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Reflecting on values in technological innovation through science fiction narrative mapping

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ABSTRACT

This practice paper explains how educators can use Sci-Fi narrative mapping to foster ethical reflection about values in technological innovations. The paper proposes Sci-Fi narrative mapping as a novel educational method combining embodied approaches with creative writing and group work. The paper explains how to deploy this method in an engineering ethics classroom and illustrates how this method was applied in two distinctive workshops – one with students and one with educators – and discusses the outcomes of the two workshops. The paper tackles the educational goals of this method, the theoretical background on which it relies, the limitations experienced thus far, the lessons learned from the two workshops, and possible extensions to other humanistic-informed courses in engineering education.

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*“You’re not a real explorer until you’ve lost your way.” –
Tove Jansson, A Comet in Moominland (1951)*

1 1. INTRODUCTION

1.1 How to foster ethical reflection concerning future technological innovations

Decisions about what technologies should be developed in the near future are riddled with unacknowledged moral value choices and political considerations (Winner, 1990). For example, to tackle the fallout from climate change, should humanity develop flights to Mars or underground bunkers to shield us from solar radiation? Both options are technical solutions to a societal problem, yet both have different value choices embedded in them by the implicit selection of stakeholders whose needs are to be prioritised. Regardless of whether the technological innovation is part of a governmental strategy or if it emerges from a network of commercial actors competing, engineers will be part and parcel of that decision process. While engineers are often asked to weigh in on the efficiency and feasibility of a solution through their technical advice, engineers should also have informed opinion about the societal desirability of the technical innovation and its ethical implications (van de Poel & Royakkers, 2011). This means that ethics educators need to foster and focus on those ethical skills that will help future engineers not only decide on current moral problems, but also on the future directions at stake when developing a new technology. Ethics scholarship has been arguing for several decades now that engineering education needs to contain ethical training at its core (Bucciarelli, 2008), to prepare future engineers for these kinds of decision-making moments in which they can play an essential role. However, the current ethics education in engineering curricula is predominantly focused on analysing existing technologies and past disaster cases (Martin et al., 2021; York and Conley, 2020, p. 2989).

To handle the problem of deciding which future innovations a society should pursue, engineering ethics education also needs to prepare students with the skills of value detection, such as identifying value choices and trade-offs when a novel technology is still in the planning phase and yet to be developed. Ethical skills targeting anticipation and future scenarios are not clearly fostered in the ethics classrooms (van Grunsven et al., 2023), yet these future-oriented ethical analysis skills would be most valuable to prepare students for the uncertainty inherent in the future, as pointed out by (York and Conley, 2020, p. 2986). Such skills would enable and “provoke consideration of how critical uncertainties may affect the future, and thereby broaden perspectives, challenge assumptions, and highlight hidden dangers and opportunities” (Biggs et al., 2010, p.268). Hence the question that this paper aims to answer through a practical exercise: Which pedagogical approaches would be suited to train students in envisioning values concerning future technologies?

Analysing how ethical and societal values emerge or are subverted in a technological artefact has been successfully achieved through methods such as Value Sensitive Design (Friedman et al., 2001) or Design for values (van den Hoven

et al., 2015) in engineering and technical education. These methods are pedagogically sound and can effectively help students reflect on the values embedded in a technology (Gammon et al., 2024). However, when it comes to the innovation stage of a possible technology, there is no method in engineering ethics education because it is more challenging to analyse possible values in technological innovation's planning and envisioning phase when no actual design is in sight (York and Conley, 2020). Reflecting on values in the envisioning phase of technological innovation, we are merely dealing with possible scenarios. Yet reflection on ethical and societal values is important at this stage of innovation, and it matters whether the engineers called to innovate are trained in spotting the values at stake in future and imaginary scenarios. Training for these skills requires the development of moral imagination and moral sensitivity, systematically developed in education (Coeckelbergh, 2010; Frey, 2015; Umbrello, 2020; Martin et al., 2021).

