Prometheus Challenge: An Ethics Training for Engineering Students

Seddik Benlaksira, Chloé Bonifas, Ambre Davat, Louis Devillaine, Sofía Claudia Durán Cárdenas, Marc Tilly, Thierry Ménissier, Yvan Pigeonnat

PROMETHEUS CHALLENGE: AN ETHICS TRAINING FOR ENGINEERING STUDENTS

S. Benlaksira[1,4], C. Bonifas[2,4], A. Davat[1,4], L. Devillaine[3,4], C.S. Duran-Cardenas[2], M. Tilly[2], T. Ménissier[2,4], Y. Pigeonnat[5]

[1]GRESEC, Grenoble Alpes University, Grenoble, France

[2]IPHIG, Grenoble Alpes University, Grenoble, France

[3]PACTE, Grenoble Alpes University, Grenoble, France

[4]Ethics&AI Chair, Multidisciplinary Institute in Artificial Intelligence (MIAI), Grenoble Alpes University, Grenoble, France

[5]PERFORM, Grenoble INP, Grenoble France

Conference Key Areas*: Engineering ethics education, Educating the whole engineer: teaching through and for knowing, thinking, feeling and doing*

Keywords*: ethics, active teaching, creativity*

ABSTRACT

Science and technology have the potential to profoundly transform societies. Employed within a logic of innovation, they disrupt the reference points and values needed to judge and act. This raises several ethical risks, notably the inability to know clearly whether a specific process or technical invention will raise moral issues. Because of their involvement in the design of new technologies, engineers of all specialties are the first to be exposed to this disturbing and unpleasant situation. It therefore seems essential to develop ethics training programs for this specific audience. The Prometheus Challenge is one such proposal. Inspired by the methods of active and creative pedagogy, this two-days training aims to develop awareness of ethical issues, reflexivity, and autonomy in judgment. It also fosters the ability to formulate appropriate ethical assessments of science and technology problems through collective debate. It has already been tested with four groups of students from several engineering schools in Grenoble (October 2022 and February 2024). The

Corresponding author
T. Ménissier
thierry.menissier@univ-grenoble-alpes.fr

feedback from students and facilitators is mostly positive. They praise the interdisciplinarity made possible by the mix of students from different backgrounds and the presence of various facilitators trained in ethics. They also appreciate the alternation between theoretical content and debate time, that raises awareness about ethical issues and allows them to reflect on their future engineering profession.

1 INTRODUCTION

Ethics is recognized both as a graduate attribute and a professional competence in the ENAEE (European Network for Accreditation of Engineering Education) and IEA (International Engineering Alliance) guidelines, which represent engineers in 35 countries globally. Indeed, teaching engineers about ethics is crucial for several reasons. First, choices relating to sciences, technologies, and public policies must be ethically justified, i.e. by considering socially accepted and defensible values in the context of public debate. Second, the favorable image of positivist rationalism, which has prevailed since the nineteenth century, is now in decline. Trust in science and technology is being challenged due to past industrial disasters and reactions to the current environmental crisis. This public distrust is also reinforced by the fact that engineering is often subject to a logic of productivity and profitability, relegating ethics to the background. Finally, the continuous technological innovation disrupts uses and ethical points of reference that are needed to judge and act. This raises questions about the practical application of ethics by scientists and engineers. Hence, it seems essential to propose ethics training specifically adapted to these professions and integrated into their training curriculum. This is the goal of the Prometheus Challenge, a teaching method invented by Prof. Thierry Ménissier (philosophy, Université Grenoble Alpes) (Ménissier 2022).

Based on an active and creative pedagogical approach, the Prometheus Challenge aims to develop awareness of ethical issues, reflection, autonomy of judgement, and the ability to formulate appropriate ethical evaluations for the problems posed by the design and use of technologies through collective debate. It also aims to provide philosophical knowledges adapted to current ethical issues and moral dilemmas encountered in the different fields of science and engineering.

