Working-life ethical issues faced by engineers

Ulla-Talvikki Virta

Tampere University

Finland

ORCID 0000-0001-5224-3504

Hannu-Matti Järvinen

Tampere University

Finland

ORCID 0000-0003-0047-2051

ABSTRACT

In recent years, there have been public discussions about novel ethical issues emerging from new engineering fields, such as the usage of artificial intelligence. While those are important issues to discuss, they do not necessarily reflect the ethical issues engineers face in their work. In this paper, we discuss problems that engineers of different disciplines face in their professional life, based on a survey sent to members of the Association of Academic Engineers and Architects in Finland. From the 433 respondents, we received over 130 descriptions of ethical issues encountered within their professional lives.

We divided the encountered issues of the survey into two main categories: ethical issues about general work life and those on more engineering-specific situations. The focus of this paper is on the engineering specific ethical issues and the reactions they encounter. We discuss about who noticed the problems and how the workplaces reacted to the issues. In addition, it is addressed whether companies have policies in place to handle ethical issues. Furthermore, we discuss the types of support the engineers indicated hoping to receive from different stakeholders. On a larger scale, the goal is also to gather knowledge on how to improve engineering education to meet the needs of future engineers on ethical issues.

Conference Key areas: Sustainability and ethics. Engineering curriculum design.

Keywords: engineering ethics

1 INTRODUCTION

One of the learning goals of the curricula of our university includes that the students know the ethical norms of their field and can apply them in their work. This goal has not been addressed well in engineering curricula, i.e., the student may pass a curriculum without being exposed to ethical questions. For engineering education, the problem is that for students in engineering, ethics is not high in their interest. A compulsory course on ethics would formally fulfil the requirement, but not in terms of learning if it is the only time to discuss ethics-related issues. To be effective in ethics teaching, we have to know the real-world ethical problems of the engineering profession and embed ethical questions in teaching whenever relevant in the studies.

Meanwhile, there was an ongoing discussion in the Association of Academic Engineers and

Architects in Finland (TEK) about ethical issues. TEK had a Board of Honour to handle the ethical issues. During its existence, the Board adopted the idea of Archimedean Oath [1] and made a Finnish version of it. It organised some events and released publications related to ethics, but the members of TEK did not contact the Board regarding their problems. The Board members felt they were not fulfilling the purpose of the Board, and finally, the Board suggested its termination.

However, the Council of TEK felt the need for ethical discussion is needed more than ever before; it was only the form of the Board of Honour that was outdated. The importance of ethical issues was greatly motivated by the discussions emerging from new engineering fields, such as using artificial intelligence as part of engineering products: a simple search "ethical problems of artificial intelligence" produces about 160 million hits (3.5.2021). Further, the Council wanted to know the real-world ethical issues the members of TEK were facing.

The needs of the university and TEK gave the motivation for this research since the same information would be extremely useful in designing ethical studies for engineering students and helping TEK solve its problem. Further, the study formed an opportunity to get real-world examples for handling and teaching ethical questions, too.

In this paper, we discuss issues that engineers of different disciplines face in their professional life, based on a survey conducted to members of TEK. From the 433 respondents, we received over 130 descriptions of ethical issues encountered within their professional lives.

The research questions of this paper are:

1. What kind of ethical issues the engineers face in their everyday work?

2. What are the processes of handling ethical issues in the companies, and what kind of reactions they raised?

3. Regarding the ethical issues, what kind of support engineers had got and what they wanted to have?

4. Do the findings of the above have an impact on the ethics education of engineers?

The Section 2 of the paper is a short snapshot about ethics-related work. Section 3 describes the methodology used, and the results are presented in Section 4. Section 5 contains the conclusions and discussion.

2 Related work

There has been discussion about ethics in engineering a lot, but there are not many surveys available on the everyday ethical problems of engineers. The target group of surveys is most often engineering students, or they are focusing on ethical attitudes. Some surveys include ethical issues as part of a larger set of questions ([2] is an example of this). However, also the engineers have been interviewed about ethical problems in their work. These interviews have been the basis of several example cases [3][4]. In general, most of the interview results are published in the form of example cases.