1.2 The role of narrative imagination in fostering moral imagination about future innovations

The aim of this paper is to explore the potential of a pedagogical method that allows instructors to foster the moral imagination and moral sensitivity of engineering students in relation to moral values in concerning a future technology. Moral imagination has been defined as “our capacity to empathically understand and feel with others and our ability to imagine how experience would play out under the shaping influence of various values and choices” (Johnson, 2016). While we all have the capacity to imagine experiences and feelings, some of us have this ability more developed than others, for example, artists. Hence engaging with works of art should expand our imagination in the long term, as Martha Nussbaum hypothesised. Nussbaum coined the term “narrative imagination” to designate the human capacity to understand “what it might be like in the shoes of a person different from oneself, to be an intelligent reader of that person’s story, and to understand the emotions and wishes and desires that someone so placed might have” (Nussbaum, 1998, pp. 10–11). Both Johnson and Nussbaum focus on imagination as an act of individual projection and estimation of possible emotions and reasons. Yet this kind of individual focused imagination is not of much use in technological innovation since innovators need to imagine possible future scenarios unleashed by technology and how these would play out at a societal level. For the moral imagination entailed in technological innovation, we need both narrative skills and moral sensitivity about values, with a primarily societal focus. Hence, we need to teach those skills that enable students to imagine how societies might feel and react to future technological scenarios.

This paper describes the deployment of a pedagogical exercise intended to foster moral imagination in relation to technological innovation by using narrative techniques. In designing this exercise, I drew inspiration on how to use science fiction narratives in engineering education from the previous work of Miller and Bennett (2008), who used science fiction scenarios in technological assessment with the goal of improving participants’ imagination. While in Nussbaum’s work, narrative imagination is fostered by reading a work of fiction, here the attempt was to engage students’ narrative imagination in a creative mode, through science-fiction scenario mapping. However, the narrative imagination is not stirred alone by the act of writing or planning a sci-fi scenario but rather by the process of discussing this scenario with

other people. In dialogical engagement with others, one is confronted with the limitations and biases of one’s imagination and then becomes aware of others’ perspectives. The main hypothesis in developing the exercise was that fostering narrative imagination through a collective scenario mapping exercise will expand students’ moral imagination regarding technological innovation. This hypothesis can be broken down into several sub-hypotheses:

- a) that developing sci-fi scenarios about a technology relies heavily on deploying moral imagination;
 - b) that debating in a small group the scenario with one’s team-mates should refine one’s moral imagination by confronting one with another’s perspective about values and morality;
 - c) that designing the storyline by using embodied pedagogy techniques (van Grunsven et al., 2024), such as visual story-line mapping, dialogue, and drawing cards with instructions throughout the exercise, will create obstacles and challenges for the participants, making them focus primarily on the story rather than the values at stake, thus hoping that the story will emerge with its value reflections embedded organically in it, rather than having the values planned from the start.
- With these hypotheses in mind, the pedagogical exercise was developed and deployed in two separate workshops, which will be described in the next section.

2 CONTEXT AND PRACTICAL WORK

2.1 Aims of the exercise and learning goals

The pedagogical goal baked into the exercise was to foster reflection on technological innovation and the societal impact of technology, including the societal and ethical values of a particular technology. By asking students to focus on developing a sci-fi scenario, concerns about feasibility and prudential risks are bypassed, thus moving into the speculative realm of what could be, hence into an ethics of the possible. The learning goals of the activity were: a) fostering ethical reflection about values in technological innovation, b) identification of ethical values in speculative scenarios, c) fostering teamwork and communication skills through collaborative teamwork, and, d) showcasing moral imagination about technology through the development of a fictional storyline that is novel.

