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## How Engineers Can Care from a Distance: Promoting Moral Sensitivity in Engineering Ethics Education

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### Introduction

Moral (or ethical) sensitivity is widely viewed as a foundational learning goal in engineering ethics education.<sup>2</sup> A recent literature review of US-based engineering ethics interventions, for instance, found that 25 out of the 26 reviewed articles listed “ethical sensitivity or awareness” as a learning goal (Hess & Fore 2018). One particularly prominent account of the nature of moral sensitivity and what it means for professionals to acquire and exhibit it arises in a series of articles by Kathryn Weaver and Carl Mitcham (Weaver et al. 2008; Weaver & Mitcham 2016), who focus on nurses but maintain that their account equally applies to engineers. They argue that engineers—much like nurses—are engaged in an activity in which moral sensitivity plays a central role, namely an activity of *caring* for others. They readily acknowledge, however, that the target of care in the engineering context is crucially different from the target of care in the nursing context. The nurse attempts to be sensitive to the particular needs of individual patients. We call this *particularized care*. The engineer, by contrast is tasked with designing and maintaining structures and systems that, ideally, help take care of society at large. Though Weaver and Mitcham acknowledge this contrast, it is drawn too quickly. We wager that fostering *care* within engineers-in-training requires that close attention is given to the phenomenological difference between ‘the to-be-cared-for Other’ in the world of the engineer [the *engineer’s Other*] and the ‘to-be-cared-for Other’ in the world of the nurse [the *nurse’s Other*].<sup>3</sup> By phenomenological we mean the manner in which the Other is experientially manifest in one’s activities. As the phenomenological tradition has emphasized, our experience of other people is shaped by shared practical contexts, or worlds, which are textured by background practices, norms, and ideologies (Cf. Gallagher 2007). We wager that by explicating the phenomenological specificity of the to-be-cared-for-Other in the world of the engineer, we can identify more precisely what kind of care we can expect from and help cultivate within engineers (in training).

We focus on two dimensions of the engineer’s world that can have a formative effect on how the engineer’s Other is constituted. First, at a practical level, the relationship between the engineer and her Other is characterized by *distance*, which is unavoidably built into the engineer’s practices and activities. This is contrasted with the nurse’s Other, who is characterized by *proximity*. This contrast brings out a problem or challenge: what exactly does it mean to care for an Other who is marked by distance? Second, at an ideological level, the world of the engineer is prone to a particular discourse—a particular way of understanding what engineering is, what it produces, and what it means to be a good engineer. This discourse is marked by an *ideology of*

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<sup>2</sup> We will use the terms moral sensitivity and ethical sensitivity interchangeably (See also Weaver et al. 2008).

<sup>3</sup> By phenomenological we mean how the other is experientially manifest.

*neutrality*, an umbrella term we use to refer to several interconnected background commitments, spelled out in section 3. When internalized, these background commitments exacerbate the distance between the engineer and her Other, complicating the engineering student's understanding of herself qua care-taker.

But engineering and design students can also be exposed to an alternative image of the engineer: as someone tasked with caring for society at large through thoroughly normative, value-laden activities. Yet while notions of care and care ethics have slowly permeated through scholarship (e.g., Adam & Groves 2011; Vallor 2016; van Wynsberghe 2016), the explicit delineation of care-centered approaches in engineering ethics education is still relatively novel (e.g., Russell & Vinsel 2019)

Towards elucidating and refining such a goal for education, in this chapter we propose that the pedagogical endeavor of cultivating moral sensitivity – via the notion of care-taking – should include two aims. It should dispel the ideology of neutrality while offering a *positive* image of what it means for an engineer to care for her Other. This requires that we take up the challenge, introduced in section 2, which asks “What does it mean to care for an Other who is marked by distance?” Relatedly, we must ask what it means to promote such care through our educational endeavors. While the type of care characteristic of the nurse is *particularized care*, the two types of care relevant for the engineering context are what we call *generalized care* and *universalized care*. Generalized care refers to the practice of attending to the needs, concerns, emotions and desires of those who are affected by the products and activities of engineering by taking one or some individuals as representatives of a larger cohort of stakeholders. Universalized care is exhibited when engineering activities of design and maintenance reflect a responsiveness to a universally shared feature of the engineer's Other, namely her vulnerability as a technology-dependent being. While *generalized care* has received a fair amount of attention in engineering ethics education, both at our own institution and beyond, *universalized care*, by contrast, seems to have remained largely under the radar. We conclude the paper by tentatively sketching a concrete pedagogical exercise, which we term a value-genealogy (see Stone et al. 2020), that can be used to operationalize *universalized care*.

## **1. Moral Sensitivity: An Iterative Movement Between Perception, Affectivity and Dividing Loyalties**

The notions of moral sensitivity and care are intimately related. Psychologist James R. Rest, for instance, has developed an influential account of the idea that moral sensitivity involves an awareness of how others are affected by one's own actions, and the idea that this makes moral sensitivity a foundational ethical competency for professionals like nurses and engineers. Rest presents moral sensitivity as the ability to “interpret” or “perceive” a given situation in terms of how one's own actions may or may not affect “the welfare of someone else either directly or indirectly” (1982, 29).<sup>4</sup> Rest builds on research from the field of psychology to argue that although basic, moral sensitivity is hardly automatic. Identifying salient ethical features of a situation and seeing it in terms of how one's own actions may affect both proximal and distant others are complicated by the fact that “many people have difficulty in interpreting even relatively simple situations” and that “individuals exhibit striking differences in their sensitivity to the needs and welfare of others” (29). To flag, we will expand on this idea, proposing in sections 2 and 3 that how one interprets “even relatively simple situations” and exhibits “sensitivity to the

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<sup>4</sup> Rest JR. A psychologist looks at the teaching of ethics. Hastings Center Report 1982; 12(1): 29–36.

needs and welfare of others” is, in professional contexts, partially determined by the practical and ideological ways in which one’s professional world and one’s role as a professional in that world are shaped.

While engaging with Rest’s influential proposal, Mitcham et al. (2008) propose their own model of moral sensitivity. This model, which they develop via an engagement with the professional nursing context, consists of three inter-connected moments: *moral perception*, *affectivity*, and *dividing loyalties* (Weaver et al. 2008, 8; See also Weaver & Mitcham 2016).