Since our final goal is the ethics education of engineers, the rest of this section is about engineering ethics education.

The engineering curricula can include ethics in many ways. The three main alternatives recognised by Colby and Sullivan are a stand-alone course, a brief discussion about ethics whenever ethical issues arise naturally in the courses, or modules of few hours to be included in subject courses [5]. These alternatives appear in many other publications, too, but there is no clear consensus of the best practice. However, these alternatives are not exclusive [6]. Harris et al.

emphasise the importance to introduce ethics to the students as often as possible [7].

A specific course on ethics is a simple solution to ethics education. Unfortunately, the general problem in teaching ethics to engineering students is that the students are interested in engineering, not ethics [5]. A stand-alone course might pinpoint this, lowering the interest of the students. The usefulness of the course is further decreased if it is graded accepted/fail or the credit points are low or even zero [6]. The latter is happening if there is no room in the curriculum for ethics. One of the problems can be if the teachers are from the philosophy unit. They are experts, but they do not use the language of the students. This may be one cause to skip the stand-alone course. The drawback of not having a stand-alone course is that there will not be a comprehensive view of ethics, and a stand-alone course is strongly supported by Unger [8].

The ethics studies often include the ethical codes on engineering, like Archimedean oath or codes of engineering organisations [1][9][10]. Another traditional type of bringing up ethical questions have been case studies [7][8]. Example cases are a natural way to embed ethics as a part of the engineering courses. Naturally, the cases are an integral part of stand-alone ethics courses, too. For instance, the Markkula centre at Santa Clara University offers a collection of short cases on engineering area [3]. The selection of cases is important. If they are descriptions of disasters, they do not have the desired effect. Perhaps the students do not feel they will be facing such problems themselves. The case examples should reflect the everyday life of the engineers [4].

Because of the limited amount of hours available for ethics, teaching ethics for engineers is often on the level of ethical awareness. However, that is not enough. What we want is both ethical awareness and behaviour [6].

3 METHODOLOGY

Survey was held as online survey, distributed to 6000 members of the association, 2000 of which where retired and 4000 in active work force. TEK has a policy to restrict the number of attendees to about 10 per cent of the TEK's members not to make too many surveys to appear for any individuals. Survey link was sent to the selected subjects by email. The retired members were included for two reasons: to make the number of attendees bigger, and it was thought, that because of their longer career, they had more experience on the possible problems.

Survey included common sections for all respondents, which included demographic questions as well as questions about their ethical attitudes. In addition, the common sections asked about general wishes for availability of ethical issue handling support, and if ethical issues were discussed during their studies. Secondly, respondents could describe ethical issues they had encountered in more detail. The survey structure and questions as well as answer options are fully detailed in [11]. A single respondent could describe up to three different ethical issues in more detail. The survey was provided in both English and Finnish.

