Frankenstein Lives! Teaching Mary Shelley's Novel in the Engineering Classroom

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Introduction

Mary Shelley's novel *Frankenstein*, widely regarded as the first work of modern science-fiction, presents a terrifying cautionary tale that warns against unethical practices in science and engineering. Elaborating on these emphases, recent critical editions of the novel published during its bicentennial have underscored its value as an ethical text to STEM students, educators, and professionals alike [1]. Inspired by the novel's capacity to foster moral imagination among engineers, I developed an undergraduate engineering course in science, technology, and society (STS) taught in the University of Virginia's Department of Engineering and Society called "Technology and the Frankenstein Myth." In the course, students read *Frankenstein* and reflect together on its ethical implications for their work as designers and stewards of the innovative technologies of tomorrow.

In a previous study, I examined several ethical themes, drawn from Shelley's novel, that are discussed in the course [2]. These themes center on the novel's critique of Victor Frankenstein's irresponsible, presumptuous, unaccountable, and biased practice of techno-science. The study concludes that critical engagement with Shelley's novel can help engineering undergraduates develop a professional identity, in contrast to that of Victor Frankenstein, oriented toward more ethical, socially responsible engineering practices.

The previous study is limited to an analysis of ethical themes in *Frankenstein* surveyed in the course and does not consider data regarding the learning experiences of its students. Examining such data would aid in determining the extent to which students' engagement with *Frankenstein* was able to facilitate ethical reflection and professional identity formation. To address this question, the current study begins by situating the class discussion of the novel within the broader aims and structure of the course; then, it analyzes a series of student written reflections on moral aspects of the novel and its portrayal of Victor Frankenstein specifically. The analysis organizes the data into salient themes that emerge from the written reflections illustrated by selections of student writing. The data indicate that students were able to articulate several ethical themes that emerge from the novel's depiction of Victor Frankenstein's practice of rogue techno-science and, building on those themes, express their commitment to more socially responsible engineering practices.

A Rationale and Framework for Student Motivation

A major challenge in designing a course on *Frankenstein* for engineering undergraduates was how to persuade students of the value in reading a classic literary work such as *Frankenstein*, which they typically associate with courses in the humanities that seem to have little direct bearing on engineering work. This, in fact, appears to have been the case at another university, where instructors experimented with incorporating *Frankenstein* into an introductory course in mechanical engineering [3]. These instructors had hoped that reading *Frankenstein* in an engineering classroom would enable students to draw insights from the humanities that could inform their technical designs [3]. Their efforts, however, were met with some resistance from

students in the class, who struggled to appreciate the value of Shelley's novel for their work as engineers. Although 59% of students surveyed at the end of the course conceded that *Frankenstein* had "expanded their understanding of ethics," only 11% claimed to have read it in its entirety, and several students commented that they found the novel neither enjoyable nor especially relevant to engineering practice [3].

To address the challenge of how best to motivate engineering students to invest in a critical reading of *Frankenstein*, I drew on insights from the book *How Learning Works: 7 Research Based Principles for Smart Teaching* by Susan A. Ambrose, et al. when designing the course [4]. Ambrose and her colleagues explain that when "students enter college and gain greater autonomy over what, when, and how they study and learn, motivation plays a critical role in guiding the direction, intensity, persistence, and quality of the learning behaviors in which they engage" [4]. The authors go on to enumerate several strategies for motivating students to engage with course materials and for helping them to see the value of what they are learning. Below I summarize several of their strategies and how I sought to apply them to the design of the course.

One strategy the authors discuss involves connecting course materials to interests that students have or to areas of their lives that are important to them [4]. For my course, this meant that it would not be sufficient motivation for students to read *Frankenstein* in the abstract as a literary classic; instead, they would need to encounter the novel as a text that speaks directly to aspects of engineering design and practice. Another of the authors' strategies for enhancing student motivation concerns helping students see in concrete terms the relevance and applicability of the ideas and concepts they are learning. This could involve relating course concepts to real-world contexts, examples, and events [4]. To deploy this strategy, it would be important to relate the novel's concerns about techno-science in the early nineteenth century to contemporary forms of science and engineering work whose reception among the public may be controversial or polarizing. Finally, Ambrose and her co-authors recommend a strategy for motivating students that entails helping them appreciate how their learning will contribute to their professional development and future vocational success [4]. Implementing this strategy would require that students learn from Victor Frankenstein's unethical practice of techno-science so they could avoid the many negative consequences that he both experienced and brought upon an unwitting world. In what follows, I explain how these strategies were deployed in the design of a non-technical STS course on *Frankenstein* for engineering undergraduates.

