Husbandry Systems as an Example[1]

Currently, battery cages are the most common system in industrialized countries for the housing of laying hens. The system makes it possible to produce eggs in an economically efficient and factory-like way. The system, however, has also been heavily criticized for its neglect of animal welfare by reducing chickens to production machines (e.g. Harrison 1964). A main concern in the design of battery cages – and a main reason for the introduction of the battery cage – is economic efficiency. This value has in the course of time been translated into more specific design requirements in terms of egg production per animal, feed conversion (the ratio between the weight of the food fed to the chickens and the weight of the eggs), egg weight and the mortality of chickens, all of which can be measured in tests. Other relevant design requirements relate to egg quality, manure removal and drying, and the cost price and lifetime of systems.

Important moral values in the design of battery cages include environmental sustainability (battery cages cause environmental emissions, especially ammoniac), the wellbeing of farmers (labor circumstances and profitability of the systems) and animal health and welfare. These values have in the course of time been translated

[1] A more extensive discussion with further references can be found in Van de Poel (1998).

into design requirements for battery cages and for alternative chicken husbandry systems, sometimes through government regulation. Here, I will focus on how the value of animal welfare was translated into more specific design requirements in the context of EU (European Union) regulation.

Translating animal welfare into design requirements first of all requires more insight into the notion of animal welfare, and factors that might enlarge or jeopardize it, than was possessed by the engineers and technicians involved in the design of battery cages. The scientific discipline that came to play a key role in making the notion of animal welfare more tangible was ethology. Ethology is a branch of biology that studies the behavior of animals in their natural environment. This 'natural' behavior gives ethologists a kind of reference point with respect to which they can claim to discern 'abnormality' in the behaviour of, for example, chickens in battery cages. Deviant or absent behavior can then be interpreted as possible failure of the animal to adapt itself to the new environment. This led to the notion that chickens have certain 'ethological needs' that should be respected. So, ethology as a science provided a normative standard by which to judge the suffering of animals in general and chickens in this particular case. Of course, this did not mean that all ethologists agreed on the level of animal welfare in battery cages, or on possible measures that might be taken to improve it. However, ethology offered instruments and concepts with which the general and abstract value of animal welfare could be translated into a set of more concrete norms for chicken husbandry systems. The main norms that have been articulated over the course of time are (e.g. Kuit et al. 1989):

1. Chickens should have adequate living space. As the Brambell Committee, installed by the English government and including the ethologist William Thorpe expressed it in the 1960s: "An animal should at least have sufficient freedom of movement to be able, without difficulty, to turn around, groom itself, get up, lie down and stretch its limbs" (cited in Harrison 1993: 120);
2. Chickens should be able to lay their eggs in laying nests;
3. Chickens should have the freedom to 'scratch' and to take 'dustbaths', which implies that 'litter' should be present in the husbandry systems;
4. Chickens should be able to rest on perches.

These norms have in the course of time been translated by governments into more concrete requirements, which have often been adopted as design requirements in the design of chicken husbandry systems. I focus here on the EU legislation. In the 1980s, EU rules with respect to battery cages for laying hens were laid down in Directive 88/116/EEC. This directive stipulated the minimum requirements for laying hens in battery cages coming into use after 1 January 1988. The requirements were: at least 450 cm^2 floor area per hen, 10 cm feeding trough per bird, 40 cm height over at least 65 % of the area and a floor-slope of maximally 14 %. These requirements were a further specification of the first general norm above (enough living space), but did not address the other norms. Addressing these other norms was in fact impossible in conventional battery cages and required the development of alternative systems. The main alternative systems that have been developed over the course of time are enriched battery cages and aviaries. Enriched battery cages are cages with special areas for perches, laying nests and litter. Aviaries are characterized by the presence of several levels on which the chickens can drink, eat and rest.

