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Gammon, Andrea R.; Zolyomi, Annuska; Wong, Richmond Y.; Eriksson, Eva; Jensen, Camilla Gyldendahl; Nørgård, Rikke Toft

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22

TEACHING RESPONSIBLE ENGINEERING AND DESIGN THROUGH VALUE-SENSITIVE DESIGN

Andrea R. Gammon, Annuska Zolyomi, Richmond Y. Wong, Eva Eriksson, Camilla Gyldendahl Jensen, and Rikke Toft Nørgård

Introduction

Value-sensitive design (VSD) and other values-based design approaches are advanced as means for creating better technologies, that is, technologies that support human values (Friedman & Hendry, 2019; van den Hoven et al., 2015). But so too do these approaches have considerable educational potential which, while observed by others (Cummings, 2006; Eriksson et al., 2021; Rocco et al., 2022), has received far less attention. In this chapter, we propose VSD as an effective approach for teaching ethics in design and engineering education and thus a way to cultivate designers and engineers who are socially and ethically responsive and responsible in their (future) work. VSD and other values-based design approaches explicitly consider values (e.g., privacy, dignity, sustainability) expressed using technology. Through teaching these methods, we teach designers and engineers to think about values in the various stages of technology development so as to create better technologies, and in so doing, to interrogate what 'better' means and for whom, and how to achieve this. We mean to emphasize VSD as an approach to learning by doing, a formalized but flexible process for the continuous work of designing and engineering better technologies. So, too, can VSD offer educators a highly flexible and open-ended approach for equipping students to think more carefully, comprehensively, and inclusively about how the things they make, and the ways they make them, impact others.

This chapter invites teachers to explore VSD's educational offerings and possibilities: we aim to introduce VSD to those unfamiliar and provide ideas and perspectives to deepen the knowledge of those with more experience. We consider the VSD literature an excellent resource for teaching: methods, critiques, and a wide array of examples and applications can be found in various fields and domains, much of which is accessible to engineering and design students. For this reason, this chapter draws on research and developments in VSD, values in design, and education-specific research, questions, and issues. We begin by introducing the key ideas and methods of VSD and introducing an example we drew from the literature and developed by working it through our chapter together. The example functions in two main ways: First, we use it to demonstrate key strategies for teach-

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ing VSD we take to be useful for teachers. Second, the example shows the generative possibilities of teaching VSD, as it is through developing this example for teaching VSD that new possibilities open up. Through the example, we consider the treatment of values in engineering and design classrooms, cover specific strategies for teaching VSD, and suggest methods for assessing VSD and the teaching aims we have suggested – of cultivating responsible engineering and design students. We conclude the chapter by turning to some critiques of VSD to highlight emerging work that also pushes VSD and its educational potential in new directions. Given the broad applicability of VSD to various classroom styles and settings, we have aimed at a level of generality in writing this chapter. We encourage instructors to maximize VSD's flexibility and open-ended nature by experimenting and adapting the methods and strategies presented here to best suit their classrooms and students.

We, the authors of this chapter, all have experience teaching values-based design to engineering and design students in the United States or Europe, coming to this from different academic backgrounds – philosophy, user-centered design, information management, education, and human–computer interaction.

Where to start with VSD?

Friedman et al.'s "Value sensitive design and information systems" (2008) is a natural starting place as a key paper that provides an introduction and overview useful for newcomers and accessible for students. The authors introduce VSD as a "grounded theoretical approach to values in design" (Friedman et al., 2008, p. 69), explain its methods, and propose 13 values with ethical relevance for design systems.[1] Although this paper, like most of the VSD literature, does not position itself in terms of teaching or education, it provides an excellent starting resource for introducing students to VSD. The list of values and accompanying definitions and descriptions acquaint students or other readers less familiar with values with what they are, and three detailed examples illustrate how these values take shape through technologies. This is also a starting place for this chapter. After briefly introducing VSD's main ideas and methods in the next section, we return to an example from the paper by Friedman et al., which will then reappear throughout the chapter, demonstrating how examples can be put to use for educational purposes in encouraging the development of responsible engineers and designers.

Main ideas and methods

Value-sensitive design understands technologies as value-laden: whether software, bridges, or the screen or page you read this on, technologies are designed with particular uses and aims, and so are invariably shaped by values. This means that designers and engineers, whether they mean to or not, embed values into the things they make. VSD is a leading approach for acquainting – or sensitizing – engineers and designers with values, and further, guiding how they engage values more deliberatively, comprehensively, and with the involvement of stakeholders in engineering and design processes (Davis & Nathan, 2015; Friedman & Hendry, 2019).[2] The insight that values are expressed in technologies, whether or not their designers or engineers gave any thought to these values ahead of time, is important for design and engineering students who often view technology as neutral with respect to values. That VSD as an approach helps students recognize and understand *how* values can be embedded in technologies, rather than just that they are, makes it especially useful in educational contexts for challenging the pervasive idea of technologies as neutral tools.