- 1) *Moral perception* is defined as an “intuitive discrimination of cues and patterns,” that awakens a professional to “client and situational needs.” Phenomenologically speaking, they wager that moral perception is experienced as “a gut level ‘jolt’” in response to “some cue” that something in one’s routine activities – often performed unreflectively and habitually – warrants immediate attention (Weaver et al. 2008, 609).
- 2) *Affectivity*, as defined by Weaver et al., bears a strong conceptual similarity to empathy. It offers a “vivid rendering of what it means to be human .... based on the professional putting of oneself in the place of clients” which “increases responsiveness and preserves client dignity and caring” (Weaver et al. 2008, 609).
- 3) The act of *Dividing loyalties* captures the importance of adopting “strategies of interpretation, justification, and reflection” (Weaver et al. 2008, 609) in order to arrive at different perspectives on a relevant issue – which includes perspectives held by relevant stakeholders as well as those articulated in textual “sources of knowledge (e.g., expert opinions, policies and professional conduct codes).” The act of dividing loyalties has the potential to “expose assumptions and privileges” through “critical scrutiny of the larger social system,” and to detach “from privileged relationships and the immediacy of the situation long enough to distinguish personal biases and assumptions” (Weaver et al. 2008, 609-10). As we will later suggest, a key “bias and assumption” that must be targeted pedagogically in the fostering of moral sensitivity in engineers-in-training is the ideology of neutrality.

Weaver et al. believe each of these three components are necessary conditions for genuine moral sensitivity. A nurse must possess an openness to letting unreflective routine actions be interrupted by “a gut level jolt,” the sense that something or someone in her perceptual environment requires an immediate response. But by itself moral perception falls short of moral sensitivity. After all, Weaver et al. note, “spontaneous recognition of the moral issue can be inadequate or misleading” (610). Similarly, affectivity, though crucial for a nurse’s empathic grasp of her patient’s humanity, can be “subject to personal motives and misunderstanding.” Think, for instance, of the evidence that implicit biases in healthcare providers can suppress moral perception and affectivity towards Black women during pregnancy, labor, and the post-partum period (Roeder 2019). A wider reflective perspective, through which a nurse can “solicit breadth and depth” about this issue, for instance by talking to advocacy groups or learning about the nature of implicit biases and their pernicious consequences, can circle back into moral perception and affectivity, thus widening the scope of her moral sensitivity. At the same time, Weaver and Mitcham warn that the sources professionals turn to in the process of dividing loyalties can also be capable of “uphold[ing] the hierarchy of more powerful stakeholders” or of “address[ing] only issues prior to code or policy development” (610). Hence, engaging in dividing loyalties without perceptual and affective attunement to situational demands will fall short of establishing robust moral sensitivity. As Weaver and Mitcham conclude: “when combined, the individual limitations of the attributes are overcome. In moving back and forth between moral perception, affectivity and dividing loyalties, the professional modulates a situation through interpretive understanding and evaluation” (610).

## 2. The World of Nursing and the World of Engineering

The iterative nature of this view of moral sensitivity serves as the foundation for the argument we make, namely that the specific world in which a professional is embedded – in our case the world of engineering – shapes how that professional can morally perceive and affectively respond to her to-be-cared-for Other. In homing in on the world of engineering and how moral sensitivity can be enacted there, we are critically examining Weaver and Mitcham’s claim that their account of moral sensitivity, though developed in the nursing-context, can be extended to the engineering-context. As mentioned, Weaver & Mitcham (2016) and Weaver et al. (2008) invoke a care-analogy between the professional life of the nurse and that of the engineer. In both instances, they suggest, proper care is dependent on the three moments of moral sensitivity they have identified:

Through moral perception, the professional distinguishes and appreciates the *client’s* unique situation amid its complex context. Affected by the encounter, the professional is motivated to anticipate and alleviate the suffering (in nursing) or protect safety and welfare (engineering). To inform a reasoned and appropriate course of action, the professional explores and interprets the often divided perspectives and competing demands of involved stakeholders which can include clients, social institutions, and the public (2016, 6-7, our italics).

Note how Mitcham and Weaver focus on the engineer’s relation to the *client* in establishing an analogy between moral perception in nursing and engineering contexts. But this move is problematic. For as they readily acknowledge, “Engineers need to practice ethical sensitivity ... not just with regard to their immediate clients or employers but also with respect to all those who may be affected by their work” (14). This, then, raises the question: *What does it mean to care not only for the welfare of a particular individual client with whom one stands in an in-person dyadic relationship, but also, perhaps first and foremost, to care for the welfare of “all those who may be affected” by one’s activities?* When we talk about the engineer’s Other it is precisely the other in this sense (“all those who may be affected by their work”) that interests us. From here on it is this Other that we refer to when we use the term *the engineer’s Other*. What we will now argue is that there are important phenomenological differences between ‘the to-be-cared-for Other’ in the world of the engineer [i.e. the *engineer’s Other*] and the ‘to-be-cared-for Other’ in the world of the nurse [i.e. the *nurse’s Other*]. We believe one must pay close attention to these differences in order to identify fruitful ways of promoting moral sensitivity in engineers-in-training.

### 2.1 The Other in the Practical World of Nursing

As we saw, Rest maintained that moral sensitivity is hard to achieve, with “many people” finding it difficult to “interpre[t] even relatively simple situations” (1982, 29). Of course, one could ask what counts as a relatively simple situation, particularly in complex professional settings? As Weaver and Mitcham note, “The comprehensive recognition of ethical issues is difficult because such issues are almost always embedded in webs of social custom, personal and relational histories, and competing needs and interests of professional practice” (2016, 12). Perhaps it is better to say, then, that the difficulty of moral sensitivity is lies not merely in the difficulty of “interpreting even relatively simple situations,” but also in the complexity of situations themselves - where situations that have the appearance of simplicity are in fact multi-layered and framed by a variety of relationships, norms, beliefs, institutional practices, demands, and ideologies. Ideological assumptions are the topic of the next section (3). In this section we look at the worlds of nursing and engineering from a practical point of view, as enacted through the practical day-to-day goals and activities of its professionals.

