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TOOL-BASED ETHICS EDUCATION FOR ENGINEERS; WONDERBERRIES AND WISDOM TILES

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ABSTRACT
The Dutch research project "Wijs met techniek" (Tech-Wise) explores ethics education from a tool-based, practical perspective. Especially if and how practical tools for ethical deliberation on the impact of technology can be helpful in ethics education for engineering students. The approach is first intended as a variation on theories in ethics and technology. Secondly, the approach uses a focus on the impact of technology as a way toward ethical deliberation. Both characteristics are intended to better appeal to engineering students. In the project we cover three levels of higher education: a University, a University of Applied Sciences and a School for Vocational Training.
Together we are developing and testing a suite of activating working methods that can be tailored to various engineering programmes. A first result of this is the simple workshop format "ethics for engineers", consisting of five steps with four effective ingredients. In this paper we present the general format of this workshop and dive in particular into a specific instance of the workshop called "Wonderberries". The experiences from the workshop show that with a carefully chosen combination of engaging orientation, a specific 'technology' and a concrete design exercise the ethical questions and subsequent deliberation and reflection can be very rich.

Keywords: Ethics of technology, reflective skills, impact of technology, ethical deliberation

1 INTRODUCTION
We are faced with the challenge of fully exploiting the possibilities of new technology while at the same time being open to the questions and concerns that these entail. (Future) engineers are expected to think about the effects of new technologies on people, society and the environment, as they will be contributing to the shaping of these technologies [1]. The accompanying responsibility [2] makes that educational institutions, governmental organisations and companies should offer their students and employees the opportunities for learning to reflect on the impact of technology in an accessible and practical way.

2 ETHICS IN ENGINEERING EDUCATION
The Dutch research project "Wijs met techniek" (which can be translated with Tech-Wise and in the local culture also means "happy with technology") explores ethics education from a tool-based, practical perspective. It addresses how practical tools for ethical deliberation on the impact of technology can be helpful in ethics education for engineering students. The practical approach is first intended to be a variation on teaching from theories in ethics and technology and an addition to existing approaches that start from professional development [3] and personal development [4, 5]. Secondly, the approach uses a focus on the impact of technology as a way toward ethical deliberation. First experiences learn that these characteristics are both appealing to engineering students [6]. In the project we work together in three levels of higher education: a University, a University of Applied Sciences and a School for Vocational Training.
In the first phase of the research project, experiences of consulted students and teachers indicated that practical tools for ethical deliberation are most valuable, provided that they are linked to explicit learning goals [6]. In the second phase, efforts are being made to (further) develop and test a suite of activating working methods to achieve these learning goals. The aim is to develop a package of teaching materials, together with the various engineering programmes, consisting of concrete ethical exercises and

assignments that can be used as a continuous learning line during the entire curriculum [7]. In the project we have identified four important ingredients for such exercises and assignments; 1) an ambivalent (or controversial) technology; 2) an application close-by (or appealing to the interests of the participants); 3) a concrete (design) activity and 4) the 'right' questions to ask. These ingredients should allow for effective learning experiences, especially with lecturers of engineering subjects that are themselves not trained as ethicists.

3 ACTIVATING WORKING METHODS

One example of such an activating working methods is a simple workshop format. The general format of this "ethics for engineering students" workshop consists of five activities: orientation, research, select, design, and discuss. Each activity can then be tailored to the specific engineering discipline, and the knowledge, skills, and level of expertise of the students.

Until now we have explored different techniques for an engaging orientation phase and different formats for the design. Following our four ingredients we chose different technologies for which we thought that the application is either very well known to the participants or in which the purpose of the technology is not so clear or controversial. To cater to the different engineering and design disciplines, our interpretation of what a technology is, is very broad. In Table 1 an overview is provided of the different instances of the workshop we have experienced with so far. The first four columns give a brief description of the different workshops. The 5th column indicates with which engineering disciplines the instances were tested. The last column lists some engineering disciplines for which the exercise would be particularly suitable.