In 1999 new EU legislation was adopted implying a de facto phase-out of the traditional battery cage by 2012; no new traditional battery cages were to be brought into service after 1 January 2003 (EU Council Directive 1999/74/EC). The new directive also contained requirements for enriched cages and for other alternative systems. For enriched battery cages the main requirements are (EU Council Directive 1999/74/EC, article 6.1):

(a) at least 750 cm^2 of cage area per hen, 600 cm^2 of which shall be usable; the height of the cage other than that above the usable area shall be at least 20 cm at every point and no cage shall have a total area that is less than 2,000 cm^2;
(b) a nest;
(c) litter such that pecking and scratching are possible;
(d) appropriate perches allowing at least 15 cm per hen.

For other alternative systems like the aviary, the main requirements are:

1. The stocking density must not exceed nine laying hens per m^2 usable area (i.e. about 1,100 cm^2 per hen);
2. At least one nest for every seven hens. If group nests are used, there must be at least 1 m^2 of nest space for a maximum of 120 hens;
3. At least 250 cm^2 of littered area per hen, the litter occupying at least one third of the ground surface;
4. Adequate perches, without sharp edges and providing at least 15 cm per hen.

This example shows how the general value of animal welfare was translated into more concrete design requirements. It is striking that this translation largely took place outside the design process or other engineering practices. Partly, this is the result of certain particularities of this example. Animal welfare was, and still is, a value that is rather alien to engineering and engineers lacked expertise to specify this value. Moreover, there was little market demand for alternative systems. Still, the example highlights a number of aspects that are more generally illustrative for the translation of values into design requirements.

First, the translation of values into design requirements, especially of new values, may be a lengthy and cumbersome process. This also applies to values that are initially less alien to engineering than animal welfare. A nice illustration is Vincenti's description of how the broad notion of flying qualities for aircraft was translated into more specific requirements (Vincenti 1990: chapter 3). As he argues, flying qualities were initially ill-defined, contained subjective elements and were related to different, but related needs of aircraft designers and pilots. It took a mere 25 years and much effort to translate ill-defined flying qualities into more or less well-defined design requirements.

Second, translation may require specific expertise, sometimes from outside engineering. In the case discussed here, ethology provided such expertise. In cases of environmental values, environmental science or ecology may be relevant. For values such as privacy and trust, philosophical analysis may help to better understand these values and translate them into more concrete norms. Even values like safety and usability, which are more familiar to engineering, may require specialized expertise, as witnessed by the emergence of such disciplines as safety science, safety engineering and ergonomics.

Third, translation will often partly take place outside specific design processes. The chicken husbandry example is extreme in this respect; often the final translation from more general norms into specific design requirements will take place within the design process. Nevertheless, in these cases as well engineers will often rely on specifications that are more generally available. Apart from legislation, a main source of such specifications are technical codes and standards, which are usually drawn up by engineers on standardization committees and which lay down requirements or guidelines for dealing with general values and considerations such as safety and compatibility.

Fourth, the translation of values into design requirements is value laden. It can be done in different ways. Sometimes different (sub)disciplines offer different ways of specifying a value. Sometimes specification is made dependent on what is feasible with current technology or on trade-offs with other relevant values. The reason why Directive 88/116/EEC only addressed one of the four more general ethological norms was that it was deemed economically undesirable to formulate requirements that would de facto forbid the commonly used battery cage. From a philosophical point of view, a main question is when certain specifications are adequate or at least tenable.

Fifth, the translation of values into design requirements is context-dependent. Although animal welfare is a general value, its specification is different in the context of the design of chicken husbandry systems than, for example, in the context of toxicity tests or medical experiments. EU Council Directive 1999/74/EC contained as many as three different specifications of requirements for chicken husbandry systems applying to three different types (layouts) for such systems.

Sixth, the example illustrates that values and design requirements have a hierarchical structure. In this case, the general value of animal welfare was first translated by ethologists into a range of norms for holding chickens, and then governments translated these norms into very specific requirements. In the next section, I will be exploring this hierarchical nature of values and design requirements in more detail and introducing the notion of a values hierarchy.