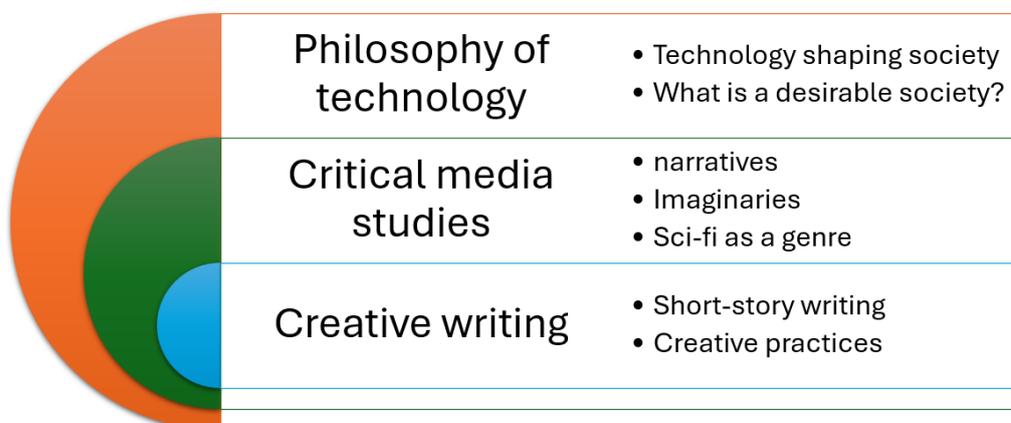


Figure 1 Interdisciplinary questions and concepts that informed the design of the exercise

The exercise was set up in an interdisciplinary way, drawing from three disciplines – as shown in Figure 1: philosophy of technology (including ethics, value-sensitive design, responsible research and innovation), creative writing (literary studies), and

critical media studies (using previous knowledge about science fiction as a genre and its constraints). In addition, the educational set-up was informed by embodied education approaches in engineering ethics education (van Grunsven et al., 2024).

2.2 Exercise design and first workshop set-up

The sci-fi storyline mapping exercise was designed as a hands-on group-based activity lasting approximately 90 minutes. All the students (in this case, 19 students in total) are divided into small groups (3-4 persons) and asked to draft the plot of a science fiction story through a guided step-by-step activity. The students are not asked to write the text of the story as such, only the main plot points that one could use later, to write the whole story.

The exercise was deployed in two separate workshops with different participants: the first workshop was deployed in a tutorial, as part of an elective course, for master's level students at a technological university, and the second workshop used the same exercise with engineering educators while adapting some elements for the educator's needs. The exercise will be briefly described below as it has already been published on an open education resources portal¹; the open-source published exercise explains in detail step by step the exercise set-up and can be used by any educator in their classes without any prior knowledge about creative writing or sci-fi narratives needed. The exercise steps are explained here in a way that does not rely on the external resource cited above.

Step 1: Students are introduced to the workshop aims and are asked to divide into small groups (3-4 persons) and sit at tables. On each table, the group has a big sheet of paper to draw on, markers, and Post-its. They will work on a large sheet of paper to diagram their storyline (in class, we used two A3 sheets glued together to make a larger A2 format).

Step 2: A representative of each group is asked to draw a card from a deck of cards with inciting incidents. In Table 1 are some examples of the cards drawn from the deck (all the cards are listed in the linked exercise):

Table 1 Inciting incident cards samples (a total of 10 cards were provided)

<p>“As we opened the hatch of our shuttle pod, we realized that the planet had oxygen atmosphere. Behind a rock, we saw something startle and move”</p>	<p>“Last night, the solar panels were hit by a meteor shower. As we woke up, we noticed that the battery pack was almost depleted. We had 3 hours before we lost all power to our shuttle en route to Pluto.”</p>
<p>“First contact with an alien species was never in our training. Yet here we were, facing a species that had 10 senses and 17 ways of expressing emotions. We had to find a way to make them understand us.”</p>	<p>“It's been 10 years, 2 months and 5 days since all electrical grids on Earth completely fried up. In spite of all attempts to restore electricity, nobody had managed to re-create an electrical spark, that is until today.”</p>

Step 3: The groups are asked to use the card they drew to map the main events in their sci-fi story, starting from this inciting incident. Each group works on a different storyline, starting from a different inciting incident card.