Table 1. "ethics for engineers" workshop instances

name	technology	orientation	exercise	tested with	suitable for
Wisdom tiles	Online meeting applications	Ironic movie clip "a conference call in real life"[1]	Write an aphorism on a Delft blue tile; a behaviour manifest in one phrase.	Engineering educators	Interaction designers, UX designers
Gender Neutral Toilets	Interior design	Ironic movie clip "gender neutral toilets"[2]	Design a lay-out for gender neutral toilets with matching logo's/signing	Interior design students, Industrial design students	Interior designers, Industrial designers, Architects
Wonder Berries	Taste influencing pills from Miracle Berry	Tasting session with several food items	Design and prototype an 'appropriate' packaging	Design educators, Industrial design students	Packaging designers, UX designers, Food engineers

A general description of the five steps:

- Orientation: experience the technology in a direct or indirect manner.
- Research: question the experience you had in the orientation phase together with your groupmates.
- Select: choose a direction for your design solution.
- Design: draft a solution, preferably with a concrete and communicable end result.
- Discuss: Look at what the other participants have come up with and start with the question how this relates to your own 'solution'.

The orientation phase can be done indirect by showing a provocative, ironic or speculative design, image, newspaper article or movie clip. When the orientation phase is done indirectly, it is however important that the participants can relate the footage to their own experiences. In the examples we chose for general experiences like online meetings and toilet arrangements as these are experienced by everyone. However, when teaching in a specific discipline one can tailor these also to specific engineering topics like for example autonomous driving for automotive engineers or health tracking systems for interaction designers. Figure 1. shows an indicative result of the "wisdom tiles" workshop

[1] (see https://www.youtube.com/watch?v=ElIUVDECGdA)
[2] (see https://www.npostart.nl/genderneutrale-toiletten/08-03-2020/POMS_NTR_16012936)

instance. In the remainder of this paper, we will discuss the set-up, execution, results, and the ideas behind the "wonderberries" workshop instance.

Figure 1. Result example of the wisdom tiles workshop with engineering educators [7]

4 WONDERBERRIES WORKSHOP

In this workshop the central 'technology' is shifting taste. Little pills, based on a natural ingredient from miracle berries, make that sour will taste sweet which is supposed to make you eat healthier (Figure 1, left) [8]. The orientation phase is done by actually eating the pills and tasting several types of food 'before' and 'after' (Figure 2, right). In the design phase the participants are then asked to create a packaging for the product. To make the discussion more open, the participants are not told what the intention of the technology is, and the existing packages are also not shown. The participants received the pills only in separate cut-out blisters. From there, one can easily imagine that it makes a difference if one packages and presents these pills in a medicine box, a sachet for sweets, a bowl of fruits or as a party drug. The idea is that, based on the presented packaging designs, the ethical implications of the technology can explicitly be discussed. The designs themselves serve as a so called boundary object [9] which makes multidisciplinary and multi-background communication easier. It is also easier to talk about something concrete than to present abstract thoughts. A principle that is adopted from other workshop formats like Lego Serious Play [10].

Figure 2. Miracle Berry tablets packaging (left) and an impression of the 'test material' of the workshop

To stimulate the discussion even more, the participants were asked to write down their initial thoughts on the product during the digesting (suck, not chew!) of the pills, answering the simple question "what am I doing?". From there the participants could start experiencing the effect with the aid of several more or less sour food products (Figure 2, right). To speed up the design process after the tasting session, the participants were then asked to make a word-spin (or mind-map) about the meaning of the pills, starting from the question "what is this pill about?".

The first time we ran the workshop with design educators, in which the participants had to fabricate their packaging designs to a presentable outcome within half an hour (Figure 3). A second run of the workshop with industrial design students was spread out over several days so there was more time to develop the packaging designs (Figure 4).