20.3 Values Hierarchies

As we saw in the animal welfare example, values and requirements have a hierarchical nature. Design requirements, as it were, constitute the most concrete layer of a hierarchy of values, norms and design requirements that can be identified or defined for a design project.[2] Figure 20.1 gives an example of a values hierarchy.

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[2] In the literature such hierarchies have been called objectives hierarchies, objectives networks or objectives trees (e.g. Keeney 1992: chapter 3; Keeney and Raiffa 1993: chapter 2; Cross 2008: chapter 6). What I call a values hierarchy below resembles what Keeney and Raiffa (1993) call an objectives hierarchy and what Cross (2008) calls an objectives tree. Keeney (1992) distinguishes

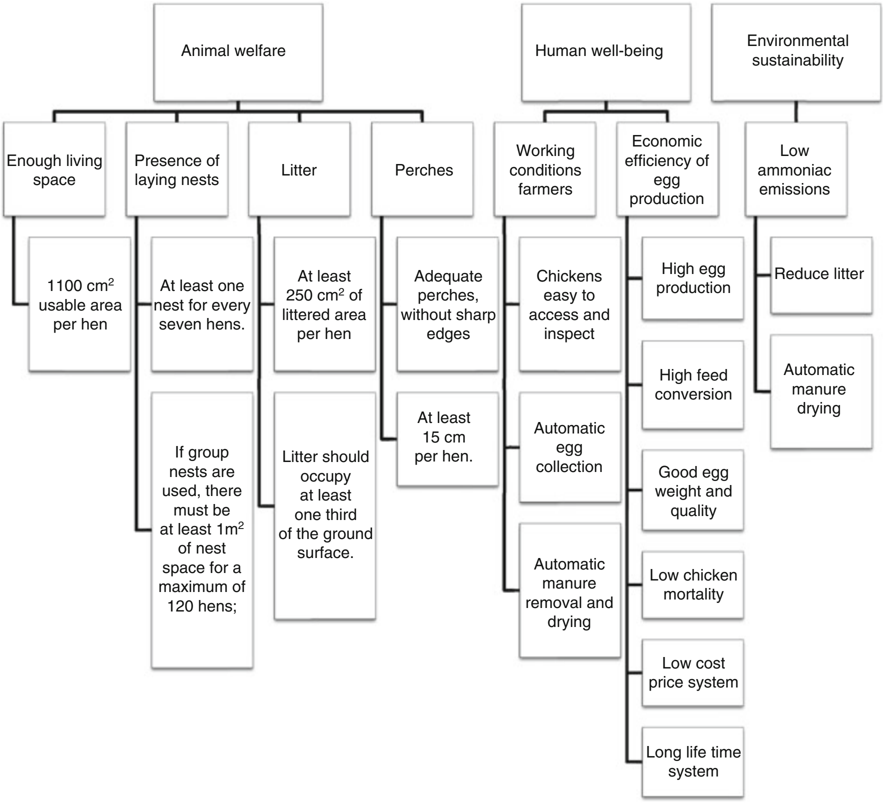

Fig. 20.1 A partial values hierarchy for the design of aviaries, a specific type of chicken husbandry systems. The design requirements for animal welfare are based on EU Council Directive 1999/74/EC

Whereas the upper layer of a values hierarchy consists of values, and the most concrete layer of design requirements, value hierarchies will usually, as in the example in Fig. 20.1, contain an intermediate layer of norms. I use the notion 'norm' here for all kinds of prescriptions for, and restrictions on, action. One kind of norms that are especially important in design are end-norms. An end-norm is a norm referring to an end to be achieved or strived for (cf. Richardson 1997: 50). The end can be a state-of-affairs but also a capability ('being able to play the piano') or even an activity ('to sing an opera'). End-norms are particularly important in design because design is aimed at the creation of technical artefacts or at least at blueprints for them. End-norms in design then may refer to properties, attributes or capabilities that the designed artefact should possess. Such end-norms may include what sometimes are called *objectives* (strivings like 'maximize safety' or 'minimize costs'

between fundamental objectives hierarchies and (means-end) objectives networks. My values hierarchies come closest to the latter but allow a larger heterogeneity of relations between the elements.