Total of 433 full responses were received, incomplete responses were excluded from the analysis. The survey produced over 130 more detailed descriptions of different ethical issues or problems respondents had encountered during their work life. Respondent could classify the issues under broader categories, but in addition to the self reported classification, we analyzed the descriptions. From our analysis we formed ethical issue types that were commonly present in the descriptions. These categories are discussed further in Section 4.
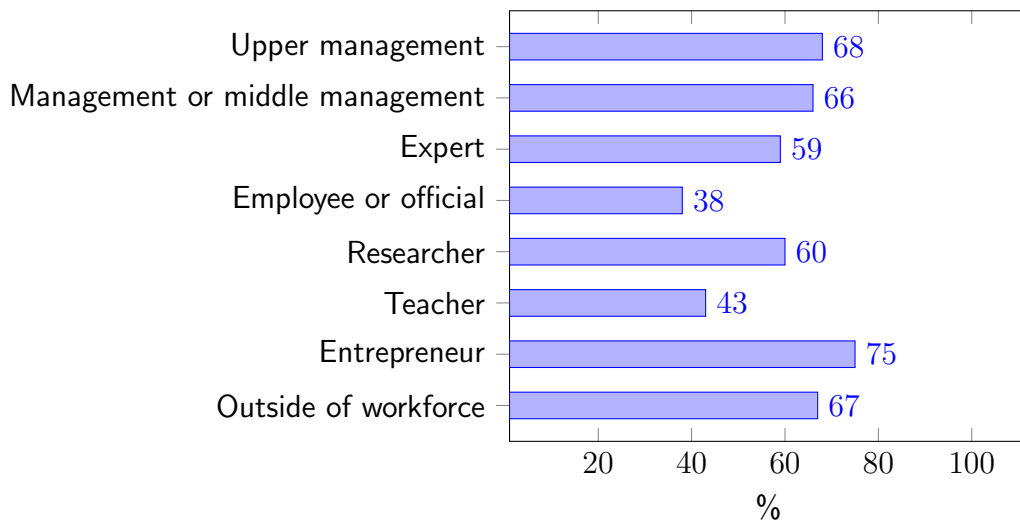
Figure 1: Relationship between respondents' position in work and encountering ethical issues.

4 RESULTS

The survey received 433 responses, of which 75% from males, 21% from females and 4% other. Among the responses there were over 130 more detailed case descriptions about different ethical issues the respondents had encountered during their work life. In this section, we discuss first backgrounds of the respondents and then focus on the case descriptions that fall under more engineering specific ethical issues rather than generic workplace issues.

Of all the respondents, approximately 60% reported having faced ethically problematic situations in their work life. There were differences between reporting with males, females and the other: 58% of males, 64% of females and 82% of other reported encountering problematic situations. From Figure 1 we can observe the differences between respondents' position in their current workplace and whether they have encountered issues or not. Based on the results, it seems that increased responsibility correlates with the likelihood of encountering ethical issues during work life. We are speculating that the increased responsibility comes with longer work career as well as wider visibility to the issues over the whole work place. It can also be noted that management as well as upper management are recognizing and aware of ethical issues that are appearing in the work life.

From the respondents and their position in the work place, it should also be noted that researchers, teachers and entrepreneurs formed together only 7% of the respondents, and expert position was most notable, with 49% of the respondents belonging in that category. People outside workforce formed only 12% of the respondents, even if the sample included disproportioned amount of retired members.

From the engineering education point of view it was alarming that 70% of the respondents mentioned that ethical issues or problems were not discussed during their studies.

4.1 The nature of problems encountered

Respondents, who described ethical issues in more detail, were able to self-classify what areas of work life situations the issues were related to. The reported areas are depicted in Figure 2. Behavior and attitudes at work places as well as working terms, conditions, management or human resources were the two most prominent categories that the respondents identified from the issues they had encountered.

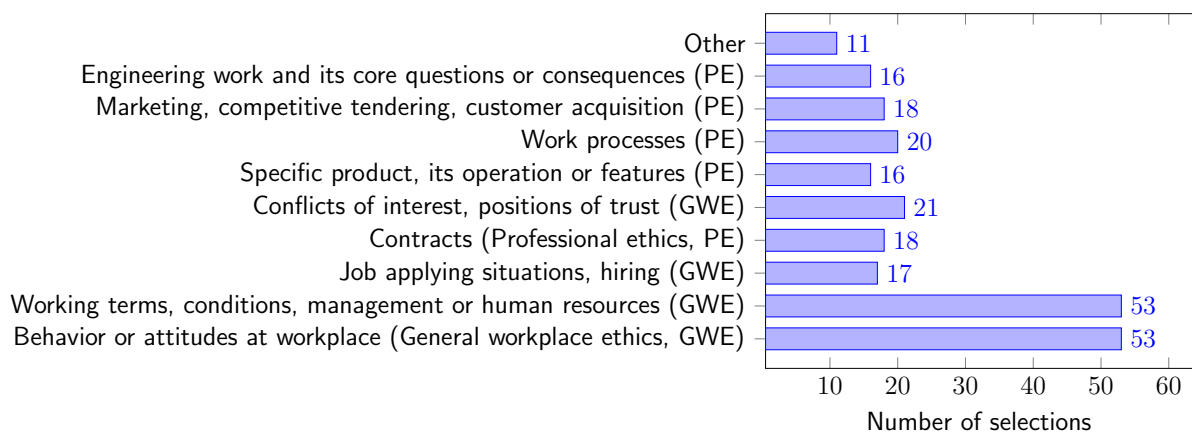In addition to the self-reported categories, we analyzed the given descriptions to identify typical