Designing a *Frankenstein*-Themed Engineering Course in STS

My primary aim in designing the course was to foster students' moral imagination and reflection about ethical aspects of engineering practice through a critical reading of Mary Shelley's *Frankenstein*. My hope was that, as a result of their learning and experience in the course, students would commit themselves to more ethical and socially responsible forms of engineering practice. For several semesters now, I have taught the course during a four-week long summer session. The semester's coursework divides into two parts, each two weeks long.

In the first two weeks of the semester, students perform a close analytical reading of *Frankenstein* to discern principal themes that characterize the Frankenstein myth. Working with Bruce Lincoln's conceptualization of myth as "ideology in narrative form" [5], students

investigate how Shelley's cautionary tale of Gothic science fiction raises concerns about misguided and unethical practices of techno-science. Specifically, students examine the novel's portrayal of Victor Frankenstein and his evolving relationship with the creature he brings to life while at university. As they read *Frankenstein*, students are guided by the question: if Shelley's novel is a cautionary tale about rogue techno-science, what kinds of practices does it warn against. Among the themes students discuss are Victor's irresponsibility, presumption, isolation, and bias in his work as a scientist and engineer. In a previous study [2], I explain how these themes are developed in class discussions of the novel as well as the role they play in helping students to construct "possible selves" [6] and professional identities in contrast to Victor Frankenstein's unethical example [7].

In the second two weeks of the semester, students discuss several works of popular science fiction that allude to and update the Frankenstein myth to address ethical concerns about emerging forms of techno-science such as genetic engineering, cloning, and artificially intelligent robots. These works include James Whale's *Bride of Frankenstein* (1935), Steven Spielberg's *Jurassic Park* (1993), Joss Whedon's *Avengers: Age of Ultron* (2015), an episode of *The X-Files*, as well as the short story "Robbie" by Isaac Asimov. Throughout the semester, students also examine how the Frankenstein myth contributes to public discourse and debate about controversial technologies such as genetically modified foods, embryo research, technologies of de-extinction, artificial intelligence, and weapons of mass destruction.

The major writing project in the course is not an essay on *Frankenstein*, the kind of which might be assigned in a course in British literature; instead, it is a research paper in which students analyze polarized public responses to an emerging technology of their choosing that interests them. To frame their argument, students draw on an essay by Martijntje Smits that uses monster theory to explain why some people dread, while others welcome, certain controversial new technologies [8]. Drawing on the work of anthropologist Mary Douglas, Smits argues that polarized responses to new technologies result from the perception that, like Frankenstein's monster, such technologies unnaturally fuse two socially constructed cultural categories regarded as distinct and mutually exclusive [8]. Such categories function as a taxonomical system for understanding reality by ordering the world into sets of binaries such as nature-culture, living-dead, human-animal, human-machine, etc. Technologies that are perceived as fusing or confusing such categories are regarded as "monstrous" and, as such, elicit polarized responses of fear in some and fascination in others [8]. From there, Smits elaborates strategies for domesticating such "monstrous" technologies to render them more acceptable to a polarized public. These strategies involve either modifying the technology to align it more closely with one category or the other in a cultural binary or adapting the cultural categories themselves to accommodate the new technological "monster" [8]. To accompany the paper, students compose a short pitch for a science-fiction story that explores potential ethical implications and impacts of the technology they examine in the research paper.

Ethical Themes from *Frankenstein* in Student Reflections

At the end of the semester in the summer of 2023, students were invited to write a retrospective reflection on how their experience in the course contributed to their formation of professional identity as prospective engineers. The prompt they were given reads as follows:

> What have you found especially interesting or helpful about the course? How has Shelley's cautionary tale about Victor Frankenstein affected your approach to engineering design and practice?

Of the twenty-two students enrolled in the course, nineteen wrote responses. Below, I analyze the student responses by identifying several salient themes that emerge from them that illustrate how their reading of *Frankenstein* contributed to their ethical formation as engineers. I also catalogue several additional themes in the student responses that address further areas of personal and professional development their learning in the course facilitated.