Mari Skancke Bjerckness and Ida Torunn Bjørk's ethnographic sketch, derived from a study of newly qualified nurses, provides an entry into the practical world of nursing and how the nurse's Other is manifested as a target of care in this world. The study contains the following vignette of Tina, a nurse who just started working at a Norwegian university hospital:

In one room, a young woman lay with her eyes closed ... Tina quietly approached the bedside and bent down, whispering: "Are you awake? Can I get you something to drink?" The patient only grunted in reply and did not open her eyes. Her face was pale and she had a kidney bowl on her chest holding some absorbent tissue. While looking at the intravenous catheter and checking the intravenous injection, Tina kept an eye on the patient's face. She stood there for some minutes. After a period of silence, the patient replied, "My mouth is dry, so perhaps just a swallow." A glass of fresh water was on the bedside table, and Tina carefully supported the patient and helped her take a small mouthful. The patient swallowed some water and spat out the rest. "Just a small swallow, yes, that's good," Tina said. After helping the patient into a comfortable position, Tina said that she would be back again soon. On the way out, I noticed a soft light in the single room, a glow from the lamp beside the bed, positioned in such a way that it would not bother the patient. I asked Tina about this patient afterwards, and she told me that the patient had a serious disease, hyperemesis gravidarum, which meant that she was constantly sick with nausea and vomiting. The patient would have to stay in bed for months or possibly for her entire pregnancy, and she was not supposed to have anything to drink or eat. "I really feel sorry for this patient, so young and being so sick day after day," she said. Later in the afternoon, and in between phone calls and her responsibilities for other patients, Tina slipped in to see the young pregnant woman. "I must not disturb her," she whispered to me. "I have to follow up and see if she is all right, and whether she has vomited." She helped the patient and offered her a special moisture stick in a glass of iced water to cleanse her mouth, which would give her a sense of tasting water. Tina's caring and sensitive attitude when taking care of the patient was in marked contrast with her much more determined and brisk manner of walking as soon as she was back in the corridor (Bjercknes & Bjørk 2012).






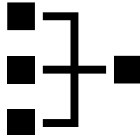
Tina's actions reflect both the capacity of putting her acquired professional medical and technical knowledge into practice and of providing fine-grained context sensitive care for her patient's particular needs, reflected in embodied and linguistic registers. In adjusting her movements and the volume of her voice to accommodate her patient's condition, and in offering words of encouragement ("just a small swallow, yes, that's good"), Tina exhibits a "vivid rendering" of her patient's particular needs and experiences. Some would argue that providing such care, which we have termed *particularized care*, is interwoven with the telos of nursing, with nurses-in-training typically referring to the care-providing component of their profession as the main motivation for pursuing this line of work (Bjercknes & Bjørk 2012; Halperin & Mashiach-Eizenberg 2014). Of course, as already noted, providing such patient-centered care is not the only responsibility of a nurse. Nurses operate in complex socio-technical systems shaped by different medical, technical, organizational, bureaucratic, social, and temporal demands. As such, we can understand nursing as involving a constant balancing-act of internalizing, implementing and abiding by third-person professional norms and knowledge and exhibiting a continual responsiveness to the first-person experiential point of view of the patient, of attending to her expressed needs and emotions, weighing what these might mean and the best response given the larger context of the patient's medical predicament. Despite the asymmetrical epistemic relationship between the nurse and her Other, with the nurse possessing a body of professional knowledge about the patient's medical situation that the patient will typically have little access to, the nurse must simultaneously possess a readiness to take the patient's verbal and bodily expressions as capable of being authoritative and of determining the appropriate course of action in providing particularized care. This balancing act typically involves being able to "provide the technical aspects of practice *in an* [often] *unreflective manner*" while also allowing for this to be

“interrupted by some cue”. The “awakening” to this cue, which Weaver, Morse and Mitcham characterized as moral perception, is said to be experienced by nurses as “a gut-level jolt ... or worry.” We propose that if *anyone* can bring about such a gut-level jolt, disrupting absorption in habitually executed professional activities, it is a concrete particular human person, visible, present, and capable of changing the course of any routine interaction.

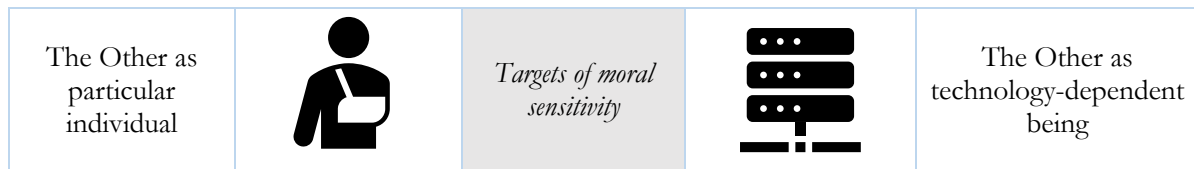
## 2.2 The Other in the Practical World of Engineering

In the practical world of engineers, a to-be-cared-for Other rarely plays this ‘jolt-producing’ role because in-person interactions between engineers and their Other are far more restricted and the kind of care engineers provide is almost never particularized. The activities of engineers in general are not aimed at the needs of particular others and a “vivid rendering” of their humanity, but at society at large or large cohorts within it.<sup>5</sup> One cannot build or maintain a bridge by “awakening [to] and particularizing” the “situational needs” of everyone who will be crossing it or who will be otherwise affected by its presence. It seems, then, that Weaver, Morse, and Mitcham’s characterizations of moral perception and affectivity miss the mark here. We posit that seeing the Other as a particular person and meeting that person’s particular needs is antithetical to the activity of engineering. Maintaining and designing products made for mass-scale use or mass-scale reproduction requires, by definition, that one treats the needs of the Other in a more homogenous uniform way. As such, we propose that where the nurse’s relation to her Other is characterized by *proximity*, the engineer’s relation to her Other is marked by *distance* (See Table 1).

Table 1 Comparing the nurse and her Other and the engineer and her Other.

The “Other” to be cared for				
The nurse’s Other	Characteristics:		The engineer’s Other	
Proximity		<i>spatiality</i>		Distance
Individualized care		<i>individualization</i>		Generalized care/ “stakeholders” as representatives
In-person care		<i>Activity</i>		Indirect care provided through systems and objects

<sup>5</sup> Though one could argue that engineers do sometimes cater to the specific needs of others, e.g. when catering to the needs of (often corporate) clients. Thanks to Glen Miller for pointing this out.