Figure 2: Self-reported categories for encountered ethical issues from the respondents.

issues. Although there has been a lot of discussion about problems arising because of artificial intelligence, there were no issues reported in this survey, that were related to AI or it's usage. In further analysis we formed first two high level classes: ethical issues related to relationships between coworkers and management of human resources and ethical issues related to technical and/or economical aspects of the work. From the descriptions, approximately 57% belonged to the first high level class and 43% to the second.

In the ethical issues related to relationships between coworkers and management of human resources, respondents discussed for example issues of unacceptable behaviour in the work place, such as harassment or discrimination. Poor management and issues with work arrangements were also common in this class. This result also shows, that respondents are considering these work place problems ethical issues as well.

Rest of this section is used to discuss in further detail the issue types that were prominent in the ethical issues related to technical and/or economical aspects of the work. Within this high level class, we identified five subcategories that were more notable: Technology-specific issues, bribery, other ethical issues in project acquisition, customer or collaborator related issues and questionable money usage.

Technology-specific issues formed 17% of the issues in the second high level class. In these descriptions, the core of the ethical issue is for example potential miss-use of the technology in unethical manner or ill-fitting or unsafe design decision that can cause harm in long term.

Bribery and so called horse-trading, or use of inside knowledge for example in project acquisition or pricing, was mentioned in 16% of the second high level class descriptions. Respondents gave descriptions, where forms of bribery ranged from providing excess hospitality to significant monetary rewards. Other observable type of project acquisition issue was exaggerated or otherwise questionable information provided during the project acquisition. It appeared in 7% of the descriptions belonging in second high level class, for example in the context of marketing exaggerated expertise for potential customers.

Engineers experienced also ethical challenges regarding the customers or collaborators they worked or considered working with. 12% of the descriptions from second high level category focused on the customers' nature, for example questioning if co-operation with organization, that engaged in unethical practices in the respondent's opinion, was ethically acceptable or not.

Questionable money usage in different manners also stood out in the case descriptions, however as a category the actual issues were more diverse in nature compared to the other categories
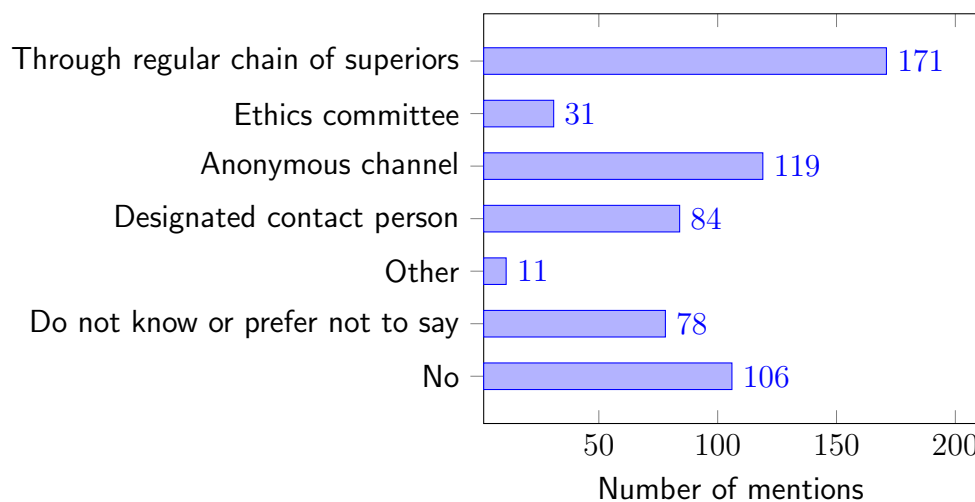
Figure 3: Respondent reported procedures in their current workplace to bring forth ethical issues or problems.