Methodologically, VSD takes the form of (1) conceptual, (2) technical, and (3) empirical investigations, which are complementary and should be mutually reinforcing, but can be done separately. That they can come apart makes VSD an attractive approach for teaching, as even partial methodological efforts can help students appreciate the value-ladenness of technologies and the manifold challenges and opportunities this introduces. *Conceptual investigations* explore what values are at play, how values might be impacted by a specific technology, and for whom. Conceptual investigations will often draw on theoretical or normative frameworks to determine relevant values, understand the meanings of these values, and identify the ways in which their meanings have changed. This can be done in a typical classroom setting, through examples, brainstorming, and discussion, using existing lists of values in VSD toolkits or in codes of conduct, for instance, and drawing from existing VSD literature for specific domains, technologies, or values. *Empirical investigations* use social science research to interrogate how, in practice, stakeholders experience values in a specific technology or design. Methods can be qualitative or quantitative, determined by what best suits the stage and needs of the project; focus groups, surveys, interviews, and behavioral studies are typical. Empirical investigations can bring to light how stakeholders respond when conflicts arise, and such investigations are needed to determine if a design, in the real world, with real stakeholders, supports intended values. Because of this, empirical investigations are difficult to achieve in classroom settings where opportunities to see a design in practice, or to survey real stakeholders, may be extremely limited. Nevertheless, partial and modified empirical investigations are possible.[3] *Technical investigations* focus on designing or adapting a technological artifact to be responsive to values and stakeholder contexts drawn from the conceptual and empirical investigations. Technical investigations turn the attention to the technology itself to see how it is or isn't supporting intended values and what technological re-designs could constitute improvements.[4]

Conducting all stages of VSD's methods isn't possible in most educational settings. However, using examples – whether from the extensive VSD research literature or based on the specific educational context – is an essential and effective way to introduce VSD and involve students in thinking through its processes. We demonstrate this strategy by developing an existing VSD case to illustrate VSD concepts and teaching activities.

Example: the Augmented Window

We find the use of examples especially important in teaching VSD. Examples provide focal points for discussion and can bring to light for students how designs afford certain uses and values and close off others.[5] Examples can be presented to students in a course simply via a case from existing literature others have researched (as we will demonstrate below), or might involve a physical or digital object for students to tinker with or re-design with specific values in mind (van Grunsven et al., 2023). Asking students to prepare and share (additional) examples of their own helps ensure that students' diverse personal interests and study backgrounds are reflected in the classroom. The 'Augmented Window' example could be presented in class by asking students to read (parts of) Friedman et al. (2006 & 2008) or by introducing the salient points of the example to students in class, leading into discussion or group work. In this chapter, the example does double work. We refer to it repeatedly throughout the chapter to illustrate several methods for teaching and assessing VSD, but additionally, and more generally, it shows VSD as amenable to iteration and development over time. The flexibility and dynamism of VSD make it especially useful for teaching in various contexts.

We will refer to an example originally presented in "Value sensitive design and information systems" (Friedman et al., 2008): the 'Augmented Window' example, which was discussed again

in "The watcher and the watched," Friedman et al. (2006). The Augmented Window comes from VSD research exploring social judgments about privacy related to surveillance and sensing technologies. In this case, Friedman et al. (2008) studied a scenario in which an office uses plasma screens to "continuously display the local real-time outdoor scene" (p. 77) of a nearby public plaza located on a university campus and frequented by the general public. Employees in offices with no view to the outside would effectively have a view to the outside through the 'augmented window' of the plasma screen in their office. As normal, passersby on the plaza would be visible to surrounding office workers with windows onto the plaza, but through this technology, so too were their images captured and broadcast by HDTV cameras onto the plasma screens for office workers whom they could not see. Friedman et al. (2008) initially investigated this case with productivity and creativity for the office workers in mind. The additional paper, "The watcher and the watched," involves conceptual and empirical investigations into privacy that develop this example in more detail and serve as a very useful resource for teaching this case or similar ones in the classroom. Different notions of privacy as a socio-technological construct are presented, followed by an empirical analysis of stakeholder views around privacy in the case of the augmented window technology. The difference in position and power between direct and indirect stakeholders is discussed, as are other dimensions: gender, cultural norms about privacy, when violations of privacy are more permissible (for instance, for security), when consent is needed, etc. As Friedman et al. (2008) suggest, this example opens discussions of indirect versus direct stakeholders, value conflicts, and how different data sources can inform empirical investigations.[6]

This example will help us illustrate how the methods of VSD can be adapted for the classroom. In returning to it throughout the chapter, we additionally hope to show how using a classic VSD example in an educational context breathes new life into it by opening it up to novel questions, approaches, and demands.