The distance between the engineer and her Other can be brought out more concretely by taking a look at an ethnographic sketch of the engineer, involved in her day-to-day activities. In the following scene, described by Louis L. Bucciarelli, we ask you to trace to what extent the engineer's Other becomes manifest, is attended to and cared for, throughout the engineer's day-to-day practical activities:

I observe members of the firm engaged in a variety of activities. Some of these are solitary: sketching at the board, running a computer analysis at the terminal, putting a prototype sub-system through its paces down in the lab, phoning a subcontractor back in the office, checking out codes in the library, conceptualizing, dreaming, detailing, cost-estimating, cursing, etc. Others are collaborative: sitting in on a design review in the board room, leading a meeting in the project manager's office, consulting with purchasing or production, advising the new hire, celebrating the shipment of the new product, negotiating time on the next design task, laughing, bantering, bickering, cursing, etc. (1988, 162)

The engineer's Other is nowhere to be found here. Much, though not all, of what the engineer attends to is what Bucciarelli terms her 'object-world:'

The mechanical engineer, designing a structure to hold the plates used to collimate an X-ray beam, moves within an object world of beams, of steel, of geometric constraints, of stress levels, of close tolerances, of bearing surfaces, of positioning errors, of fasteners, and of metal machining practice. The electrical engineer designing a photo voltaic module works in terms of voltage potentials, and of current flows. He sketches networks with special symbols for diodes and current sources, resistive elements, all within a meaningful topology. These are two different worlds. The project manager casts out schedules and milestones, worries about manpower allocation and development cost trends, speaks of interface constraints and critical paths: another object world (1988, 162).

From these brief sketches, one can see that an engineer's proximal other is not in any immediate sense the to-be-cared for Other, but her colleagues with whom she collaborates, her direct clients, and the technological artefacts to be maintained or designed through her activities. \

But the emphatic distance between the engineer and her to-be-cared-for Other is not just a result of the world of engineering understood in a day-today practical sense. The challenge of promoting a self-conception of the engineer as care-taker in engineering students is exacerbated by an ideology of neutrality that often circulates in the world of engineering and engineering education. Although the degree to which the ideology of neutrality is internalized by students will depend on cultural and institutional variations, we maintain that traces of it are typically found at technical universities around the globe.

### 3 Ideological Mechanisms Shaping the World of Engineering

As we sketched in section 2.1, being a good nurse involves a balancing act between internalizing and applying third-person expert knowledge (knowledge of clinical technology; diseases and bodily processes; institutional rules and protocols) and taking seriously a patient's first-person reports and expressions of their needs, feelings and sensations. Of course, individual nurses may fail in performing this difficult balancing act. For instance, moral perception and affectivity may



be hindered by an over-reliance on a third-person medical-technical apprehension of a situation and an undervaluing of a patient's first-person reports.<sup>6</sup> We already mentioned, for instance, that the first-person reports of pregnant, birthing, or post-partum Black women are disregarded at a disproportionate and deadly rate (Roeder 2019). Crucially, though, we categorize these occurrences *as* failures. We think something has gone wrong in how the nurse executes precisely their role *as* a nurse. A good nurse, a nurse who performs their role well, is typically understood as someone who exhibits not only the practical medical-technical know-how characteristic of their field, but also as someone who is responsive to the humanity in their patients, someone who puts herself “in the place of clients” with the aim of preserving “client dignity and caring” (Weaver et al. 2008, 609). Attunement to a patient's expressed needs, feelings and emotions is as much a part of being a good nurse as exhibiting the required medical and technical knowledge.

Engineers and engineers-in-training are judged in strikingly different terms. Despite the fact that nearly every professional code of conduct for engineers characterizes engineering as an activity that “must be dedicated to the protection of the public health, safety, and welfare” and that “has a direct and vital impact on the quality of life for all people,” the idea that engineers are *at their very core* in the business of care-taking is largely absent from the engineer-in-training's self-conception qua engineer,<sup>7</sup> Anecdotally, when we ask TU Delft students what it means to be a good engineer, the answers we typically receive contain references to technical, scientific and managerial skills. Being a Good engineer in the care-taking ethical sense of the word tends to be seen as a separate category from being a good engineer in the functional sense of the word; it is of course viewed as commendable if an engineer falls into both categories at once, but concerning oneself with the ethical care-providing dimensions and consequences of one's line of work is generally not seen as *constitutive* of what it means to be a good (well-performing) engineer.

These anecdotal observations about how engineering students understand ‘the good engineer’ are confirmed by engineering ethics educators at institutions across the globe. In a focus group in 2019, we discussed the challenges of teaching ethics to engineering with thirteen engineering ethics lecturers and professors from a variety of institutions in Europe, Australia, and the USA.<sup>8</sup> One of the main findings was that ‘simply’ getting students to see ethical issues as deeply intertwined with their practice (i.e., getting them to see how their technical activities might impact on the well-being of distant others) was widely seen as a primary marker of success in teaching ethics to engineering students. Even at institutions that explicitly foreground ethics in their engineering curricula, the idea that engineers are *at heart* involved in an irreducibly ethical endeavor of caring for direct and indirect stakeholders does not seem to feature prominently among students.

Why is this so? What we will suggest now is that this is in part because engineering students either explicitly or implicitly accept an ideology of neutrality, or one or more of the background assumptions of which this ideology consists (See also, Cech 2013).<sup>9</sup> We take this ideology to consist of the following views:

- 1) The *neutrality thesis* of technology (Cf. Cech 2013; Roeser 2012; Vermaas et.al 2011; Winner 1980)
- 2) The *applied-science-view* of engineering (Cf. Cech 2013; Vermaas et al. 2011)
- 3) The *rationalistic view* of engineering-relevant knowledge (Cf. Roeser 2006)

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<sup>6</sup> Of course, other factors come into play as well, such as bureaucracy—with nurses getting bogged down in institutional rules and protocols—or time-pressure and an overload of patients to care for. And the balancing act goes both ways. A nurse could over-value the expressed experience of a patient at the expense of situation-relevant third-person knowledge and protocol.

<sup>7</sup> <https://www.nspe.org/resources/ethics/code-ethics>

<sup>8</sup> Admittedly, the data gathered from our focus group may reflect a Western bias.

<sup>9</sup> Cech speaks of an ideology of depoliticization, which refers to the assumption that engineering is a strictly “technical” space where ‘social’ or ‘political’ issues such as inequality are tangential to engineer's work” (Cech 2013, 67).



4) The *technocratic view* of the engineer as social actor (Cf. Cech 2013; Roeser 2012)

According to the neutrality thesis of technological artefacts, a technology's ability to promote or undermine human welfare is determined by the intentions of its users. Indeed, facial recognition technology, nuclear energy, and social media platforms are all products of engineering that can be used in ways that are good or bad for human beings and the planet at large. But the neutrality thesis states that there is nothing about these technologies *themselves* – nothing in their “nuts and bolts” to speak with Langdon Winner (1980, 28) – that undermines or promotes well-being.<sup>10</sup> As such, the designing of technological artefacts too is deemed to be neutral with respect to ethics.