By invoking the name Prometheus, we wish to express that today’s engineering students potentially find themselves in the situation experienced by the titan of Greek mythology. This legend is related by Hesiod in his Theogony: Prometheus gave fire to humans after stealing it from the Olympian gods. This present, fire, the symbol of technical intelligence, turns out to be ambivalent. While it is an effective means of transforming matter, it is also potentially destructive and dangerous if left unchecked. Moreover, the myth tells us that the possession of fire carries the risk of fostering what the ancient Greeks called hubris: a propensity for excess and violence, which can lead to uncontrolled and potentially destructive behavior for the individual and society. The myth of Prometheus therefore seems to contain a warning about the dangers associated with the use of technology and the risks inherent in its advances. The exploitation of technical tools, the acquisition and domination of technical knowledge, as well as the development of technological and scientific power, represent major challenges for humans. Some psychoanalysts even go so far as to speak of a deep and insurmountable guilt, described as "Promethean guilt" (Azar 2015). This myth has resurfaced in popular culture with remarkable force, recurrence and fecundity, whether through novels since Mary Shelley's "Modern Prometheus" (Shelley 1818), or more

recently in mainstream films, such as the Prometheus of Ridley Scott in 2012. These numerous revivals reflect the importance of the myth of Prometheus for our time. Today's scientists and engineers are faced with the challenge of mastering powerful science and technology, with effects that are often ambiguous and potentially disturbing for society and nature.

In this article, we wish to present the context and method of this training. Then, we will analyze the sessions organized up to now to reflect on how best to promote ethics training in the scientific and engineering community.

2 BACKGROUND

The Grenoble area is a major center for research and innovation, sometimes referred to as "Europe's Silicon Valley". It boasts numerous cutting-edge infrastructures, including the European Synchrotron Radiation Facility. Grenoble Alpes University is also a major center for technical and scientific training. In particular, it is home to the Grenoble Polytechnic Institute (Grenoble INP), which groups together 7 engineering schools and 1 management school. Including the integrated preparatory cycles, Grenoble INP welcomes over 8,000 students and awards around 1,500 engineering diplomas per year.

In 2022 et 2024, Grenoble INP organized the Kaleidoscope week: an event meant to bring together students from different schools during several educational workshops. Each student had the opportunity to choose from about fifty different activities, including the Prometheus Challenge. This challenge was proposed and supervised by members of the Ethics & AI chair of the MIAI Institute (Multidisciplinary Institute in Artificial Intelligence), one of the 3 French research institutes in artificial intelligence. We also relied on the tools and methods developed by Promising, the pedagogy and creative thinking department of the university.

3 THEORETICAL AND METHODOLOGICAL FRAMEWORK

3.1 Theories at the service of practice

The Prometheus Challenge is scheduled to last 2 days. It is divided into a series of nine modules, listed in Table 1. Its purpose is to make students practice ethics. It is based on an active problem-solving pedagogy where theory is necessarily linked to practice.

The training begins with workshops to raise student's awareness of the ethical issues associated with engineering professions (modules 1 to 4). During module 5, we present four distinct forms of reasoning used to address moral problems[2] : Kantian deontologism, Bentham's utilitarianism, Aristotelian virtue ethics and axiology. After a short presentation of these forms of reasoning, students are invited to implement them on a topic of their choice to test their differences and limitations. The choice of these theoretical currents responds to a methodological concern: since ethics is not an absolute value and ethical judgments may vary, we choose to appeal to different

[2] Deontologism, Utilitarianism and Virtue ethics are the normative ethics theories more commonly studied, see (Billier 2014) or (Downs 2012). Axiology (theory of values) was added, since it is particularly well suited to tackling ethical challenges.

schools to account for the different possibilities of reasoning. The Prometheus Challenge thus demonstrates an assumed eclecticism.

In addition to the four forms of reasoning mentioned, two theoretical elements that are particularly important for ethical reflection are also mentioned: the notion of responsibility and that of value. The notion of responsibility is introduced through the figures of Prometheus, then that of Frankenstein (introduction to the challenge and module 3), to raise the consequences of actions undertaken in the name of technology and science. Indeed, these two literary figures open the door to a reflection on the anticipation of rebound effects and the long-term perspective of the practice. Then, the work on values (modules 6 and 7) allows us to return to the foundations of philosophical reflection on morality and its norms. Values, which are strongly rooted in culture, are intuitively mobilized to address morally problematic situations. A work of reflection on values, justification, and hierarchy allows us to take a step back from this intuitive level, to register on a critical level (according to Richard Hare's distinction (Hare 2017)) and thus refine the ability to make ethical judgments.