Teaching VSD

VSD is well-poised to serve as a formalized, active learning approach to ethics, especially since VSD is designed to be applied through an iterative, reflexive design process (Cummings, 2006). VSD offers a conceptual framework for practical investigations that can teach design and engineering students to grapple with the real-world complexities of technology. However, VSD was developed in research and design contexts, and the development of education-specific resources for teaching VSD has lagged behind (Eriksson et al., 2021). In this section, we focus on *teaching* VSD. We discuss issues with introducing students to values, and then turn to three foundational VSD approaches, which we translate into an educational context.

Teaching 'values'

Typically, in VSD, 'values' are defined as "what a person or group of people consider to be important in life" (Friedman et al., 2008, p. 70).[7] Even this broad definition can be challenging for students – especially those encountering human or moral values for the first time and finding values discussions abstract and vague. Nevertheless, we suggest that VSD is an excellent approach for acquainting students with values. VSD doesn't remain at a level of high abstraction but always uses concrete technologies to bring values into focus. Offering an example – of a technology where a value (or potential conflict) is salient – is a good way to begin. Turning again to the Augmented Window example, the value of privacy is likely to arise, and indeed, Friedman et al. (2006) addressed individual privacy in "The watcher and the watched." Privacy, the authors claim, is "an enduring human value" (Friedman et al., 2006, p. 237) and is one students will have personal

experience and working knowledge of.[8] We suggest that in this and all cases, thinking about the value through the technology at issue, in this case, through the Augmented Window, helps to make otherwise abstract ideas and concepts more concrete for students. Privacy is thus, in this case, understood *through* the "technological capture and display of people's images" (Friedman et al. 2006, p. 237) shown to others remotely.

Another strategy for teaching values is to consider in what ways design and engineering students may have encountered the notion of values in their education, lived experiences, and training for professional practice. Ethics in engineering has been legitimized through education accreditation organizations and software engineering professional organizations, which introduce values and ethical principles in their codes of conduct or other guiding documents. Such codes describe how professionals should behave, approach creating systems, and strive to design and implement high-quality systems. For example, the Accreditation Board for Engineering and Technology (ABET) requires a student learning outcome of "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts" (Accreditation Board for Engineering and Technology, 2022). The Association for Computing Machinery's 'Code of Ethics and Professional Conduct' mentions several values that resonate with VSD, including privacy, security, and confidentiality (Association for Computing Machinery, 2018).

Students may also engage with values when learning to elicit user requirements and assess software quality or create design briefs. User requirements often encompass ways a system or product is meaningful to the user regarding functionality and value or refer to fundamental engineering quality requirements, such as robustness and security. In software engineering, the paradigm of value-based software engineering (VBSE) argues for the importance of considering values throughout software engineering principles and practices (Association for Computing Machinery, 2018) and frames 'value' as an ultimate benefit of the project – as perceived by project stakeholders – "whether tangible or intangible, economic or social, monetary or utilitarian, or even aesthetic or ethical" (Biffl et al., 2006, p. X). VBSE takes a practical approach to values, considering them as drivers in software engineering decisions that occur in management-oriented and software lifecycle activities. Working from this framework and highlighting human or moral values is another approach for improving students' proficiency with values.

Design students educated in the paradigm of human-centered design (HCD) focus their practice on designing for people and society (Meyer & Norman, 2020). However, they may assume or be taught that technology is value neutral. Meyer and Norman argue for design schools to teach students not just on the skills for creating polished design, but how to embrace and design for the complexity, frustrations, and tensions of the real world. Modern design students "must meet new ethical challenges that go along with an expansion into different global territories with different sustainability issues, different cultures, and different value systems" (Meyer & Norman, 2020, p. 26).

Stakeholder analysis

A critical step in any VSD conceptual investigation is an analysis of those interested in or impacted by the technology and the relevant values they hold: the *stakeholder analysis*. Stakeholders include direct stakeholders, who will use the product, and indirect stakeholders, including project decision-makers and bystanders impacted by product use. The list of values can be based on empirical investigation, conceptual work by the design team, or values identified in existing VSD literature.

Table 22.1 Initial stakeholder analysis – Augmented Window

Type	*Stakeholder*	*Key values*	*Benefits*	*Harms*
Direct	Office employees (watchers)	Productivity, health	Connection, workplace comfort	Unease, distractions
Indirect	Passersby through plaza (the watched)	Privacy, safety, autonomy	Witnesses if there is an incident	Loss of anonymity and privacy; feeling surveilled; lack of consent
Indirect	Research team	Ethical research, responsibility, reflection	Empirical research, rich understanding of values in technology	Probing sensitive issues related to safety, surveillance, consent

Table 22.1 shows the beginnings of a stakeholder analysis of the Augmented Window case. In the classroom, an instructor might introduce the case, asking students to create or complete a similar table using their knowledge, related literature, and possibly short interviews with university students and personnel. Being able to distinguish between, and identify, direct and indirect stakeholders is an important learning outcome for students who may have previously focused their design attention on a narrowly scoped set of end-users and may not have considered how indirect stakeholders influence the adoption and impact of technology. Commonalities and differences in the students' stakeholder analyses are useful to discuss together in the classroom.