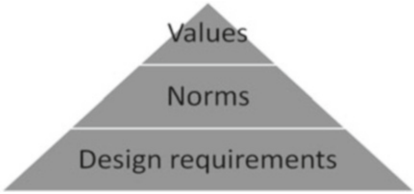

Fig. 20.2 The three basic layers of a values hierarchy. Note that each of the layers may itself be hierarchically layered

without a specific target), *goals* (that specify a target such as 'this car should have a maximum speed op 150 km/h') and *constraints* (that set boundary or minimum conditions). Figure 20.2 depicts the three basic layers of a values hierarchy.

Figure 20.2 suggests that the formulation of design requirements is based on certain values. Although that is basically what I am claiming here, a range of clarifications is in place to make clear what this claim entails in my view and what it does not. First, it should be noted that the relation between the different layers of a values hierarchy is not deductive. Elements at the lower levels cannot be logically deduced from higher level elements. One reason for this is that the lower levels are more concrete or specific and that formulating them requires taking into account the specific context or design project for which the values hierarchy is constructed. The point is, however, not just that we should take into account contextual information; the point is also that there is usually a certain degree of 'latitude' or 'discretion' in translating higher-level elements into lower-level elements. Such translations are sometimes called *specifications*, a term I will also use.[3] Specification involves (value) judgment and usually more than one specification is possible. This is not to deny that we can formulate criteria for when a certain specification is adequate or tenable (I will be doing so in the next section), but these criteria will usually not narrow down the range of possible specifications to one specification that is the only one allowable.

Second, values hierarchies can be constructed top-down as well as bottom-up. In the latter case, one starts with more specific design requirements and looks for more general norms and values on which these requirements may be based or to which they may contribute. Often constructing a values hierarchy will require working in both directions. We have already seen that working top-down requires specification, but what is involved in constructing a values hierarchy bottom-up? One suggestion is that the elements higher in the hierarchy give an answer to the question *why* we aim for or adhere to certain elements lower in the hierarchy (Cross 2008: 81). This suggests that the higher-level elements have a motivating and justifying role with respect to lower-level elements. I will take up this suggestion by saying that the lower level elements are done *for the sake of* the higher-level elements.

The *for the sake of* relation is antisymmetrical (Richardson 1997: 54–57). If A is done for the sake of B, B is not done for the sake of A (unless A = B). It can easily be seen that values hierarchies are antisymmetrical in this sense. Chickens should

[3] Cf. Richardson (1997). In the engineering literature, specification is also used in a number of different meanings which I do not intend to imply here.

have enough living space for the sake of animal welfare, but it is nonsensical to say that animal welfare is a value for the sake of chickens having enough living space.[4] The reason for the antisymmetry of *for the sake of* is that the elements higher in the values hierarchy are more general and abstract than the lower elements. While you can do something specific for the sake of something more general; the opposite seems impossible. The antisymmetry of the *for the sake of* relation suggests that the elements at the highest level of the values hierarchies are to be done for their own sake. The most obvious candidates for the highest level in the values hierarchy are therefore intrinsic or final values, which are defined as values that are strived for for their own sake (Zimmerman 2004).

A number of things can be done for the sake of something else. The relation of A being done *for the sake of* B can therefore be seen as the placeholder for a number of more specific relations. One possibility is that A is a means to B. Another possibility is that A is a subordinate goal or end, the achievement of which contributes to (the achievement of) B. A third possibility is that A enables the achievement of B, without itself contributing to that achievement. If A takes away an obstacle to B, A may be done for the sake of B.