The idea that technological objects are value-neutral is related to a way of understanding the domain or activity of engineering itself, namely as the practical application of rigorous scientific theorizing. As Vermaas et al. explain, this “applied-science-view cannot be separated from the way in which engineers perceived themselves. From the dawn of the Industrial Revolution until far into the last century, traditional engineering disciplines such as civil and mechanical engineering shifted increasingly from continuations of practical and traditional craftsmanship to the scientific end of the spectrum” (2011, 55-6). As they further point out, this shift directly impacted on the education of engineers: “engineering curricula were organized in such a way that students were taught, above all else, just how to apply the theories gained from applied scientific research” (56).

If we leave unquestioned the view of engineering as an activity that takes ‘pure’ descriptive scientific knowledge and churns that knowledge into value-neutral artefacts, this will inform students’ conception of what it is to perform that activity well; what it means to become a good engineer. Good engineers are seen as

no-nonsense problem solvers, guided by scientific rationality and an eye for invention. Efficiency and practicality are the buzzwords. Emotional bias and ungrounded action are anathemas. Give them a problem to solve, specify the boundary conditions, and let them go at it free of external influence (and responsibility). If problems should arise beyond the work bench or factory floor, these are better left to management or (heaven forbid) to politicians. (Herkert 2001, 410)

Exhibiting care for and moral sensitivity towards the well-being of others is quite clearly not an integral part of the way in which the world of the engineer and the engineer's role in the world at large are framed here. Although the applied-science-view of engineering has come under pressure in recent decades (Cf. Vincenti 1990), and although countless engineering curricula have adopted a broader perspective on what it means to be a good engineer, the effects of this view still continue to reverberate through the world into which engineers-in-training are enculturated.

Roeser (2012) has challenged the view of engineers “as the archetype of people who make decisions in a rational and quantitative way.” Instead, she argues that what we need is “a new understanding of the competencies of engineers: they should not be unemotional calculators; quite the opposite, they should work to cultivate their moral emotions and sensitivity” (2012, 103). Attempts to cultivate this in engineers-in-training may be met with some reluctance. As an engineering ethics professor from TU Eindhoven pointed out in our focus group: “the students have this rationalistic view of ‘that are the facts’ and the things besides the facts are emotions and are irrelevant. We bring something else and there is resistance.”<sup>11</sup>

One way to tackle this is by confronting students with the questionable theoretical assumption that rationality and emotions are antithetical notions. This view rests on an over-

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<sup>10</sup> Winner is emphatically critical of the value-neutrality thesis.

<sup>11</sup> Marin, Lavinia; Grunsven, Janna van; Stone, E. Taylor (2022): Transcripts of focus group with educators on the topic of teaching ethics to engineers. 4TU.ResearchData. Dataset. <https://doi.org/10.4121/19657161.v1>

simplified view of emotions that fails to take into account how emotions often help bring out morally salient features of a situation (Roeser 2012). To *feel* indignation when discovering that you and your children have been knowingly, avoidably or even purposely exposed to dangerous toxic waste or psychologically damaging technologies, is to exhibit a *rational* response to the morally salient features of those situations; it is a way of getting things right, in a moral sense, about what should or should not have occurred here. By contrast, someone who doesn't feel indignation is having a different cognitive understanding of the situation, an understanding that misses part of what is morally relevant: "by caring about certain things we are able to perceive evaluative aspects of the world that we would otherwise not be able to be aware of." (Roeser 2012, 106)

Our Ethics and Philosophy of Technology Section at TU Delft invites its engineering students to explicitly reflect on the value-neutrality thesis and the applied-science-view of technology (Cf. van Grunsven et al. 2021; Van de Poel & Royakkers 2011). To give a simple example, by explicating the difference between descriptive versus normative statements and by asking students to categorize common engineering-statements, such as "this high frequency switch is *safe*," or "this is a *good* high frequency switch," students begin to attend to the ineluctably normative-evaluative judgments that they make all the time, in a manner that problematizes the "applied science view" of engineering.<sup>12</sup> And by asking students to use the value-neutrality thesis in order to make sense of commonplace innovations and artefacts such as the speed bump or hostile design (e.g. park benches designed so as to prevent homeless people from sleeping on them) (Cf. Rosenberger 2020; Verbeek 2011), students become aware of the limits of the value-neutrality thesis and the ways in which technological innovations profoundly shape the possibilities for action, the values, and the social infrastructure of society.

One reason why it is particularly important to challenge engineering students' often unexamined dichotomous view of rationality versus emotions, is that this view, when left in place, can exacerbate the already distant relation between the engineer and her Other. In the previous section, we suggested that when individual nurses prioritize third-personal knowledge wholly at the expense of a perceptual affective attunement to the needs and the emotions of her patients, we categorize those moments as moments of failure and believe that the nurse has failed in her role qua nurse. What we are seeing here, in the context of engineering, is that the ideological tenets we have been identifying can enact a world in which the engineer's Other's feelings and emotions tend to not just be improperly cared for but purposefully sidelined, as the emotionally charged responses of laypersons to technological innovations and interventions are discredited for reflecting a 'non-rational' ill-informed stance (Cf. Roeser 2012). As mentioned, we can invite students to question the legitimacy of this *technocratic* outlook by challenging the theoretical separation between rationality and emotion. Role-play activities, e.g. in the form of stake-holder meetings, offer an embodied experiential way of trying to cross the distance that is created when engineers-in-training assume that her Other's emotional responses to a technology can be discredited in virtue of their alleged irrationality. Weaver and Mitcham concur, proposing that "Role taking opportunities ... help students identify blind spots that limit them from seeing others' perspectives" (2016, 7-8).

Indeed, without seeing those other perspectives, engineers will often end up incorporating their own assumptions and biases about what their users need into designs. To name just one of many examples: engineers and designers have been known to build augmentative and alternative communication (AAC) technologies for non-speaking children without actually consulting children in order to establish what symbols would optimally promote expressivity, thus unintentionally but effectively silencing a whole cohort of people whom they were precisely aiming to equip with effective expressive resources (Van Grunsven & Roeser 2021). What this

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<sup>12</sup> These examples are taken from the course *Philosophy of Engineering Science and Design*, taught by our colleague Maarten Franssen (for a more comprehensive picture of the Delft approach to philosophy and ethics of engineering teaching see <https://www.tudelft.nl/ethics/>)

example illustrates is that the link between being a good (well-functioning) engineer and being an engineer who cares for her stakeholder's needs, desires, and experiences is an intimate one, such that a failure to care in this sense just is a failure to do one's work well.