As stakeholder values are identified and more deeply understood, value tensions within and across stakeholder groups become evident. For example, the Augmented Window may give employees an increased sense of community or gains in productivity, which all stakeholders likely value broadly, but not at the expense of the privacy lost when public spaces are surveilled. Therefore, it is essential for stakeholder analysis to be considered a living document that VSD researchers can enrich as they integrate their deepening knowledge through empirical investigations, group reflection, and class discussions.

We also suggest increasing student reflection on students' own responsibilities and values by asking them to reflect on and include the research team's values, as seen in Table 22.1. This aligns with Borning and Muller's call for VSD researchers and designers to be more transparent and explicit about their values, methodological choices, and analysis (Borning & Muller, 2012). A shared and prioritized set of values is challenging to craft, yet is crucial because design action is guided by the character and responsibilities of the designer (Gray & Boling, 2016). The process of students considering, sharing, and negotiating project values greatly benefits from instructor guidance, as teachers can draw from well-established value frameworks, such as Schwartz's Theory of Basic Values (Schwartz, 2012).

Values hierarchies

Building upon stakeholder analysis, students benefit from a formalized approach to thinking about how values connect to or are translated into design. Such a translation is aided by the values hierarchy technique introduced by van de Poel (2013). A values hierarchy is a strategy for visualizing the relations between values, norms, and design requirements. It can be read from values downwards, with values *specified* into relevant norms, which are further *specified* into design requirements, or from design requirements upwards, where design requirements are *for the sake* of the specific norm, which is *for the sake* of the key value.

Thinking again of the Augmented Window case, building a values hierarchy would work from the key values already identified in the stakeholder analysis (Table 22.1). While any of the named values could be used, productivity, the original value motivating the Augmented Window case, is a good candidate for illustration. For this value, norms for the work environment are indicated. Norms can be brainstormed based on the example (as in Figure 22.1) or involve research into health and safety requirements or empirical findings on productivity in the workplace. Relevant norms are then further translated, or specified, into design requirements for the Augmented Window. The values hierarchy in Figure 22.1 provides an initial sketch; much more detail could be elaborated, especially concerning specific design requirements per norm.

Students can create 'values hierarchies' for any value. Even constructing cursory values hierarchies can help students get a better grip on values, as this technique works by turning values, which may be vague and abstract, into concrete, actionable requirements by connecting them to norms and then to design requirements. Including multiple values or stakeholders can also illuminate conflicts between values as they are translated into design requirements that may be inconsistent. (Already in Figure 22.1 we see a conflict between an imagined design requirement of having openable windows for fresh air and the use of a plasma display, substituting a real window. If expanded to include additional values, a values hierarchy would show conflicts between values of privacy and productivity.) Distinguishing between values, norms, and design requirements, and understanding the relationships between these, are key VSD intended learning outcomes that the values hierarchy technique helps students achieve.

Envisioning cards

Envisioning cards are another example of a VSD method useful for teaching. Nathan et al. (2008) proposed criteria – stakeholders, time, value, and pervasiveness – for envisioning systemic effects on persons and society. These were then formalized into 32 themed envisioning cards and accompanying toolkit (Friedman & Hendry, 2012). Each theme is accompanied with a tailored activity spurring designers to engage in actions such as think, identify, sketch, or act. The cards and activities together can engage students in directed and more purposeful ethics-based brainstorming than other ideation techniques.[9]

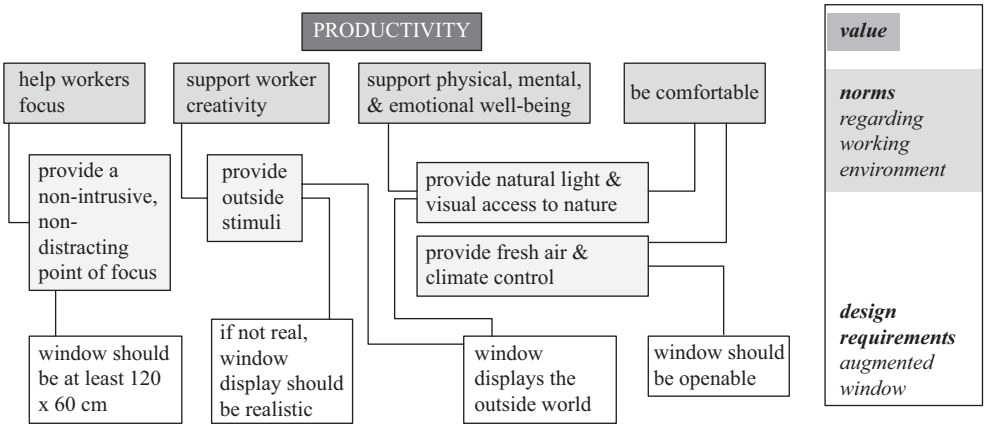

Figure 22.1 Productivity values hierarchy – Augmented Window.