The *for the sake of* relation is normative. It can neither be reduced to a means-end or causal relation nor to a purely conceptual relation. The best way to capture the normativity of this relation is, I think, to say that the higher elements provide reasons for the lower level elements. The notion of reasons refers here both to a motivational and to a justificatory element. The normativity of the *for the sake of* relation suggests that the higher levels elements justify, or give (moral) authority to, the lower level elements. However, since, as argued earlier, lower levels cannot be deduced from higher levels, justification at a higher level is not automatically transferred to the lower levels. The degree of justification, or normative support, which is transferred from higher to lower levels depends on the plausibility or adequacy of the specifications made.

20.4 Specification

I will now further explore the relation or activity of specification by which values are translated into design requirements. Although specification proceeds top-down in a values hierarchy, what I am going to say about whether a certain specification of a value into design requirements is adequate or at least tenable can also be applied as a critical assessment for values hierarchies that are constructed bottom-up. It might then be used to assess whether the design requirements

[4] Note that it does make sense, however, to say that animal welfare is a value (partly) *because* chickens should have enough living space. This suggests two things. First, the relation *for the sake of* is not exhausted by its justificatory part that may be expressed by *because* and, second, the justificatory relation that is expressed by *because* may be bidirectional.

sufficiently cover the value on which they are based and may potentially lead to new design requirements or the reformulation of existing design requirements (or the reformulation of the value).

The specification of values is to be distinguished from an activity that is somewhat related but different in scope and aim: the conceptualization of values. Conceptualization of value is the providing of a definition, analysis or description of a value that clarifies its meaning and often its applicability. Ethologists, for example, conceptualized animal welfare as the fulfillment of certain ethological needs that animals like chickens have in ‘natural’ circumstances. Usually different conceptualizations of a value are possible. The value of individual human freedom may, for example, be conceptualized as ‘the absence of external constraints on individual actions’ or as ‘the ability to make one’s own choices in life.’ The second conceptualization strikes me as more adequate because it seems better to capture why we consider ‘individual human freedom’ a value. Most people do not strive for a life without any external constraints. They have friends and family; make commitments and promises, all of which usually introduce additional constraints, without necessarily experiencing a loss of freedom. What seems more important or essential to freedom is the ability to make such choices yourself, without being forced or manipulated to make them. As this example suggests, some conceptualizations may be more adequate than others. An important criterion for the adequacy of a conceptualization, as suggested by this example, is that the conceptualization does justice to, or at least coheres with, the reasons we have to consider the value valuable in the first place. In many cases different conceptualizations of a value meeting this criterion may be possible.

Conceptualization is largely a philosophical activity that does often not require detailed knowledge of the domain in which the value is applied.[5] This is so because conceptualization does not add content to the value but merely tries to clarify what is already contained in the value. Specification, on the other hand, adds content, and this content is context or domain specific. Specification therefore requires context- or domain-specific knowledge. For example, it might be known that – on the basis of experience and engineering analysis – the main safety risk of a certain type of technical installation is that it explodes. In that case, safety may be specified into the norm ‘minimize the probability of the installation exploding.’ In other cases, a

[5] It is worth noting that the general conceptualization of animal welfare by ethologists in terms of the fulfillment of certain ethological needs that animals like chickens have in ‘natural’ circumstances does require very limited domain-specific knowledge. The conceptualization does not require any detailed knowledge of what these needs or what natural circumstances would be, only that these can be somehow identified. Philosophers might indeed criticize this conceptualization of animal welfare on a number of grounds. They may, for example, doubt whether there exists such a thing as ‘natural’ circumstances and, even if such circumstances would have existed, they may question why these circumstances would provide a normative yardstick (How convincing would it be to argue that killing or rape is part of human welfare or wellbeing because in ‘natural’ circumstances humans felt a need for them? Of course, animals are not humans). In fact, other conceptualizations of animal welfare are possible, for example, in terms of how animals ‘feel’, which might be measured for example in terms of stress.

technical installation may be very unlikely to explode but toxic substances may possibly escape from it. Safety may then be specified as 'minimize the probability and amount of toxic releases from the installation' or 'try to replace the toxic substance with a functionally equivalent non-toxic substance.' As these examples illustrate, the adequacy (or least tenability) of a specification is usually highly context-specific. What is an adequate specification of the value of safety for the first type of installation is not an adequate specification for the second type of installation and vice versa.