Table 1. Modules' descriptions

Modules	**Description of the activities carried out by the students**	**Duration**
Identify ethical situations and make recommendations		
1) Ethical risks	Choose a technology that raises risks. Identify those that fall under ethics. Formulate recommendations to mitigate these risks.	30 min
2) Cases of conscience	Imagine an example of an ethical dilemma that an engineer may face. Describe possible solutions.	30 min
3) Frankenstein's responsibility	Identify examples in history or current events of rebound effects that are harmful or dangerous for humanity. Formulate recommendations to frame/regulate these effects.	30 min
Imagining desirable futures		
4) Utopia or dystopia	Using a recent (or future) technology, imagine an ideal society. Represent it graphically.	1h-1h30
Enriching Ethical Reasoning		
5) Ethics beyond utilitarianism	Analyze the dilemmas identified above from the perspective of different forms of ethical reasoning (utilitarianism, deontologism, aretaism, axiologism)	1h30-2h
Reflect on the ethics of your profession		
6) Engineer's values	Identify a list of values that can be claimed by engineers.	45 min
7) Value cards	Depict the most important value(s).	45 min
8) Engineer's oath	Prepare a solemn declaration committing to respect the above values.	1h-2h
9) What's next?	Imagine what actions can be implemented at the end of the training.	30 min

3.2 An active and creative pedagogy

The pedagogical challenge of this training is to transmit knowledge in ethics that can be used to address complex situations. To achieve this, we rely on an active pedagogy based on creativity and emotion. We take into account the three strategies proposed by (Vanpee, Godin, et Lebrun 2008) for implementing active teaching in large group: 1) placing the student in an active situation based on global and complex tasks; 2) splitting up the groups; 3) encouraging the transfer of learning by implementing contextualized teaching. Each theoretical content is followed by group application exercises, based on concrete cases proposed by the facilitators and by the students. The modules on ethical risks and cases of conscience (modules 1 and 2) allow a step back on the social dimension of the engineering profession, particularly concerning technological innovation. Then, the participants are engaged in a reflection on the potential unforeseen rebound effects related to scientific development (module 3), and next to formulate ethical assessment, based on the work on values (modules 6 and 7).

This teaching strategy aims to include the three main factors that encourage student commitment, acording to (Viau 2009). First, a sense of value of the activity is created by contextualising it to the students' future profession. The second factor is controllability, which refers to the potential control that students have over the course of the activities proposed to them. Since the students themselves choose the subjects on which they work, the sense of controllability is very high in the Prometheus Challenge. The final factor is the sense of competence to complete a task, which is facilitated by providing them with the key elements (theoretical content, support) so that they can carry out the activities required.

In this way, students are led to develop reasoned points of view that are subject to a rational, collective and supervised discussion. Here, the role of facilitators is essential. They are responsible for guiding discussions during the group reflection process and then in plenary. This follow-up makes it possible to clarify the theoretical elements covered and to highlight the students' mode of reasoning. Facilitators must then be able to adapt their knowledge of ethics to the problems proposed by the participants during the workshops.

In addition, the Prometheus Challenge calls for creativity, assessment, and emotion to promote ethical sensitivity and the appropriation of theoretical concepts. Creativity and assessment are at the top of Bloom's taxonomy of educational objectives, because they foster learning that lasts (Anderson et Krathwohl 2001). Emotion is also an important variable in the learning process (Puozzo 2013) since there is a "close relationship between the content of an idea and the affective dimension to which it is attached" (*Ibid.*). In the case of the Prometheus Challenge, a real work on emotion is required from all the participants. From the very beginning of the training, the facilitators have to create an atmosphere that makes students willing to work collectively, to listen and to be open to each other. Since the participants don't know each other, each half-day starts with a few minutes of warm-up and ice-breaker activities. The body is engaged by vocal exercises or by movements where the awareness of others is important (for example: walk in a defined area and follow changes of pace).

Regarding the content, the modules are introduced with mythical narratives, literary and historical references with strong symbolism, to question the engineering profession, its potentials, and its risks. Group exercises seek to deepen this emotional work, engaging the creativity of the students. It is also an opportunity for them to engage in activities that are rarely present in their usual curriculum, such as drawing or theatrical performance. In particular, the modules on utopia (module 4), values (module 6-7) and engineer's oath (module 8) lead students to imagine the potential of their profession, as well as the possible contributions they can make, by giving free rein to their imagination. Examples of their creations are showed in Figure 1.