In the Augmented Window example, students could pick an envisioning card they find relevant and thought-provoking to discuss and share. A possibility could be "The Long Now," which invites designers to think of long-term use of the technology, across generations and for people who would grow up with this technology. The power of the envisioning cards lies in their provocative design prompts. "The Long Now" prompts designers to sketch the interactions occurring over 5-year intervals as the technology and stakeholders shift over time. Another interesting card could be "Choosing Not to Use," presenting the possibility of a deliberate choice not to use the technology. This card could raise important questions of who actually is in a position to choose not to engage, as indirect stakeholders caught on camera may not be able to make this choice for themselves. Student engagement with envisioning cards can lead to vibrant discussions alongside probing design work.

Additional resources

In addition to the teaching-focused suggestions already elaborated, many VSD resources and toolkits are available to educators to guide or scaffold teaching. The most extensive and programmatic set of resources is the Value Sensitive Design in Higher Education (VASE) program, which provides a pedagogical framework and teaching resources targeted towards university-level design and development programs. VASE identifies three core competency pillars: (1) Ethics and Values, (2) Designers and Stakeholders, and (3) Technology and Design, which the creators use to anchor design phases, defined as value theory, research, synthesis, ideation, and evaluation. In the VASE pedagogical framework, each pillar is mapped to 28 teaching activities with corresponding assessment activities to support teachers in VSD teaching and evaluating students' learning outcomes in value-sensitive ways (Value Sensitive Design in Higher Education, 2021). Resources can also be found through the University of Washington's VSD Lab Cooperative[10] and the Delft Design for Values Institute.[11]

Finally, we suggest that the teachers make use of the broad, multidisciplinary, and ever-growing research literature on VSD. A key resource is the *Handbook of Ethics, Values, Technological Design* (van den Hoven et al., 2015) for its range of chapters on designing for specific values (from 'Human Wellbeing' to 'Presence'), as well as domains (from Economics and Fashion to Water Management). Conference proceedings and technical literature (especially from conferences affiliated with the Association for Computation Machinery, e.g., the CHI conference on Human Factors in Computing Systems; Conference on Computer Supported Cooperative Work; Conference on Computers and Accessibility) are excellent places to look for VSD literature that is especially accessible for engineering students and that offer some of the most recent applications of VSD.

Assessment

When applying VSD to educate responsible designers, there is a need to not only teach students about values in design but also assess their learning (Eriksson et al., 2022). Using different assessment forms that align with VSD teaching activities and support VSD-based intended learning outcomes (ILOs) can create a more substantiated VSD teaching and learning culture. The assessment forms and activities thus need to provide students involved in design and technology with an awareness of the role values play in design. This section connects VSD teaching and assessment activities to show how assessment *of*, *for*, and *as* learning creates different opportunities for assessing values in design. Four different assessment forms (summative, formative, ipsative, and authentic) are introduced, and teaching activities from the above section are connected with

assessment activities developed specifically for teaching values in design, continuing to use the Augmented Window example for illustration.

Values-based teaching in education encompasses cognitive understanding as well as affective and behavioral components, requiring more than measuring knowledge or skills.[12] This makes it challenging to develop standardized assessment criteria (Dann, 2014; William & Thompson, 2008). Creating assessment methods that accurately gauge a student's ethical decision-making process is challenging and requires assessment activities that focus on this process – which is not easily quantifiable or measurable. In addition, design is a practical discipline. Assessing how students translate their understanding of values into practical design processes and solutions is something that requires methods sensitive to the methodological characteristics and specific teaching activities of VSD. Assessments focusing solely on, for example, theoretical knowledge may not effectively assess students' ability to incorporate values into their design work (Dann, 2014; Friedman & Hendry, 2019; William & Thompson, 2008).

Overall, assessing students' learning about values in design is complex due to the subjective nature of values, the abstract concepts involved, the multifaceted nature of assessment, and the ethical considerations of VSD. It requires thoughtful consideration and appropriate assessment strategies to ensure fair and meaningful evaluation (Frauenberger et al., 2016; Friedman & Hendry, 2012; William & Thompson, 2008). To address these challenges in teaching, a combination of assessment methods can be used, including open-ended assignments, portfolio reviews, case studies, and peer feedback. This is to attain alignment between *how teachers teach* VSD and *how students' VSD learning is evaluated*, as well as for teachers to gain a more comprehensive understanding of students' learning about values in design. It is crucial to provide VSD-focused and operational assessment criteria that can foster open discussions, critical thinking, and self-reflection among students (Hughes et al., 2014).

Below, using the VASE resource, we illustrate how concrete VSD teaching and assessment activities can be aligned to evaluate students' learning. Here, the VASE teaching activities of *listing stakeholders and their values* (using stakeholder analysis), *understanding value tensions* (working with values hierarchies), and *envisioning future scenarios* (using envisioning cards) make use of the four complementary assessment types.