Although specifying values requires more than philosophical analysis, a philosophical analysis of the activity of specification may be helpful to judge the adequacy, or tenability, of certain specifications that are made in engineering design. For our current purpose, specification may be defined as the translation of a general value into one or more specific design requirements. This translation may be broken down in two steps[6]:

1. The translation of a general *value* into one or more general *norms*;
2. The translation of these *general* norms into more *specific* design requirements.

The first translation implies a transition from the evaluative to the deontic (or prescriptive) domain. Values are relevant for evaluating the worth or goodness of certain options or objects. However, they do not directly imply certain prescriptions or restrictions for action. Norms on the other hand are deontic because they articulate certain prescriptions for or restrictions on action.

For the transition from the evaluative to the deontic domain that is required in the first translation, the relation between values and reasons is relevant. There is no agreement in the philosophical literature on how values and reasons are related. One category of theories, often called 'consequentialism', holds that we have reason to do what has or brings about value, that we should increase the amount of value in the world or even should maximize it. Other theories hold that reasons are prior to values. Elisabeth Anderson, for example, defends what she calls an expressive theory of rational choice (Anderson 1993). According to her statements like 'x is good' or 'x is valuable' can be reduced to 'it is rational to adopt a certain favorable attitude towards x.'

I will not take a position in the theoretical debate about the exact relation between reasons and values. It is, however, worth noting that the positions just briefly mentioned seem to suppose a certain correspondence between values and reasons of the following kind:

> (V) If x is valuable (in a certain respect) or is a value one has reasons (of a certain kind) for a positive response (a pro-attitude or a pro-behavior) towards x.

This statement is intended to be neutral with respect to the question of whether values ground reasons or reasons ground values or that neither can be reduced to the other. As Dancy (2005) notes, whatever position one takes in this debate, something

[6] In practice, the translation may be made in one step, but even then it may be analyzed as involving these two steps.

like (V) seems to be true. The notion of positive response in (V) is meant to capture a range of pro-attitudes and pro-behaviors, such as desiring, promoting, increasing, maximizing, caring for, admiring, protecting, respecting, enjoying, loving et cetera.

Here we are interested in the case where x is a value and (V) tells us that x then corresponds with certain reasons that express a positive response to x. In the design process these may often be reasons to increase or even maximize x if x is a positive value like safety. However, increasing or maximizing a value may not always be a proper response; for some values it may be more appropriate to cherish them, to admire them, to protect them or to respect them. Moreover, although in context of design the proper response to a value may often be to take it into account in the design process and to try to embody it in the design, this is certainly not always the only or even the most appropriate response. Values like freedom and democracy might be appropriately translated into design requirements for a designed product (cf. Sclove 1995), but they may also be translated into requirements for the design process rather than the product designed. My focus is here on the translation of values into design requirements, but a proper response to values in design may be broader than this specific focus.

Two criteria might be formulated for the adequacy or tenability of a certain translation of a value into general norms. The first is that the norm should count as an appropriate response to the value. The second is that the norm, or set of norms, is sufficient to properly respond to or engage with the value. The first criterion tries to avoid inappropriate responses to a value, the second tries to avoid the problem that one response could be selectively chosen which in isolation does not do justice to the value. Applying both criteria requires a judgment that is context-specific. In the context of a beautiful sunset, a proper response to the value of aesthetic beauty is to enjoy it; in the context of architectural design a proper response might be to respect the value of aesthetic beauty and to try to embody it in the design. In the first context, bothering about how the sunset can be made more beautiful would be an odd and inappropriate response, while in the second context admiring the beauty of the building would be odd as long as it has not been designed and built.