Ethical Themes from Frankenstein

In their responses, students identified several ethical themes from Shelley's novel that had a significant impact on their approach to engineering practice. For the purposes of this analysis, a theme refers to a descriptive abstract construct that denotes conceptual links among various kinds of expressions [9]. In some instances, themes emerge from explicit expressions that are stated directly in student writing (e.g., "consequences"); in other places, themes may be somewhat more implicit and indirectly expressed (e.g., "potential impacts"). Although there was invariably a degree of overlap in thematic expressions in the students' writing, as students often wove together references to multiple thematic elements in their reflections, a combination of explicit and implicit markers provided sufficient differentiation among themes for the purposes of identification and analysis. Below, I have catalogued the themes based on the frequency with which they appear, whether explicitly or implicitly, in students' written reflections. This number (frequency) is indicated in parentheses following the title of the theme. I have also included some anonymized excerpts of student writing[1] that illustrate how particular students express a theme and relate it to *Frankenstein* and/or an aspect of ethical engineering practice they aspire to embody.

1. Considering Consequences (11)

Students commit to carefully considering the possible consequences of techno-scientific advancements to assess the ethical implications of their impacts on people and the environment. In the excerpt below, the student's commitment to weighing potential consequences of engineering designs is set in contrast to Victor Frankenstein's portrayal as reckless and lacking ethical forethought. Here, Victor functions for the student as a negative "possible self" [6] to be avoided in favor of constructing a more socially responsible professional identity.

> One aspect that has stood out to me is the emphasis on the ethical considerations and consequences of scientific advancements. Shelley's novel serves as a stark reminder that technological innovation should not be pursued without careful reflection on its potential impacts. Victor Frankenstein's reckless pursuit of knowledge and his failure to consider the ethical implications of his actions lead to disastrous consequences. This has made me more mindful of the importance of responsible engineering practices and the need to consider the broader societal and ethical implications of the technologies I work on.

[1] The use of anonymized excerpts of student writing for analytical purposes has been approved by the University of Virginia IRB.

2. Accounting for Diverse Perspectives (7)
Students underscore the importance of accounting for diverse viewpoints and interdisciplinary perspectives when approaching engineering challenges. In the selection below, the student writer associates the variety of disciplines the novel draws on with the multiple perspectives a conscientious engineer must consider when designing technologies for diverse stakeholders.

> The course has also fostered a deeper appreciation for interdisciplinary perspectives. Shelley's novel intertwines elements of science, morality, philosophy, and human nature, emphasizing the importance of considering diverse viewpoints in engineering design. Recognizing the complexity of the issues at hand, I now strive to incorporate interdisciplinary collaboration and engage with ethical, social, and environmental dimensions in my engineering practice.

3. Avoiding Technical Sweetness (7)
Students express their intention to avoid the allure of "technical sweetness" when designing technologies. Technical sweetness refers to the experience of elation scientists and engineers can have when arriving at an especially satisfying solution to a particular challenge [10]. Often accompanying the pursuit of technical sweetness is a blindness to potential consequences that might follow from the solution, coupled with an unwillingness to consider whether resolving the problem is desirable and worthwhile in the first place [10]. Below, the student associates the concept of technical sweetness with Victor Frankenstein's moral failings and further explains that, in prioritizing quantitative factors, engineers often omit important ethical considerations such as these from the technical design process.

> Shelley's cautionary tale about Victor Frankenstein has taught me to think about all of the possible consequences when I am approaching and [sic.] engineering problem. In most of my other engineering classes, we focus on many aspects of the results of our engineering designs. Will the design fit into the constraints given? Will it be affordable to the general public? I have never had a class, until now, where we discussed "technical sweetness" and how important the ethical consequences are to consider. I am surprised we haven't focused on this more in other classes because it is a crucial component. I hope that as an engineer I will stop and consider how my technology will be perceived by the public, and if it even should be created.

4. Taking Responsibility (4)
Students commit to assuming responsibility for the technologies they design throughout their lifecycle to ensure they work to enhance human well-being instead of harming people or the environment. In the excerpt below, note how the priority the student places on responsible engineering is explicitly linked to lessons drawn from *Frankenstein*.

> I found the analysis of modern technology through the lens of the Frankenstein myth to be particularly interesting during this course. While I had read and analyzed the novel in high school, I hadn't considered how far the implications of Mary Shelley's work could stretch and how they could be applied to my practices as [sic.] research as an engineer. From an engineering perspective, Shelley's tale highlights the importance of ethical considerations and responsible innovation which will undoubtedly change my approach

> to engineering design and practice. I am now much more aware of the need to consider the potential consequences of my creations, both intended and unintended, and to prioritize safety, sustainability, and social implications. I also see now the importance of taking responsibility of my creations throughout their lifecycle, ensuring proper maintenance, addressing potential risks, and mitigating any harm caused.