Summative assessment/activities assess students' knowledge and comprehension of teaching material. Summative assessment refers to evaluating the student's learning, knowledge proficiency, or success at the end of the process in terms of their understanding, application, or critical analysis of design principles and ethical considerations. A VSD-relevant and sensitive summative assessment activity related to envisioning cards could be *case-based assessment for responsible designers*,[13] where students are asked to focus on imaging potential consequences, long-term effects, and societal impacts through a value scenario that goes beyond what would normally be described as intended use. Students can then analyze the potential consequences of the case, using relevant envisioning criteria (including values) through a value scenario and provide suggestions for how to mitigate negative consequences (e.g., regarding re-design, further stakeholder dialogue, possible tensions) through re-thinking the design.

Formative assessment/activities support students and teachers in identifying and closing knowledge gaps. Formative assessment promotes reflection about learning and teaching and charts the development of these processes over time. It is utilized by teachers to gain an understanding of their students' current knowledge and skills to guide future and formative learning. Concerning the above example of working with values hierarchies, teachers can formatively evaluate students' understanding of value tensions by having them write a *reflective values report*[14] about perceived

value tensions within the case. Value tensions show how a product, system, or service, like the Augmented Window, can contain elements that compromise or undermine some stakeholders' values. Students reflect on how identified value tensions relate to or emerge from the design's values, how the values of different stakeholders may be at odds with each other, and why value tensions are important to consider.[15] Formative assessment and activities are ideal for guiding how this knowledge affects students' future thinking and practice.

Ipsative assessment/activities enable teachers to compare a student's current work with previous work – either in the same field through time or in comparison with other fields. Ipsative assessment is a highly personalized form of assessment where progress is measured against the needs and goals of the individual, not in comparison to external standards or peers' performance. As such, ipsative assessment activities focus on the student's ability to describe changes within their acquisition of knowledge, concepts, ideas, beliefs, and facts related to working with values in design. A *personal values-reflection video*[16] is a useful method for ipsative assessment. Here, teachers can ask students to record a group video about stakeholder values with a focus on how the VSD analysis shifted students' views on what being a responsible designer requires and how they might now approach design differently. To ensure alignment between the teaching and assessment activity, students should focus on how they now understand the diversity of possible stakeholders in new ways and how they can reflect on the possible consequences of considering diverse stakeholders in ways they were not able to before.

Authentic assessment/activities emphasize the importance of contextualized design activities and assignments focusing on a problem identification that points to a 'real-life practice' wherein students must present their ability to translate and integrate their knowledge. The participation of stakeholders or people from an external community of practice often constitutes an essential premise for conducting authentic assessment. However, this might not always be possible. Here, students can use their emerging understanding and identity of what it means to be a responsible designer to engage in authentic assessment dialogues with each other. Teachers can facilitate authentic assessment through *peer feedback for responsible designers*[17] by asking students to take on the role of VSD teachers and designers in relation to specific VSD assessment criteria applied to each other's stakeholder analysis. In this assessment activity, it is important for the teacher to focus on the students' abilities to capture and address the visible signs of learning through peer feedback: to think, act, and behave like a responsible designer.

In conclusion, using different assessment forms can create a more varied teaching and learning culture as well as enhance alignment between teaching and evaluating VSD. It is crucial to align assessment methods with teaching approaches and ILOs to effectively teach values in design. Even then, however, assessing students' understanding of values in design presents unique challenges. Values are subjective and contextual and often involve complex and abstract concepts. Evaluating the students' comprehension of ethical values requires more than measuring knowledge or skills – it requires assessing their attitudes, decision-making processes, and practical application in real-world scenarios. By adopting the principles of assessment *for* learning and assessment *as* learning, teachers can create a more holistic approach to assessing students' understanding of values in design. This demands an intentional and comprehensive assessment strategy that combines different assessment types and activities that are aligned with VSD teaching activities and ILOs, and that encourages student engagement, reflection, and critical thinking. By aligning assessment practices and criteria with teaching practices and ILOs, teachers can support and promote students' understanding of values in design and their ability to apply them effectively in real-world scenarios and future professional practice.

Extending VSD

The classroom setting provides an opportunity to adapt and refine VSD's methods for teaching. We, as educators of future engineers and designers, have the responsibility to ensure that what and how we teach responds to the changing contexts and demands of their future work. We conclude the chapter by highlighting three critiques of VSD that, in our view, represent essential developments in the VSD literature and that pose rich educational opportunities. Here again, we use the Augmented Window example to show how established ideas and cases can be adapted and updated based on developments in the field.