The second step in specification is the translation of general norms into more specific design requirements. The requirement can be more specific with respect to the (a) scope of applicability of the norm, (b) goals or aims strived for and (c) actions or means to achieve these aims (cf. Richardson 1997: 73). An example is the specification of the general norm ‘maximize the operational safety of a chemical plant’ into the following design requirement: ‘minimize the probability of fatal accidents (specification of the goal) when the chemical plant is operated appropriately (specification of the scope) by adding redundant safety valves (specification of the means)’. In this case, the design requirement specifies the general norm in three dimensions, but specification may also be restricted to one or two dimensions.

A specification substantively qualifies the initial norm by adding information ‘describing what the action or end is or where, when, why, how, by what means, by whom, or to whom the action is to be done or the end is to be pursued’ (Richardson 1997: 73). Obviously, different pieces of information may be added so that a general norm can be specified in a large multiplicity of ways. Not all specifications are

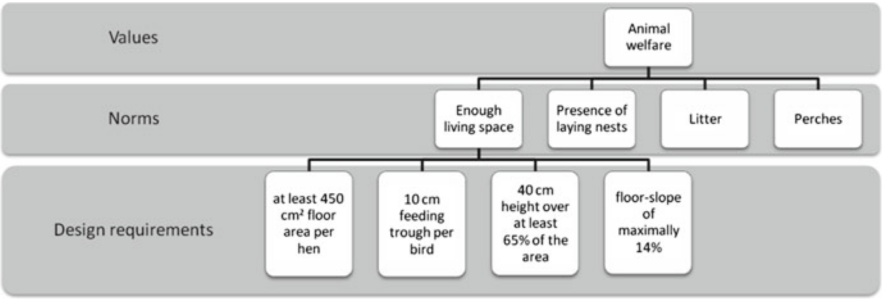

Fig. 20.3 The specification of animal welfare in EU Council Directive 88/116/EEC

adequate or tenable, however. In general one would want to require that actions – or in our case: designs – that count as satisfying the specific design requirements also count as satisfying the general norm (cf. Richardson 1997: 72–73). In the above example 'maximizing operational safety' is specified as 'minimizing the probability of fatal accidents.' This specification is adequate if in all cases in which the probability of fatal accidents is minimized operational safety is maximized. Now arguably operational safety encompasses not only avoiding or at least minimizing fatal accidents but also avoiding or minimizing accidents in which people get hurt but do not die. This does not make the specification necessarily inadequate, however. Perhaps it is known on the basis of statistical evidence, for example, that in this type of installation there is a strict correlation between the probability of fatal accidents and the probability of accidents only leading to injuries, so that minimizing the one implies minimizing the other. In that case, the specification may still be adequate. In other situations, it may be inadequate and it might be necessary to add a design requirement related to minimizing non-fatal accidents.

We can now also see why the specification of animal welfare in the EU Council Directive 88/116/EEC in the example with which I started may strike us as inadequate (see Fig. 20.3). It translates only one of the more general norms for animal welfare into specific design requirements and neglects the others. Therefore meeting the formulated design requirements hardly seems to amount to a sufficient response to the value of animal welfare in the design of chicken husbandry systems.

20.5 Conclusions

In this paper I have discussed the values hierarchy and the relations of specification and *for the sake of* as ways to relate general and abstract values to specific design requirements that can guide the design process. These conceptual tools can be used to translate values into more specific design requirements. They may also be used to reconstruct for the sake of which values certain design requirements are pursued. Usually values hierarchies will be constructed by a combination or iteration of bottom-up and top-down moves, so adding an element of reflection and critical discussion to the formulation of both values and design requirements in the design process.