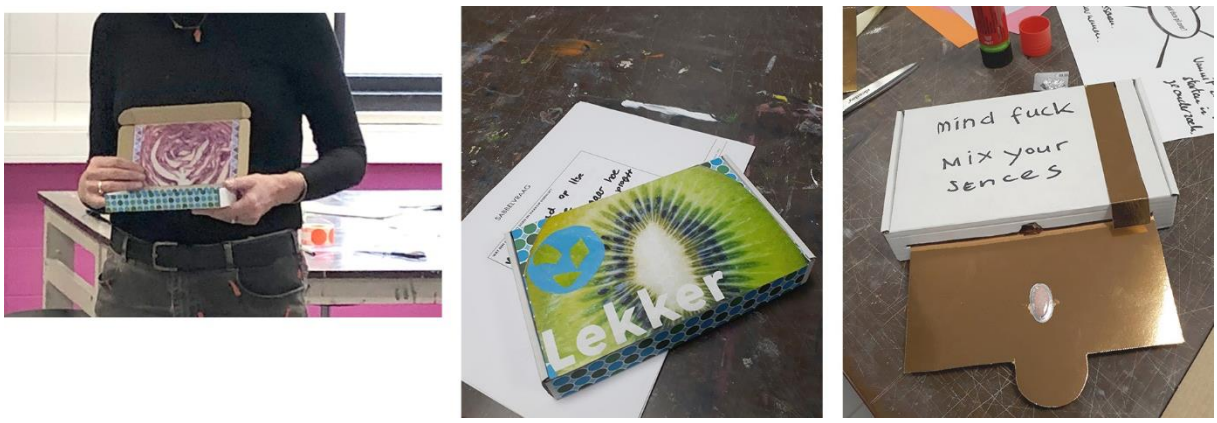

Figure 3. A participant pitching the prototyped packaging "lekker" [tasteful] which was supposed to help relieving starvation in underdeveloped countries. The "Mind Fuck" packaging presented a single pill as something special for an evenly special experience

Interestingly, the packaging proposals in figure three are very different in their approach and communication of the technology. Although the goals of the two proposals seem legitimate for the first packaging (relieving starvation) and rather gratuitous for the second one (have a fun experience), the related ethical reflection learns quite the opposite. Helping people in need that have little access to good food with sending them a means to eat bad food is rather doubtful. While providing people with a voluntary fun experience is not, and even better when the packaging is inhibiting overuse and addiction by providing only one pill.

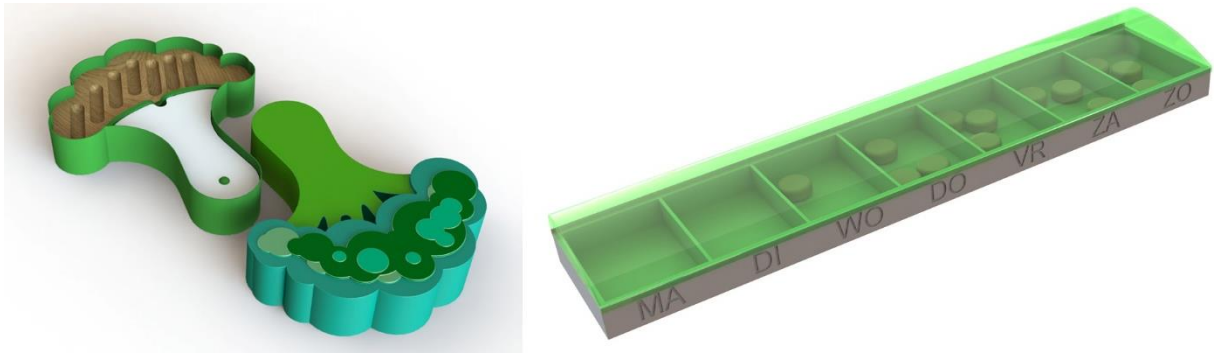

Figure 4. Two packaging designs from a three-day workshop. The broccoli shaped container is meant to aid children in eating healthy food. The other design was meant to help patients regain their taste after chemotherapy and was styled in a typical day-by-day medicine dispenser [by Jesper Cassiman, Ennis Jacobs, Yosse Claesen & David Florea]

The two packaging designs in Figure 4 are also ethically different. Not many people are inclined to disapprove with restoring a bodily function after being ill. The 'serious' medicine like packaging underlines this legitimacy of the goal. Otherwise, for a lot of people tricking children into eating something they do not want can be doubtful. Even when the end goal (healthier children) is definitely not. This unease can even be emphasised by the playful toy-like packaging design which is of course part of the trick.