To sum up, for engineering students to see their professional role as marked by a form of care, pedagogical activities need to challenge the ideology of neutrality. A way to do this is by encouraging students to identify with the needs and emotions of those impacted by the artifacts or systems they will build and maintain. Furthermore, identifying relevant stakeholder groups and taking seriously their specific needs and emotions seems often, if not always, essential for designing something that actually functions well. Specifying the needs of her 'Other' in accordance with relevant cohorts of stakeholders may partially overcome the distance between the engineer and her Other (and provide key information for determining design-requirements). However, the engineer inevitably falls short of the kind of particularized care ideally offered by the nurse. Instead the engineer offers what can be labeled as *generalized care* – care that aims to close the distance between the engineer and her Other by taking seriously the needs, emotions, concerns, and desires of a group of stakeholders (e.g. non-speaking children who depend on AAC for their daily communication needs). Of course, by taking one or some individuals as representatives of a larger cohort, the engineer's efforts of providing generalized care, though undeniably essential, will at the same time fail to live up to the standards of care as identified by Weaver, Mitcham and Morse. Generalized care by definition cannot exhibit the kind of particularized, situation-specific moral perception and affectivity towards persons that they have built into their account. The other in her particularity remains, to a degree, at a distance.

If our phenomenological analysis is right in suggesting that distance is to some degree inevitably built into the engineer's relation to her Other, it questions the move to transpose a particularized notion of care (characteristic of the nursing context) into the engineering classroom. When contrasted with particularized care, the generalized care that we want to encourage in our engineering students may feel like a fundamentally flawed type of care (which in turn could demotivate students from prioritizing such care). But perhaps there is another approach. What we will now propose is that there is a different way of introducing care into the engineering education context. This approach shifts away from particularized care and instead introduces a second form of care relevant for engineering ethics education. In addition to generalized care, we propose the usefulness of what we call *universalized care*. This notion of care offers a positive view of what it means to develop a sensitivity to an Other marked by an irreducible distance.

#### **4. Engineers as Maintainers and the Notion of Universalized Care**

In the previous section we cited Vermaas et al. (2011), who describe the historical shift away from engineering understood as a “practical and traditional craftsmanship to the scientific end of the spectrum” (56). This shift in the understanding of engineering points to the availability of an alternative discourse, a different way for thinking about what engineering is and what engineers (should) do. As Bucciarelli brings out, such an alternative is necessary if we want to make sense of a wide range of activities and judgments that do not fit in comfortably with the ideologized picture of the engineer as the applied scientist moving about in her pristine object-world:

What engineers do, and are expected to do, includes much more than rational problem solving and constructing efficient means to reach desired, externally specified ends. In engineering practice, value judgements are made all the time, often not explicitly – about the user, about robustness, about quality, about responsibilities, safety, societal benefit, risks and cost. However, it is object-world work that is [often] seen as primary by engineering faculty – and consequently seen as such by our students. (Bucciarelli 2008, p. 143).

Here, then, is a sketch of the state of affairs as it pertains to engineering students being socialized into the world of engineering. There are at least two distinctly different discourses, two ways of framing what the world of engineering is like, what becoming a good engineer involves, what engineers-in-training should practice and focus their attention on, what they should become sensitive to. First, there is the picture of the engineer as moving about in an ethically-neutral world applying emotion-free scientific knowledge to produce value-neutral technical artefacts. Second, there is the picture of the engineer as essentially in the business of care, of attending (even if implicitly) to issues concerning a technology's degrees of safety, risk, and ability to promote well-being in its users.<sup>13</sup>

As Andy Russel and Lee Vinsel have recently suggested (2019), we can get a firm handle on the idea of engineering as a form of care via a realistic look at some of the “basic facts of ordinary life with technology” and of the role that engineers play in maintaining this life (p. 256). *Maintaining* is the crucial notion here. For as Russel and Vinsel emphasize: “much of modern life depends on well-functioning technological systems, and the vast majority of human work will always be aimed at maintaining them—that is, the labor is oriented towards taking care of the world and its inhabitants” (261). Indeed, as it turns out over 70% of trained engineers will end up dedicating their professional lives not to innovating and designing but to maintaining; to taking care of the technical systems that quietly support our daily functioning.<sup>14</sup> However, Russel and Vinsel note that in engineering education and “in most technology studies, maintenance, repair, and upkeep are largely ignored, rendered invisible” (256. See also Young 2021).

Russel and Vinsel draw a comparison between the quiet supporting role that women have traditionally played in maintaining the daily functioning of the family and engineers as quiet care-takers of the technical systems upon which we all depend. With this analogy, they present care ethics as the central normative ethical theory to be incorporated into engineering education. For those familiar with care ethics, this suggestion may come as a surprise. After all, the emphasis in care ethics is typically on particularized care and “the compelling moral salience of attending to and meeting the needs of the particular others for whom we take responsibility.” (Held 2006, 10). Not surprisingly, then, care ethics has played an important role in the education of nurses. It is perhaps fairly straightforward to imagine a positive role for care-ethics in the evaluation of a particular sub-set of technological artefacts, namely artefacts such as care and service-robots, which fulfil a central role in a dyadic relationship (Cf Van Wynsberghe 2016). But what Russel and Vinsel are proposing is that care ethics should be considered central for the education of engineers *tout court*. But, how can care-ethics – as a theory that is in the first instance focused on dyadic close-personal relationships with and responsibilities to particular others – play such a central role?

Perhaps seemingly contradictory, we suggest that Russel and Vinsel's proposal, with its emphasis on maintenance, repair, upkeep, rehabilitation, and care for technical structures, opens up a positive approach to what it means to care *precisely* for a distant Other. Specifically, we propose that one important form of care in the world of engineering is what we call *universalized care*. The idea is that universalized care, which is performed by maintaining, preserving, and rehabilitating physical structures, is care for the engineer's Other in her universally shared standing as a vulnerable technology-dependent being; as someone whose daily functioning and well-being depends on well-functioning technological systems. This proposal is admittedly

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<sup>13</sup> One might even want to argue that there are three pictures: 1) the picture of engineering as it is framed from the perspective of the ideology of neutrality; 2) a picture that recognizes ethics as important for engineers and which focuses on those ethical theories most in line with some of the rationalistic, calculative postures built into the first picture (in other words, the emphasis in the second view is on rule-based ethical theories and how they can help engineers make better ethical decisions), and then there is the third picture, which foregrounds the role of emotions and attitudes of care as central to engineering qua activity.