Power

Accounting for power is not explicitly addressed in the VSD framework, beyond legitimizing direct and indirect stakeholders (Friedman & Hendry, 2019). This has been a point of recent critique (Jacobs et al., 2021). Even the act of deciding how to identify relevant values involves deciding *whose* values to elicit. But this can also be limited, which the Augmented Window example aptly illustrates. Friedman et al. (2006) explicitly considered power dynamics in their research, inquiring about and contrasting the privacy beliefs of both the direct and indirect stakeholders, all of whom were people working at or present on a university campus. While directly relevant in this case and methodologically sound, choosing to engage people physically present on a university campus is a choice that may overrepresent socially privileged populations and fail to include populations whose perspectives are often not considered in technology design. This is especially relevant in the United States, where communities of specific racial or socio-economic backgrounds are over-surveilled (Billies, 2015). Regarding power dimensions, this reveals a limitation of the VSD framework which makes the concrete technology the focal point: by homing in on this specific window operating in this specific location – a space of privilege – the researchers gained a robust understanding of privacy vis-à-vis the Augmented Window, but missed understanding how power dynamics determine who even features in this research and how conceptions of privacy may vary more broadly.

One approach that can address this shortcoming in VSD is to give voice to communities historically underrepresented in design and technology initiatives. Research on the experiences of autistic students in higher education, a setting in which autistic students experience lower graduation rates than neurotypical peers (White et al., 2016), demonstrates this approach. Rather than interviewing faculty and neurotypical students, Zolyomi et al. (2017, 2018) interviewed autistic students and disability services staff in higher education to understand the dynamics of class-based teamwork from the perspective of neurodivergent students and those who directly support them with disability services. Based on interview insights, key values of autistic students were identified as freedom from stigma, individual comfort, social comfort, social connection, and team cohesion. Investigating the more dominant stakeholders in higher education would elicit different values and value tensions.

The decisions regarding how to account for power relations highlight the responsibility of researchers to practice reflexivity. VSD researchers can describe their own positionality, reflecting on the influence of their lived experiences and potential bias on their methodological choices and interpretation of data – as demonstrated in Alsheikh et al. (2011) and delineated as a researcher stance by Yoo et al. (2013). Bringing these considerations into the classroom trains engineers and designers from an early stage to be sensitive to who is represented, who has agency, and how power dimensions shape these and other aspects of design.

Instructors can also prepare students to navigate issues of *organizational power* when using VSD in practice beyond educational environments. Many challenges to implementing VSD in practice are organizational. In other organizational and institutional contexts, students may work with others unfamiliar with VSD or may not have the social power to implement VSD on their own. There can be tension between an individual's knowledge and desire to practice VSD, co-workers' awareness of values as considerations in design, and ongoing organizational practices (Chivukula et al., 2020) – particularly in private industry when taking the time and resources to address values may be seen as conflicting with a company's profit motive. Although the Augmented Window example project was conducted by a research lab explicitly interested in using and developing VSD principles, a team in a different research lab or private company could easily develop a similar Augmented Window focusing on its technical development or its potential as a profitable product. In those situations, a VSD-minded engineer would need to navigate the social dynamics of that team in order to convince others to follow a VSD approach.

This suggests that students should also learn how to navigate organizational contexts when attempting to implement VSD. Strategies might include having students view themselves as a 'values advocate' to help educate others on a team or in an organization (Shilton, 2013); attending to the emotional labor often required to advocate for values within organizations (Su et al., 2021; Wong, 2021); considering when they might choose to resist or conform with organizational norms when advocating for addressing values issues (Wong, 2021); understanding potential allies within an organization such as 'ethics owners' who may be more empowered decision-makers (Metcalf et al., 2019); or seeking support through community and collective action (Pillai et al., 2022). Introducing these strategies in a classroom environment might use Authentic Assessment techniques and involve group discussions or role-playing, e.g. (Shilton et al., 2020).

Norms and multiculturalism

In addition to considering whose values to elicit, designers should also consider whose cultural norms are reflected in design processes. Much VSD literature suggests human values are or could be universal, aligning, for instance, with the United Nations' Declaration of Human Rights. However, this perspective has been critiqued. JafariNaimi et al. (2015) argue that values are situated in people's lived experiences and practices, and the expression of the same value may look very different in different times and places. For instance, conceptions and practices of privacy differ across regions and cultural backgrounds and are based on the use of online tools (Abokhodair & Hodges, 2019). Designers can attune themselves to these issues by working with people from diverse communities and backgrounds, considering multiple conceptions and dimensions of the same value – for example, Mulligan et al. (2016)'s 'Analytic' tool for privacy – by using tools that foreground consideration of multiculturalism (e.g., the multicultural envisioning card). Here, we suggest that education has a key role to play. Already pointing out cultural differences and the possibilities for bias as part of value conceptualization helps students reflect on their own positions and assumptions. Raising values as hypotheses (JafariNaimi et al., 2015) to be explored and investigated from various perspectives opens up VSD to more diverse and participatory practices.

Alternatively, Martin et al. (2023) propose *norm*-sensitive design, arguing that norms better capture behaviors and avoid Western biases encoded in values-based frameworks. However, norms can also reinforce existing inequalities or arrangements of powers within a community (McDonald & Forte, 2020). The Augmented Window example, developed in the early 2000s, showcases these issues. Norms about recording in public spaces have changed such that people's responses would likely differ (informed perhaps by more stringent data regulations or the prolif-

eration of doorbell cameras). Discussing this case with students could illustrate how norms and values change even over relatively short timescales and how values are interpreted differently in different cultural contexts.