5. Avoiding Isolation / Practicing Transparency and Accountability (4)
Students express their intention to avoid developing technologies in secret, as Victor did, isolated from colleagues, stakeholders, and the public. Instead, they commit to open engineering practices of transparency and accountability in their work. In the excerpts below, the students explain how the novel's portrayal of Victor Frankenstein has prompted them to emphasize openness, collaboration, and accountability in techno-scientific work, which they associate with ethical and socially responsible engineering practices.

> Shelleys [sic.] tale about Frankenstein has taught me. . . that projects should not be done alone or without review from trusted ethical sources

> Shelley's cautionary tale and many of its adaptations have warned me of. . . the importance to work openly with my peers and the scientific community to ensure that all technologies are developed responsibly.

6. Learning from Experience / Mistakes (3)
Students articulate a desire to learn from experience to better anticipate and avoid potential negative impacts of their work as engineers. Intriguingly, the first student writer wants to follow Victor's example by learning from a negative past experience, while the second student wishes to avoid repeating Victor's mistakes.

> I think it is important that I learn from my mistakes. Victor almost made a second monster. He realized what the true implications of that creation could be after creating the first monster and elected to destroy it. As such one can see he learned from his mistakes. I would hope to do the same.

> During this course, I found that the tragic story of Frankenstein really opened my eyes to the darker side of innovation. As an engineer myself, I have been somewhat tunnel visioned into seeing my work as only helping the world, and did not give too much consideration on [sic.] the potential future harm that the products I create may have. Frankenstein has made my approach to engineering and innovation more cautious. I will take the lessons from this story and ensure I do not repeat similar mistakes that Victor made.

7. Practicing Care (3)
Students commit to practicing principles of care ethics [11] [12] in their work as engineers, including cultivating empathy and taking responsibility both for the well-being of the people affected by their work and for the fate of the technologies they design. Below, the student identifies a lack of empathy and care as among Victor Frankenstein's moral failings.

> Understanding how care ethics could apply through various contexts was eye-opening to me as to how we should approach new and novel situations like this in the future. Empathy is truly an important tool for an engineer, and ignoring it will not only harm you, but everyone around you. Realizing that now rather than later is a privilege that some engineers – like Frankenstein – did not have. I will strive to utilize empathy through the lens of care ethics in an attempt to benefit not only society but to elevate the work that I produce.

Additional Themes

Below are several more salient themes that appeared in student responses. They speak to further aspects of students' experience in the course that affected their personal and/or professional development. As with the themes enumerated above, the number in parentheses after each theme's title indicates the frequency with which it occurs, explicitly or implicitly, in student writing.

1. Understanding Polarized Public Responses to New Technology (11)

To guide their work on the research paper, students draw on an article by M. Smits that uses monster theory to explain why public response to emerging technologies can be polarized [8]. As mentioned above, Smits argues that polarized public response to technical innovations occurs when a technology is perceived as "monstrous," that is, as unnaturally combining two cultural categories that are typically thought of as distinct and mutually exclusive (e.g., living-dead, human-machine, nature-culture, etc.). Many students found this argument compelling and its insights productive for positioning new technologies in such a way as to mitigate their polarizing effects. For the students whose work is excerpted below, Smit's argument underscores the importance of taking stakeholders' perspectives seriously and provides a helpful framework for how to improve public reception of potentially controversial technologies. Notably, in the second excerpt the student contrasts the idea that engineers should consider how the public might receive new technology to Victor's self-absorbed failure to do so in *Frankenstein*.

> I found Smits's monster theory to be the most interesting thing about the course to me. I have seen many people be very reluctant to certain forms of technology that, to me, seem very obviously beneficial for all parties involved, and it has left me very confused. After seeing Smits's ideas that the combination of cultural categories invokes feelings of uneasiness, I was presented not just with an understanding of those who reject certain technologies I advocate for, but also with an epiphany that I, too, have felt uneasy about technologies that combine cultural categories. Smits's monster theory will empower me as an engineer to consider the public reception to technologies that I am working on ahead of time. If I am in a circumstance where a technology that I am involved with invokes a polarized response from the public, I will be able to consider both the assimilation and adaptation strategies to push the technology closer to a cultural category.