<sup>14</sup> As Russel and Vinsel note, “Most civil engineers work on keeping up existing physical infrastructures, like roads and bridges. Even in “cutting-edge” fields, like software, about 70% of budgets go into maintenance and upkeep, whereas only about 8% of budgets go into new design” (p. 257).

abstract, but it could motivate and frame important ethical questions about what it means to be responsive as an engineer to the Other as a technology-dependent being. For instance, it could bring out the profound moral failure of engineers who purposely exploit the ways in which human beings can become dependent on technologies. Think of how engineers working for *Facebook* and *Instagram* intentionally operationalized such dependency in order to advance corporate financial interests. By embedding an in-class evaluation of these software engineers into a wider conception of engineering as care-taking, our proposal is that we can invite students to consider that while these engineers may be undeniably skilled in a technical sense, they nevertheless fall short of being good engineers. When looked at through the lens of the value-neutrality thesis, these engineers will likely be seen as good, i.e. well-functioning engineers who just happen to have morally bad intentions. We want to propose a different take on the situation. Whereas the nurse fails in her role as a nurse when she lacks responsiveness to her Other's particular needs and well-being, we suggest that the engineers in this example fail in their role as engineers when they lack responsiveness to their Other by purposely exploiting the universal human feature of technology-dependence to the detriment of their well-being.

In sum, engineers are not in the business of caring for her Other as a unique individual with whom she stands in a close personal relationship. We suggested that generalized gestures towards overcoming the distance between the engineer and her Other, for instance through stakeholder meetings and processes of co-creation, are undeniably important. This pertains both to making sure one's designs optimally fulfil the needs of cohorts of stakeholders (recall the AAC technology example), and for exposing engineers-in-training to the idea that they are in the care-taking business. However, we also added to this that care for the Other – in the context of engineering – involves recognition of a more universal feature of the engineer's Other, namely their deep dependency on the technological systems that engineers design, build, and maintain. Recognizing this is fully compatible with, and puts forth, a positive view of what it means to care for an Other in her distance.

## 5. Concluding Remarks and a Tentative Pedagogical Proposal





As we have seen, Mitcham and his collaborators understand moral sensitivity as an iterative movement between moral perception, affectivity and dividing loyalties. What we have argued in this paper is that this view of moral sensitivity cannot be readily transported from the nursing context to the engineering context on the basis of a care-analogy. The particularized care characteristic of the nursing context is decisively different from the generalized and universalized forms of care characteristic of the engineering context. That said, we agreed with Mitcham and his collaborators that care should be foregrounded as a central notion for engineering (ethics) education. As Russel and Vinsel furthermore suggest, this points to a key role for care ethics in engineering (ethics) curricula. While we don't disagree with Russel and Vinsel, we want to conclude by making the tentative suggestion that a bottom-up approach might be desirable, particularly in the male-dominated engineering world, where insights from a feminist ethics of care might be met with significant resistance. Though we should of course never insulate students from ideas they might initially feel uncomfortable with, there seems to be a pedagogical advantage to gradually getting students to see care-related concepts as being central to rather than external to engineering itself. We propose that this can be achieved through a pedagogical exercise that we have termed a *value genealogy of technology* (Stone et al. 2020), where students discover the historical value-laden shifts that have taken place in how the profession of engineering and the practical self-conception of the engineer have been framed.<sup>15</sup> The idea of engaging in a "value genealogy of engineering" is that students will find care-taking as an activity (and a value) throughout the historical development of engineering in at least two ways: in a

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<sup>15</sup> In doing so, we are fully in line with Carl Mitcham's significant historical approach to engineering, which sheds light on the cultural and historical frames we put on this profession (Cf. Mitcham and Muñoz 2010).

narrow sense via the upkeep of essential systems and infrastructures, and broadly in their role of designing and building the sociotechnical systems upon which we inextricably rely. We think that this active learning exercise in which students discover on their own the prevalence of care in engineering has the potential to introduce notions of care in the ethics classroom, while “meeting students where they are,” to speak with Mary Sunderland (2014).

Table 2 Pedagogical interventions proposed based on the two forms of care specific to engineering.

Forms of care in engineering	Pedagogical interventions proposed
Generalized care	Stakeholder involvement 
	Role-playing 
	Emotions observed as proxies for moral reasons 
Universalized care	Value-genealogy of engineering as profession 

To harken back once more to the picture of moral sensitivity with which we started our analysis: through a focus on care and maintenance, the engineering student’s moral sensitivity can be refined, opening up a perceptual awakening and affectivity towards the complex nature of the engineer’s Other. This awakening is in part promoted through an understanding of the ideology of neutrality as a moment in the history engineering. Becoming aware of this ideology *as* an ideology can then be seen as an activity of *dividing loyalties* that allows for a reflexive and critical view of the biases and presuppositions inherited within the world of engineering. This process of deepening the engineering student’s moral sensitivity is perhaps as much a process of the student becoming aware of her professional world, how it shapes her understanding of herself, and what it means to be a good engineer.