¹ <https://edusources.nl/materials/eee79e8a-5456-403d-9e5d-fba2f9686f72>

of the workshop, and later, in a survey three weeks after the exercise was deployed. The purpose of the survey was to see the long-term effects of the exercise, for example, if students used the insights in their own stories or if they remembered the exercise.

In the immediate assessment by the instructor leading the workshop, several findings were most salient when the student groups discussed the storylines they had drafted. First, the notion of a desirable ending concerning the value at hand was mainly misunderstood, as most groups drafted happy endings for all the characters involved in their stories. For the next iterations, the notion of a desirable ending needs to be explained more clearly. Similarly, the undesirable ending was primarily about the characters in the story – they all die – and it did not involve the value as was intended. The values were embedded in the storylines in some key moments but not in the three endings. Sometimes, the meaning of the values on the cards was misunderstood; for example, one group thought that human well-being is wellness (as in going to a spa kind of wellness). Hence, the next time the exercise is deployed, the value cards should also briefly define the value at stake. The stories drafted in this first workshop were interesting and showcased that students understood what a plot twist is, they took some time to carefully draft the characters in the story, ultimately showcasing a writerly approach. However, because the cards with the value and the emotion disrupted their thinking process, the stories drafted were not as continuous as if the groups were asked to draft them without interruptions. The card drawing was meant to disrupt their thinking and introduce ethical considerations. However, it also disrupted the storylines, as the students wrote the next action in their story as including the emotion or the value selected. Simply put, the value was not deeply embedded in the storyline; it appeared at a key moment but was then forgotten. A lesson learned to be applied for the next iteration is that the value card and the emotion card should be drawn at the same time as the inciting incident card. Having all three cards in front of them from the beginning, the student groups can draft the story without interruptions and probably embed the value and emotion more organically. However, if this alternation of the exercise will happen in the subsequent iterations, then the exercise designer needs to find other ways of making the exercise embodied and interactive.

Longer term assessment. In the student survey three weeks after the course ended, only one student explicitly mentioned this exercise and offered ideas for future iterations: the student commented on the set-up of the exercise as offering too much information to the students, having too many steps, hence too many decisions to take, while not giving enough time to reflect on the story they were crafting. This insight also reflects the atmosphere in the classroom during the tutorial with the workshop: somewhat chaotic, with many things going on in different groups simultaneously. Considering the students' observations in the survey and the instructors' observations, offering fewer instructions and all the cards at the beginning should help the student groups stay in the writing flow longer. The exercise was by design kept outside the assessment part of the course, to make the participants feel free in their imaginative endeavours. The exercise was assessed holistically, in the context of the entire course, assuming an ecological cognition approach to fostering skills (Coppola et al., 2024).

3.2 Second workshop outcomes (educators' workshop)

A month later, the same exercise was deployed in a workshop held with educators and instructors. The workshop's theme was "Education 2050", and the primary aim was to foster visions and reflections about the future of education. Hence, the participants in this workshop were unfamiliar with the creative writing techniques, and their knowledge of the sci-fi genre was also not something that could be used. To modify the exercise for this group of participants and for the different learning outcomes, the inciting incident prompt cards were modified, and some examples of prompt cards are mentioned in Table 2 below.