Fig. 1 Examples of student creative productions.
On the left, module 4 (utopia). On the right, module 7 (value cards).

4 RESULTS

For its first edition at Kaleidoscope Week (October 2022), the Prometheus Challenge took place over two sessions, with a total of 175 participants. In February 2024, the second edition took place, with 53 participants also spread over two sessions[3]. We collected the participants' feedback over the two years through an online survey filled at the end of the training (module 9). The first part of the survey contains several closed-ended questions regarding the session of the challenge, school of the student and overall assessment. The second part of the survey consists of three open-ended questions: strengths of the training, weaknesses, and suggestions for improvement.
We received 107 responses in 2022 and 46 responses in 2024. There are no substantial differences between the first and second editions, nor according to the schools from which the participants come from.

The overall assessment of the activity is positive, with an average of 4.4/6, on a scale where 4 corresponds to "satisfactory" and 5 corresponds to "very satisfactory" (see Figure 2). Among the strengths identified by the respondents in both parts of the survey, we can mention the plurality of the discussions (favorized by the instruction to create groups between students from different backgrounds), as well as the balance between theory and practical work.

[3] This year we see a lower number of students, partly because in 2022 several schools have asked their students to choose an activity on ethics. This year it was no longer the case.

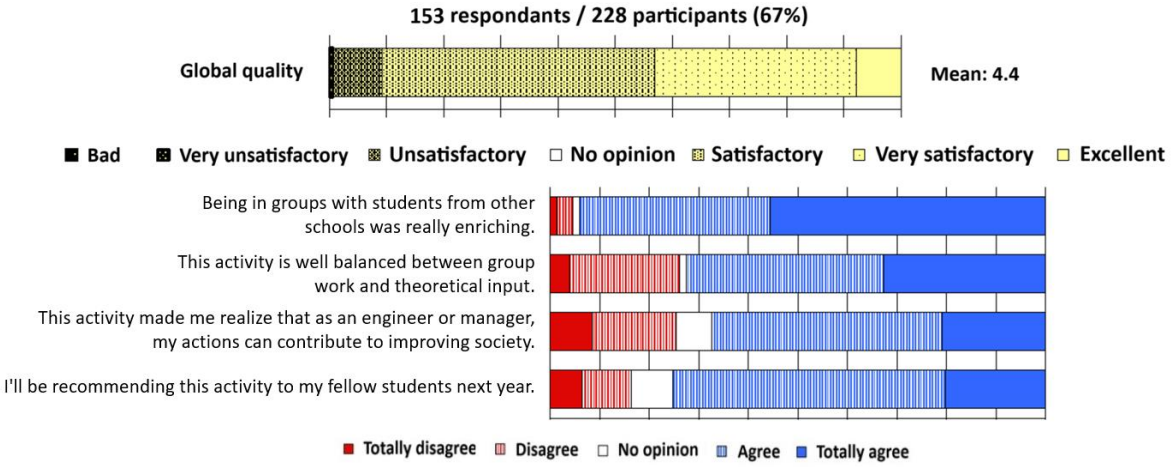

Fig 2. Student survey results (2022 and 2024)

While answering the open-ended questions, the students mentioned four other positive aspects: the theoretical contributions in philosophy (9 mentions for the year 2024, out of 46 responses); the role played by the facilitators (7 mentions in 2024), whose relevance of their interventions and varied backgrounds are appreciated ("supervisors who get out of the habit", "Interventions by philosophy professors"), as well as reflexivity on the engineering profession ("open-mindedness and reflection on our future actions") and the pedagogical approach integrating collective debates.

These elements seem significant, since they are then found in the participants' proposals. For the 2024 session, 7 people expressed that they would have appreciated more theoretical or philosophical elements. In addition, the role of the speakers is also mentioned 7 times in 2024, but this time concerning their support for the groups and their feedback on the activities carried out, as a point to improve or a weak point ("Make more visits to the groups"). These remarks seem to us to underline the involvement of the students in the exercises. In 2024, 4 students proposed to increase debate times.