All-in-all the miracle berries in the Wonderberry workshop were an excellent vehicle to demonstrate the all-encompassing ambiguity of technology. Insights from philosophy of technology deepened the reflection further. The miracle berries can for instance be linked to the ancient Greek concept of the Pharmakon, which can both mean "healing medicine" *and* "poison" [11]. Technologies do not simply have a well-defined function. What is actually the purpose of this strange thing, that makes sour taste sweet? All it does is convert, which reminds of a characterization of the technological by Bruno Latour [12] as that which bends, transforms, reverses an element in how all things connect to all other things in the world. That description differs from "functionality", as it does not refer to functionality for a well-defined purpose, but alludes to a change of direction, regardless of purpose, in any direction. Which again addresses the responsibility of the designer-engineer to consciously choose the *better* direction.

5 ETHICAL DELIBERATIONS

As said, the last important ingredient is to ask the right questions. This does not mean that there are also wrong questions, rather that there are specific questions that make explicit how the exercises from the workshop are linked to ethical deliberation. To show this we take a step back -or zoom out if you wish- to discuss the theoretical concepts that are underpinning our approach. We will limit ourselves to highlighting a few aspects, following up on the question how the approach on ethics and technology that we are specializing in does connect to engineering education. Our approach is about ethical reflection on the impact of technology. This means an intricate relation between ethical questioning and technology from the onset, in response to insight in the meaning and the effects of technology [13]. This approach is very clear in the Product Impact Tool[3] which offers an overview of concepts and examples for understanding the impact of technology on different levels, or in other words how technology is affecting us humans from all sides [14]. This tool is intended to be useful for analysing the effects of technologies, and to help to design for desired impact on society. We have used and tested this tool in industrial design education extensively, especially in the context of responsible design [15-17]. Within the Tech-Wise project we found that it also stimulates ethical deliberation about technologies [18, 19].
In order to offer a more accessible tool in which the connection between the impact and the ethics of technology is more upfront we have also developed a concise tool in the form of a short list of deliberation questions about means and ends. We called this the Ethical Readiness Check[4] to explicitly mention the term ethics, unlike the Product Impact Tool. The term ethical readiness further refers to Technological Readiness Levels, a concept that is widely used in engineering [20]. In this list of questions, means and ends form a scheme, clearly related to technology and to ethics, which is very simple and familiar in the basis. However, ultimately the relationships between means and ends, and between ethics and technology are very complex. Inspiration for this approach of using the familiar but rich scheme of means and ends stems from Bruno Latour [21] and Dietmar Hübner [22].
The Ethical Readiness Check consists essentially of two basic questions in terms of means and ends of a technical innovation: 1) Is the technology a means for a good end?; and 2) Is it the good means for the end? These two questions can then be unfolded and developed. For example: What is the goal? Are there conflicting goals and values? May there be an alternate goal, or something like a double agenda? Is the technical means effective and fitting for the goal? What are the actual effects of the technology? Are there also side effects, regardless the intentions? Maybe even counteracting to the initial goal? Or harming other goals that are also important? The last questions about the effects of technology can then be supported with the analysis of impacts through the beforementioned Product Impact Tool [14]. The Ethical Readiness Check in its turn makes the connection between impact and ethics more explicit.

6 DISCUSSIONS

For now, we have only tested the workshop format with a few technologies and a few engineering disciplines, however also with different levels of knowledge and experience. The results are interesting and inspiring although we need to expand the experience base to be conclusive about the effectivity. Especially evaluating whether the ingredients of the workshop are also sufficient for lecturers without a background in ethics. Several important insights already came to the fore though; firstly, actually writing down of thoughts in templates is important to govern the progress in reflecting and deliberation. Secondly, starting the discussion actively as facilitator of the workshop is still necessary, otherwise an attitude of ‘solving the problem’ that is so ingrained in the character of engineers can easily prevail.

7 CONCLUSIONS

The experiences from the workshop show that with this carefully chosen combination of engaging orientation on a specific ‘technology’ and concrete design exercise the ethical questions and subsequent deliberation and reflection can be very rich. Depending on the knowledge and interest of your students, these reflections can then be explicated with applicable tools and ethical theories.

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[3] (see www.productimpacttool.org)
[4] (see www.stevendorrestijn.nl/downloads/Ethical_Readiness_Check_concept.pdf)

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