mentioned in this section. Examples ranged from questionable investments to pricing practices. 17% from these descriptions fell under the questionable money usage category.

4.2 The handling of problems in companies

Handling the ethical issues in companies varied: Some companies had existing procedures for both bringing ethical issues forth as well as ways of supporting the employees in solving the issue. Figure 3 presents the methods to bring ethical issues forth. Respondents could select several fitting options, if their employer had multiple options available. It is notable, that out of the 433 respondents, 42% reported that there either was no procedure to report ethical issues, or they were not aware of such procedure. In the places that had procedures at place, reporting through regular chain of superiors was common occurrence, as 39% of the respondents reported at least this method of bringing forth the ethical issues. It should be noted though that as 15% of the case descriptions directly mentioned someone in the employee's chain of command being part of the ethical issue, relying purely on reporting through the chain of command may leave employees at loss, when the issue is regarding the superiors.

Figure 4 presents the procedures that are available in companies to address the ethical issues, or to support the employees after the problem has been encountered. Again the "no" or "do not know or prefer not to answer" options are dominating the responses, with 57% of respondents reporting either of those options.

Within the described cases, it was extremely rare that the ethical issue was noticed purely by external actors. Out of the 135 cases, 74% reported that the ethical issue was noticed by the respondent themselves and 51% by other members of the project group or work community, often by both. Cases, where either other project stakeholders or external actors noticed the ethical issue while respondent or other project members did not, were extremely rare. Only two cases from the 135 descriptions filled this criteria.

Reactions to situations, where ethical issue was brought forward varied as we can see from the responses. When asked, what was the reaction of the decision makers to solve or handle the ethical issue (during the first encounter if respondent told about type example), respondents reported following: 25% mentioned negative reactions towards bringing it forth. 32% reported that the issue was ignored or buried and 29% mentioned that it was discussed but actions were not taken or issue was left to hang in the air. Only in 13% of the cases the policies or practices were changed, and even more rare, reported by 4%, the identified ethical issue led
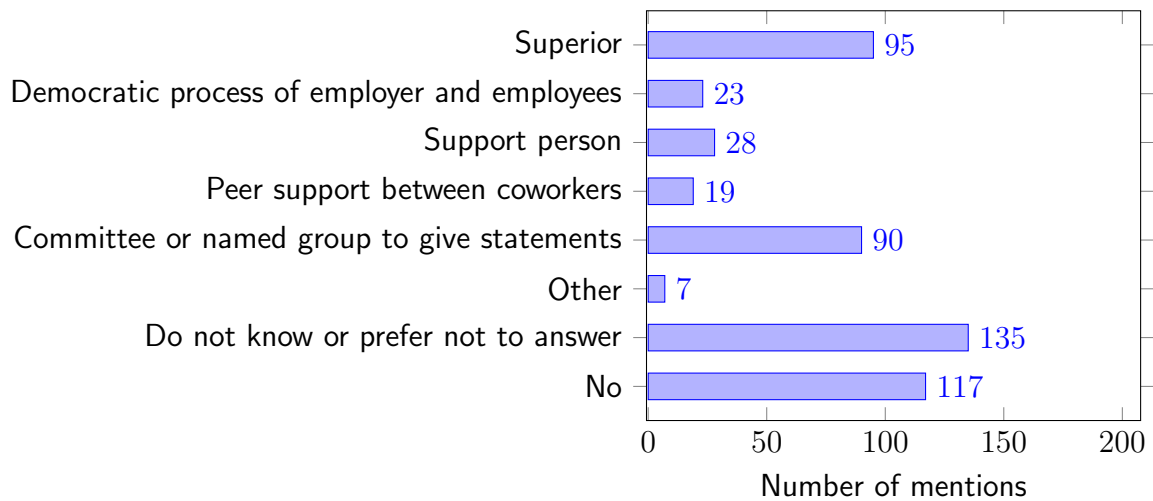
Figure 4: Respondent reported procedures in their current workplace to address and solve ethical issues, or provided after-care.