Multi-species VSD

The human-centered perspective in design and engineering privileges humans over all other species but becomes inadequate in the era of the Anthropocene (Crutzen, 2006; Haraway, 2015; see also Chapter 6). We need new approaches in engineering education capable of engaging and caring for multiple species and environments, and where non-human beings are also considered users, designers, participants, and stakeholders of technologies. In addition to this being a ripe area for research, we suggest educators can contribute to opening up VSD to multi-species frameworks.

Speculative design presents a common approach for considering values and multi-species perspectives (e.g., Nijs et al., 2020; Smith & Qaurooni, 2020), and works well in educational contexts. Speculative design relies on speculation and proposition, aims to enact change, and can be useful for understanding future consequences and implications of the entangled relationship between multiple species, technology, and humans (Auger, 2013; Dunne & Raby, 2013). A hands-on approach is to train students to adapt VSD methods to include multi-species perspectives in the design process, for example, by creating a set of non-human personas (Tomitsch et al., 2021) representing various species to be included as direct or indirect stakeholders. Non-human personas can be used to inform the initial concept design, to evaluate potential solutions, or to critique a design solution through the perspective of non-human stakeholders.

Like most other VSD applications, the Augmented Window is anthropocentric for considering only human stakeholders. But more deeply, it might exemplify VSD's limited engagement with the non-human. VSD rarely considers non-human stakeholders in its processes. And this example shows that if non-human nature does feature, it is as something to behold, from indoors, something that might be instrumentalized (in this case, to increase worker productivity), not something to engage, or to design for or with. A multi-species interpretation of VSD would challenge this relation, urging that non-human perspectives and agencies are not only considered in stakeholder analyses but that new forms of engagement are developed, bringing multi-species actors into the design process. We believe this broadening of design and engineering is needed and that a multi-species expansion of VSD in our classrooms can cultivate engineers and designers with the requisite attention and responsiveness for addressing mounting environmental crises.

Conclusion

We have advanced VSD as an approach for helping students develop sensitivity to values and stakeholders in the design and engineering practices needed to be responsive and responsible designers and engineers. VSD provides an excellent framework for teaching values through technologies in development. We have highlighted VSD's open-ended and iterative nature, showing how existing examples from the VSD literature can be further developed and how existing VSD tools and methods are fruitfully repurposed for teaching. We have also prompted teachers to respond to challenges posed to VSD to make the framework more responsive to power dimensions, cultural differences, and non-human perspectives. We conclude with a final point of encouragement for teachers: while we have highlighted the educational potential of VSD for students, especially because of its flexibility and openness, VSD is also rewarding for teachers. As teachers using VSD in our classrooms, we have found it to be highly generative, allowing for experimentation, iteration, connections with research, and rich discussions with our students, who often come

to see technologies and their role in creating them in new ways. We hope this chapter motivates more educators to adopt and adapt VSD for their students.

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Notes

1 Human welfare, ownership and property, privacy, freedom from bias, universal usability, trust, autonomy, informed consent, accountability, courtesy, identity, calmness, and environmental sustainability.
2 Again, we direct readers and students to Friedman et al. 2008 for a more thorough introduction to VSD than we can provide here.
3 Possible strategies from our institutions include the use of online testimonials in healthcare technologies (van Grunsven et al., 2023) and Amazon reviews of voice assistants to analyze user experiences (Olya Kudina).
4 Andersen and Cawthorne (2021) use technical investigations to address educational challenges in value-sensitive drone design.
5 Langdon Winner's "Do Artifacts have Politics?" (1980) shows this through the famous example of Robert Moses's low-hanging bridges and the far less famous example of the mechanical tomato harvester.
6 As well as their limitations: see Friedman et al. (2006).
7 This definition has been criticized: e.g., Manders-Huits (2011). Van De Poel (2015) provides a helpful orientation to values for engineers.
8 The extended stakeholder research and discussion in Friedman et al. (2006) can be used to illustrate the full extent of empirical investigations in VSD, or to supplement when conducting empirical investigations not possible in class.
9 Card decks can be downloaded and printed for free: https://vsdesign.org/toolkits/
10 https://vsdcoop.ischool.uw.edu/index.php/VSD_Coop
11 https://www.delftdesignforvalues.nl/fundamentals/
12 See Chapter 27 for a detailed discussion of assessment and common learning objectives in engineering ethics.
13 See https://teachingforvaluesindesign.eu/A9_casebasedassessment.html for a step-by-step description.
14 See https://teachingforvaluesindesign.eu/A2_reflectivevaluesreport.html.
15 See https://teachingforvaluesindesign.eu/20_understandingvaluetensions.html.
16 See https://teachingforvaluesindesign.eu/A3_personalvaluesreflectionvideo.html.
17 See https://teachingforvaluesindesign.eu/A8_peerfeedback.html.

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