Overall, the pedagogical objectives seem to have been achieved. We interpret the requests of some participants for more philosophical content and time for debates as a proof of success in raising awareness of ethical issues. Exchanges within each group and plenary discussions allowed us to see an appropriation of the theoretical content. Among the points for improvement, we recognize the importance of strengthening exchanges between student groups, an important moment for clarifying the ethical concepts.

5 CONCLUSION

Active pedagogy is the key to success for the Prometheus Challenge. By alternating the transmission of theoretical knowledge with practical collective work, in a creative and welcoming atmosphere, it allows an open-mindedness that is conducive to ethical reflexivity. The challenge is experienced by the participants as an enrichment and a valuable opportunity to reflect on their future engineering practices. The post-

challenge survey analysis shows their engagement and satisfaction. It must be underlined that the role of facilitators is crucial. While transmitting philosophical theories, they must continuously adapt to the participants by clarifying the concepts to their understanding and integrating their topics of concerns, thus strengthening their involvement and interest in the challenge.

The Prometheus Challenge places animation at the heart of its innovative pedagogy by offering a continuous and complete training process to participants. After completing the training, each participant has the possibility to become a facilitator. To obtain the facilitator certification, a candidate needs to participate in a 6-hour preparation seminar and to accompany a complete cycle of the challenge as a co-facilitator. They can then join the team of facilitators, a think tank that contributes to improve the challenge, exchange best practices, and develop their skills in ethics. This ongoing training process ensures respect for the values of democratic inclusion defended by the first creator of the challenge. It also promotes the renewal of the team of facilitators, whose expansion and diversification allow to reach an increasingly wider public.

Although originally proposed for engineers, the Prometheus Challenge has been designed to be easily adapted to other audiences. A double transformation can be carried out: the modification of the initial myth and the choice of suitable examples, without upsetting the order of the modules. A version for management students could be based on the myth of Midas, which describes the curse that befalls the ruler of Phrygia, punished by Dionysus for wanting to accumulate too much money. A version oriented towards environmental ethics has been tested and named by the students from the myth of Persephone, which evokes the regular return of the seasons. In these modifications, the initial myth plays the same role as that of Prometheus: to provide an imaginative and emotional basis that engages the participants in ethical reflection.

REFERENCES

Anderson, Lorin W., and David R. Krathwohl. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives: complete edition*. Addison Wesley Longman, Inc, 2001.

Azar, Amine. 2015. "Trois sources de la culpabilité : surmoïque, œdipienne et prométhéenne". *Ashtaroût, bulletin volant n° 2015·0303*, mars. https://www.academia.edu/11295107/Trois_sources_de_la_culpabilit%C3%A9_surmo%C3%AFque_%C5%93dipienne_and_prom%C3%A9th%C3%A9enne_version_remani%C3%A9e_.

Billier, Jean-Cassien. *Introduction à l'éthique*. Paris : Presses Universitaires de France, 2014. https://www.cairn.info/introduction-a-l-ethique--9782130632610.htm.

Downs, Jennifer. "A Brief History of Ethics". *Ethics in Forensic Science*, 2012, 1-25. Oxford: Elsevier.

Hare, Richard M. "Methods of bioethics: Some defective proposals". *Ethics and Medical Decision-Making*, 2017, 393-406. Routledge.

Ménissier, Thierry. *Challenge Prométhée. Une formation pratique à l'éthique pour les scientifiques et les ingénieur.es*. TheBookEdition, 2022.

Puozzo, Isabelle. "Pédagogie de la créativité : de l'émotion à l'apprentissage." *Éducation et socialisation*, nº 33 (juin 2013). https://doi.org/10.4000/edso.174.

Ridley, Scott. *Prometheus*. 2012.

Shelley, Mary Wollstonecraft. *Frankenstein; or, The Modern Prometheus*. 1818. https://gutenberg.org/ebooks/42324.

Vanpee, Dominique, Véronique Godin, and Marcel Lebrun. "Améliorer l'enseignement en grands groupes à la lumière de quelques principes de pédagogie active." *Pédagogie médicale,* 2008, 32-41.

Viau, Rolland. *La motivation en contexte scolaire (6e édition)*. De Boeck Supérieur, 2009.