to withdrawing from the situation or project, or refusing to join or participate in it in the first place.

4.3 The support received and desired

Based on the case descriptions, engineers are lacking in available support to help with handling the ethical issues they encounter. 55% of those who left more detailed description said that there was no available support to solve the situation. In addition to that, 16% responded with "do not know or prefer not to answer". It seems, that large majority of the respondents who reported the ethical issues, either did not have help available or were not aware of the potential help they could have. This is in line with the general responses, that outlined the available support in their current companies.

Figure 5 presents the results of what kind of support respondent wished to have for handling ethical issues, as well as who should provide said support. In most of the areas respondents felt, that it was the duty of the employer to provide the support, either directly or through external actors. Only in legal services the labour unions were the most desired support provider.

The most desired support were example cases, educational material like ethical codes and support personnel.

4.4 Threats to validity

The survey was sent to 6000 members of TEK, out of which 2000 were retired. Of the 433 respondents, only 50 were not in the working life. That number includes retired and unemployed. Hence, about 88% were working, meaning that the results give a good snapshot of the current situation. However, it has to be noted that the respondents could describe quite old cases if they wanted to. For some groups of the respondent background (in Figure 1), the number of respondents is small.

5 DISCUSSION

Although the study was partly motivated by AI applications in the engineering domain, none of the respondents reported a case where AI was present. This does not mean the problem of AI is not a real one. Only small minority of engineers are working close to AI applications, and the survey was not limited to areas where AI is known to be used. The results indicate that the education of ethical issues has to cover traditional engineering areas, too. This is clearly
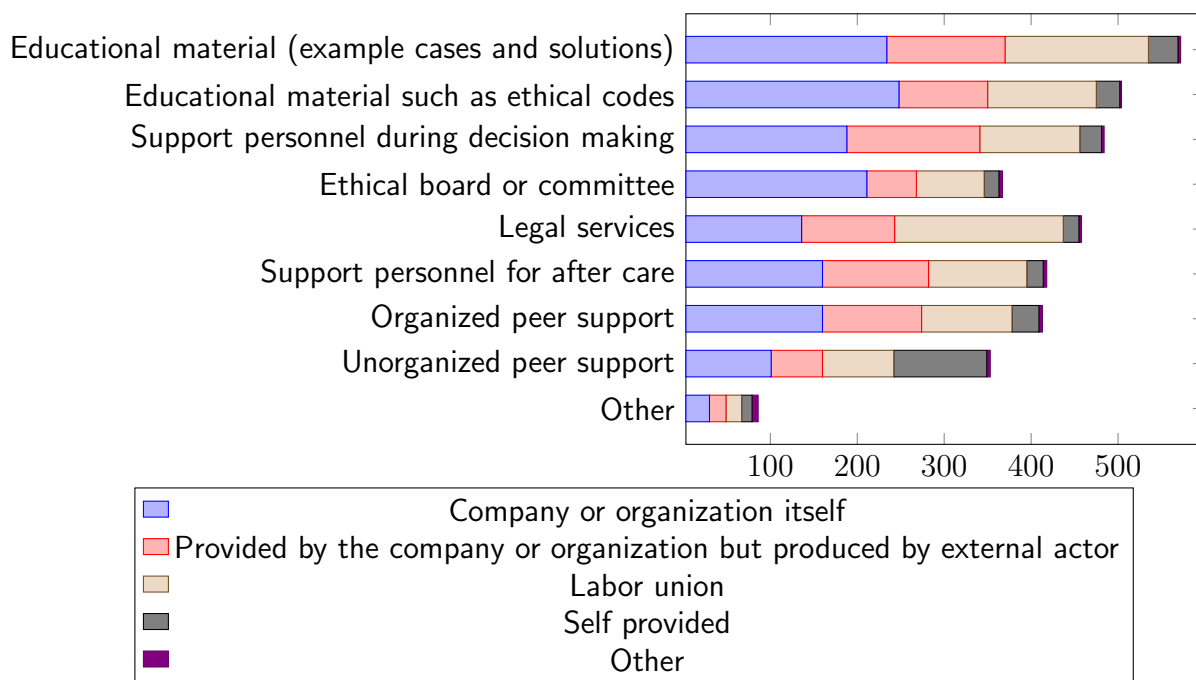
Figure 5: What kind of support respondents wanted to have and who would provide it.