Table 2 Inciting incident cards for the educator's workshop

<p>It is 2050 and half of the Netherlands is under constant flooding, making people move up East. A team of societal and engineering stakeholders gathers to find a long-term plan for technical education in this uncertain world.</p>	<p>It is 2050 and most cognitive work has been delegated to AI and LLMs (such as coding, data analysis, product design, modeling of problems). A group of societal stakeholders gathers to decide what should be taught at the 4 technical universities in the Netherlands such that the education will not be rendered obsolete by future AI developments.</p>
<p>It is 2025, the universities have become the example in the Netherlands as socially safe and human friendly environments. What other kinds of things happen there?</p>	<p>It is 2050 and the universities are the centers for innovation and development fully supported by the government, 100% integrated with industry and government with the knowledge agenda. What other kinds of things happen there?</p>

Except for the prompt cards, the steps of the exercise were the same. The workshop leader concluded that the stories drafted by the four groups of participants were highly original and coherent (see Figure 3 for samples). The values embedded in the storylines were also effectively embedded in the three possible endings. Overall, the workshop was experienced as successful by everyone involved, as it fostered a rich collective reflection about the future of education and the values we want to secure in this future. In this collective reflective discussion after the workshop, the echoes of the stories were visible in the discussion, leading to a preliminary conclusion that priming one's narrative imagination before the actual debate does lead to rich discussions and more explorative. To explain why this workshop was more successful than the student workshop, one hypothesis of the workshop convenor was the participants' level of maturity and experience. All participants were educators and instructors with some experience in engineering education, and the questions and situations on the prompt cards were quite relevant to their own work.

4 CONCLUSIONS AND IMPLICATIONS

4.1 Adaptability and impact

As shown by the second deployment of the exercise in the educators' workshop, this exercise is highly adaptable to other educational contexts if the inciting incident

cards are adapted to the topic at hand. The instructors may choose to develop different cards with inciting incidents relating to a specific issue of concern, or they can choose a select set of values to focus on. The exercise can be deployed in any class that aims to foster a discussion about the values embedded in a particular technology, even if the participants are not familiar with creative writing techniques or with the constraints of the sci-fi genre. In addition, the exercise can be adapted for online environments, by asking the teams to work collaboratively on a white board or a canvas. Furthermore, the exercise is well suited to foster interdisciplinary discussions around an issue of concern that would ask people from various disciplines to come together and reflect on what they see as desirable futures. One example of this interdisciplinary application is when discussing socio-technical systems: how should we imagine future health systems, how should resilient cities be planned for imagining a window of 100 years from now on? In these discussions, not only engineers, but urban planners, policy experts, governance specialists and managers of technology can weigh in. An inherent constraint of this exercise is the assumption of a common cultural background which is spelled out in how participants understand what is sci fi and story mapping. For example, in Chinese culture, the classical plot structure has a different shape than in Western-based fiction and having participants from a variety of cultures working on the same story may give rise to misunderstandings about what counts as a literary plot, but this should also be seen as an additional occasion for reflection and insight. The impact of the exercise needs to be more systematically measured in future deployments, as previous iterations were unsystematic, relying on the instructors' observations and the student feedback in surveys.

4.2 Future iterations and variations

The exercise works well to start an engaging discussion in class by using the crafted sci-fi storylines as a starting point for value scenarios about the technological futures. However, based on the feedback received from participants, two changes will be made to make it more effective in fostering narrative and moral imagination. One change is to ask students to draft some storylines individually before class and then ask them in groups to workshop these storylines and debate the possible and desirable paths that the story should take. The creative flow should remain undisturbed in this iteration, while the workshop time in class will be used for the in-group ethical reflection about the stories previously developed. In another envisioned iteration, this exercise can be made more embodied by bringing in objects (such as Lego blocks and small trinkets) to stand for and symbolise the characters and their path in the story. By making the story more tangible, the hope is to give rise to alternative ways of imagining the story outcomes. These future iterations and the two variations will be explored in future classes and workshops that the author of this paper will organise. A more rigorous assessment of the exercise outcomes needs to be designed and implemented in these future iterations, by using a triangulation approach (pre- and post-workshop surveys, participant in depth interviews, ethnographic observations, and peer feedback on other's storylines).

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