## References

- Adam, B. & Groves, C. (2011). Futures Tended: Care and Future-Oriented Responsibility. *Bulletin of Science, Technology & Society* 31(1), 17-27.
- Bjerknes, M. S., & Bjørk, I. T. (2012). Entry into nursing: an ethnographic study of newly qualified nurses taking on the nursing role in a hospital setting. *Nursing research and practice*, 2012, 690348. <https://doi.org/10.1155/2012/690348>
- Bucciarelli, L. L. (1988). An ethnographic perspective on engineering design. *Design Studies*, 9, 159–168. [https://doi.org/10.1016/0142-694X\(88\)90045-2](https://doi.org/10.1016/0142-694X(88)90045-2).
- Bucciarelli, L. L. (2008). Ethics and engineering education. *European Journal of Engineering Education*, 33, 141–149. <https://doi.org/10.1080/03043790801979856>.
- Cech, E. A. (2013). The (Mis)Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers’ Ability to Think About Social Injustices. In J. Lucena (Ed.), *Engineering Education for Social Justice* (Vol. 10, pp. 67–84, Philosophy of Engineering and Technology). Dordrecht: Springer Netherlands.
- Franssen, M., G.J. Lockhorst, I. van de Poel. (2018) “Philosophy of Technology, entry in The Stanford Encyclopedia of Philosophy (<https://plato.stanford.edu/entries/technology/#NeutVersMoraAgen> (First published Fri Feb 20, 2009; substantive revision Thu Sep 6, 2018)
- Gallagher, S. (2007) Simulation trouble. *Social Neuroscience*, 2(3-4), pp.353–365.
- Halperin, O. & M. Mashiach-Eizenberg. (2014). “Becoming a nurse — A study of career choice and professional adaptation among Israeli Jewish and Arab nursing students: A quantitative research study,” *Nurse Education Today*, 34, 1330-34
- Herkert, J. R. (2001). Future directions in engineering ethics research: microethics, macroethics and the role of professional societies. *Science and engineering ethics*, 7, 403–414. <https://doi.org/10.1007/s11948-001-0062-2>.
- Held, V. (2006). *The ethics of care: Personal, political, and global*. Oxford University Press on Demand.
- Hess, J.L. & Fore, G. (2018). A Systematic Literature Review of US Engineering Ethics Interventions. *Science and Engineering Ethics* 24: 551-583.
- Johnston, S., Lee, A., & McGregor, H. (1996). Engineering as Captive Discourse. *Society for Philosophy and Technology Quarterly Electronic Journal*, 1, 128–136. <https://doi.org/10.5840/techne199613/413>.
- Johnson, Deborah G. & Wetmore, Jameson M. (2007). “STS and Ethics: Implications for Engineering Ethics.” In *The Handbook of Science and Technology Studies* (3<sup>rd</sup> edition), 567-581.
- Marin, Lavinia; Grunsvan, Janna van; Stone, E. Taylor (2022): Transcripts of focus group with educators on the topic of teaching ethics to engineers. 4TU.ResearchData. Dataset. <https://doi.org/10.4121/19657161.v1>
- Mellström, U. (2004). Machines and Masculine Subjectivity. *Men and Masculinities*, 6, 368–382. <https://doi.org/10.1177/1097184X03260960>.



- Mitcham, C., & Muñoz, D. (2010). *Humanitarian engineering* (Synthesis lectures on engineers, technology and society, Vol. 13). [San Rafael, Calif.]: Morgan & Claypool Publ.
- Rest, J. R. (1982). A psychologist looks at the teaching of ethics. *Hastings Center Report*, 29-36.
- Roeder, A. (2019). America is failing its black mothers. *Harvard Public Health*, 1-28.
- Roeser, S. (2012). Emotional engineers: toward morally responsible design. *Science and engineering ethics*, 18, 103–115. <https://doi.org/10.1007/s11948-010-9236-0>.
- Rosenberger, R. (2020). On hostile design: Theoretical and empirical prospects. *Urban Studies*, 57(4), 883-893.
- Russell, A. L., & Vinsel, L. (2019). Make maintainers: engineering education and an ethics of care. In M. H. Wisnioski, E. S. Hintz, & M. S. Kleine (Eds.), *Does America need more innovators?* (pp. 249–269, Lemelson center studies in invention and innovation series). Cambridge MA: The MIT Press.
- Stone, T., Marin, L., & van Grunsven, J. (2020). Before Responsible Innovation: Teaching Anticipation as an Intellectual Virtue for Engineers. In J. van der Veen & H.-M. Järvinen (Eds.), *Engaging Engineering Education: Proceedings of the 48<sup>th</sup> Annual Conference of the European Society for Engineering Education (SEFI)*, pp. 1401-1408. ISBN: 978-2-87352-020-5
- Sunderland M. E. (2014). Taking emotion seriously: meeting students where they are. *Science and engineering ethics*, 20(1), 183–195. <https://doi.org/10.1007/s11948-012-9427-y>
- Vallor, Shannon (2016). *Technology and the Virtues: A Philosophical Guide to a Future Worth Wanting*. Oxford: Oxford University Press.
- Van de Poel, I. & L. Royakkers (2011) *Ethics, Technology, and Engineering: an Introduction*. Wiley-Blackwell
- Van Grunsven, J., N. Doorn, L. Marin, S. Roeser & T. Stone (2021). “How to Teach Engineering Ethics? A Retrospective and Prospective Sketch of the TU Delft Approach.” *Advances in Engineering Education*, 9 (4)
- Van Grunsven J. & S Roeser. 2021. “AAC Technology, Autism, and the Empathic Turn,” *Social Epistemology* DOI: [10.1080/02691728.2021.1897189](https://doi.org/10.1080/02691728.2021.1897189)
- Van Wynsberghe, A. (2016). Service robots, care ethics, and design. *Ethics and information technology*, 18(4), 311-321.
- Verbeek, P.-P. (2011). *Moralizing Technology: Understanding and Designing the Morality of Things*. Chicago: University of Chicago Press.
- Vermaas, P., Kroes, P., van de Poel, I., Franssen, M., & Houkes, W. (2011). A philosophy of technology: from technical artefacts to sociotechnical systems. *Synthesis Lectures on Engineers, Technology, and Society*, 6(1), 1-134.
- Vincenti, Walter G. (1990). *What Engineers Know and How They Know It: Analytical Studies From Aeronautical History*. Baltimore: Johns Hopkins University Press.

Weaver, K., Morse, J., & Mitcham, C. (2008). Ethical sensitivity in professional practice: concept analysis. *Journal of advanced nursing*, 62, 607–618. <https://doi.org/10.1111/j.1365-2648.2008.04625.x>.

Weaver, K., & Mitcham, C. (2016). Prospects for Developing Ethical Sensitivity in Nursing, Engineering, and Other Technical Professions Education. *British Journal of Education, Society & Behavioural Science*, 18, 1–18. <https://doi.org/10.9734/BJESBS/2016/27485>.

Winner, L. (1980). Do Artifacts Have Politics? *Daedalus*, 109 (1), 121-136.

Winner, L. (1990). Engineering Ethics and Political Imagination

Young, M. T. (2021). Maintenance. In *Routledge Handbook of the Philosophy of Engineering*. Diane P. Michelfelder and Neelke Doorn. (Eds). New York / Oxon: Routledge.