evident in software products, where the program may make decisions based on traditional algorithms without AI [11], but even these cases were missing in the responses.

In general, it was a surprise that cases which were related to engineering or technology were clearly few in number, compared to those related to human factors. Human factors show up also in some published example cases [3]. Its importance emphasise that the ethics education in engineering cannot be focused on ethical problems in engineering only but should give a comprehensive view of ethics.

A notable trend from the responses was, that engineers do not have much support when solving the ethical issues. As over half of all the respondents noted, that their current workplace did not have or the respondent did not know about the procedures to handle ethical issues, it is not surprising that similarly, over half of the description givers noted, that they did not receive any support to handle the ethical issue they encountered. This lack of support challenges also the ethical education of engineers, as current situation requires self reliance from the engineers for solving the problems.

The respondents expected the employer to organise support for ethical issues either directly or indirectly. The second choice of providers for support was the labour union (like TEK). This fits well to the result that the higher role in the company the respondent had, the more problems they had noticed. Only for legal support, the labour unions' role was bigger than that of the employer, which may be an indication of problems where the employer is on the opposite side of the issue. The two top desired ways for support were example cases and ethical codes, which fits well to the core topics of ethical education reported in the literature. The descriptions collected in this survey can, in their part, be used to create example cases.

6 ACKNOWLEDGEMENTS

References

[1] Archimedean. Archimedean Oath, 1990. URL `https://www.wikizero.com/en/Archimedean_Oath`.

[2] James D. Lang, Susan Cruse, Francis D. McVey, and John McMasters. Industry expectations of new engineers: A survey to assist curriculum designers. *Journal of Engineering Education*, 88(1):43–51, 1999.

[3] Markkula center. Engineering ethics cases. URL `https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases/`.

[4] Stephen H. Unger. Examples of real world engineering ethics problems. *Science and Engineering Ethics*, 6(3), 2000.

[5] Anne Colby and William M. Sullivan. Ethics teaching in undergraduate engineering education. *Journal of Engineering Education*, 97(3):327–338, 2008.

[6] D. Bairaktarova and A. Woodcock. Engineering student's ethical awareness and behavior: A new motivational model. *Sci Eng Ethics*, 23:1129–1157, 2017. URL `https://doi.org/10.1007/s11948-016-9814-x`.

[7] Charles Harris, Michael Davids, Michael Pritchard, and Michael Rabins. Engineering ethics: What? why? how? and when? *Journal of Engineering Education*, 85(2):93–96, 1996.

[8] Stephen H. Unger. How best to inject ethics into an engineering curriculum with a required course. *International Journal of Engineering Education*, 21(3), 2005.

[9] ACM. ACM code of ethics and professional conduct, 1992. URL `http://www.acm.org/about-acm/acm-code-of-ethics-and-professional-conduct`.

[10] IEEE. IEEE code of ethics, 2006. URL `http://dusk.geo.orst.edu/ethics/codes/IEEE_code.pdf`.

[11] Anonymous. Refernce made anonymous for paper review. In *anonymous*, date hidden.