As we have seen, the specification relation is non-deductive and context-dependent. It implies certain value judgments. Although I have proposed certain criteria to judge the adequacy of a specification, often more than one specification will be reasonably defensible. Given that in design usually one specification has eventually to be chosen, one might wonder how to choose between competing reasonable specifications or how to deal with disagreements between the different parties involved in design about the specification to be used in the actual design process. For the moment I only want to point out that the approach proposed in this paper at least helps to trace more precisely the value judgments and possible disagreements about them, even it does not offer a way to solve these conflicts.

More precisely, the reconstruction of a values hierarchy makes the translation of values into design requirements not only more systematic, it makes the value judgments involved also explicit, debatable and transparent. They become explicit in the specific translations that are made between the different levels of a values hierarchy. This explication creates room for critical reflection on the translations made and makes these debatable among the parties involved. Moreover a values hierarchy may be helpful in pinpointing exactly where there is disagreement about the specification of values in design. Finally, a values hierarchy may, once the designers have chosen a specific specification, make those choices, and especially the implied value judgments, more transparent to outsiders. This is important because design usually impacts on others besides the designers. Although 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.

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References

Anderson, E. (1993). *Value in ethics and economics*. Cambridge, MA: Harvard University Press.

Cross, N. (2008). *Engineering design methods. Strategies for product design* (4th ed.). Chichester: Wiley.

Dancy, J. (2005). Should we pass the buck? In T. Rønnow-Rasmussen & M. J. Zimmerman (Eds.), *Recent work on intrinsic value* (pp. 33–44). Dordrecht: Springer.

Flanagan, M., Howe, D. C., & Nissenbaum, H. (2008). Embodying values in technology. Theory and practise. In J. Van den Hoven & J. Weckert (Eds.), *Information technology and moral philosophy* (pp. 322–353). Cambridge: Cambridge University Press.

Friedman, B., & Kahn, P. H., Jr. (2003). Human values, ethics and design. In J. Jacko & A. Sears (Eds.), *Handbook of human-computer interaction* (pp. 1177–1201). Mahwah: Lawrence Erlbaum.

Harrison, R. (1964). *Animal machines; The new factory farming industry*. London: Vincent Stuart.

Harrison, R. (1993). Case study: Farm animals. In R. J. Berry (Ed.), *Environmental dilemmas: Ethics and decisions* (pp. 118–135). London: Chapman & Hall.

Keeney, R. L. (1992). *Value-focused thinking: A path to creative decision making*. Cambridge, MA: Harvard University Press.

Keeney, R. L., & Raiffa, H. (1993). *Decisions with multiple objectives*: *Preferences and value tradeoffs*. Cambridge/New York: Cambridge University Press. (Original edition published in 1976 by Wiley)

Kuit, A. R., Ehlhardt, D. A., & Blokhuis, H. J. (1989). *Alternative improved housing systems for poultry*. Beekbergen: Ministry of Agriculture and Fisheries of the Netherlands, Directorate of Agricultural Research.

Richardson, H. S. (1997). *Practical reasoning about final ends*. Cambridge: Cambridge University Press.

Sclove, R. E. (1995). *Democracy and technology*. New York: The Guilford Press.

Van de Poel, I. (1998). Why are chickens housed in battery cages? In C. Disco & B. van der Meulen (Eds.), *Getting new technologies together. Studies in making sociotechnical order* (pp. 143–178). Berlin: Walter de Gruyter.

Van den Hoven, J. (2007). ICT and value sensitive design. In P. Goujon, S. Lavelle, P. Duquenoy, K. Kimppa, & V. Laurent (Eds.), *The information society: Innovation, legitimacy, ethics and democracy in honor of Professor Jacques Berleur S.J.* (pp. 67–72). Boston: Springer.

Vincenti, W. G. (1990). *What engineers know and how they know it* (Analytical studies from aeronautical history). Baltimore/London: The John Hopkins University Press.

Zimmerman, M. J. (2004). Intrinsic vs. extrinsic value. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Fall 2004 ed.). Stanford: Stanford University. URL: http://plato.stanford.edu/archives/fall2004/entries/value-intrinsic-extrinsic/