> I found this course helpful because it allowed for me to take a view of technology from both a Monster Embracing and a Monster Exorcising view. There were certain technologies where I was on one side or another, either viewing it as completely evil or as a common good for all, but it's important to realize, as you are designing and

> evaluating technology, that there can be both positive and negative reception. It is important to learn how to design for both, or how to convince or alter society to allow for the technology to be integrated into it. It is easy for engineers to be blinded by what they think is best for society that they forget to think about the rest of society and how their technology can impact it in ways they had not considered, much like Victor Frankenstein when he created the Monster. It's books like these and ideas such as these, not created by engineers or scientists, that reminds us of how society can view the technological innovations that scientists and engineers create and introduce into society, and how we can treat the technology as a member of society to increase its potential positive impact.

2. Relevance to Professional Development (4)
Several students mention that the course contributed directly to their ethical formation as prospective engineering professionals. In the first excerpt below, the student explains that Shelley's novel has provided inspiration for prioritizing social good in engineering work, while the second student commits to practicing ethical forethought when working professionally with gene-editing technologies.

> Shelley's cautionary tale has had a profound impact on my approach to engineering design and practice. It has made me more conscious of the ethical implications, responsibility, and potential consequences of technological innovations. By drawing from Shelley's insights, I aim to pursue engineering endeavors that prioritize responsible innovation, consider diverse perspectives, and prioritize the well-being of individuals and society as a whole.

> I found that overall, this course has been incredibly insightful as to what challenges I should expect when I graduate and get a job. I plan to hopefully go into genetic engineering which has endless possibilities, however, after writing my research paper I now know the dangers of taking genetic engineering too far. Shelley's cautionary tale has taught me that just because you can does not always mean you should. Victor was capable of playing God and creating human life, but he should not have. If he had thought before he acted and before he got wrapped up in technical sweetness, he would not have had to suffer the loss of his family and eventually his own life. No matter what field I go into, I will make sure that this novel stays with me as a lesson to think about the consequences of what I create before it is too late.

3. Renewed Interest in Literature and Art (3)
A final, somewhat surprising though welcome theme that emerges in student responses is a sense of renewed joy in reading fiction as well as an appreciation for the capacity of literature and art to provide personal enrichment and facilitate ethical reflection. For example, the student writer below wonders at the artistic craft of literary works such as *Frankenstein*, which encourage the kind of close reading that gives careful attention to how narrative structure and rhetorical details contribute to meaning. The student then articulates the value of applying similar analytical skills to other forms of art, such as Edward Hopper's painting *Nighthawks*, which was discussed in class.

> Until this course, I feel like I had been reading books the wrong way. It surprised me how much even the smallest things matter in a novel or any type of writing. Previously, I used to read books without making deeper connections to the underlying themes. I didn't realize that even minor details at the beginning could hold significant meaning for the entire novel. By reading Frankenstein, I learned to carefully examine each scene and piece of text. The discussions we had in the course helped me understand the finer details of the texts. I've come to understand that in certain cases, prior events are crucial for a sentence to have meaning I didn't realize how important different forms of art could be. Arts tell stories [sic.]. For instance, if I saw the painting "Nighthawks" by Edward Hopper a month ago, I would just quickly look at it and think, "Oh, there are people drinking in a bar." But now, I understand what the painting is trying to show and I can see the actual colors in the artwork. This course has made me more curious and taught me to appreciate all kinds of art.

Conclusion

This study has performed a thematic analysis of end-of-semester reflective statements written by students enrolled in the summer 2023 class of "Technology and the Frankenstein Myth" taught in the University of Virginia's Department of Engineering and Society. The aim of this analysis has been to determine the extent to which students' reading of Mary Shelley's *Frankenstein* helped cultivate moral imagination and a commitment to ethical engineering. The students' reflective statements indicate that they were able to articulate several ethical themes that emerge from the novel's depiction of Victor Frankenstein's practice of rogue techno-science. Further, students were then able to build on those themes to construct more ethically oriented "possible selves" [6] and professional identities in contrast to that of Victor. Perhaps the summary statement below, written by a student in the class, says it best:

> Frankenstein has been one of my favorite novels ever since I read it a few years ago. However, I never looked at it from the techno-scientific perspective, and it expanded my views on the ethics of engineering works and made me appreciate the novel even more.

This student's affirmation of the novel's constructive contributions to an understanding of engineering ethics, together with those of other students in the class, suggests that science-fiction texts such as Mary Shelley's *Frankenstein* have the capacity to inspire the kind of moral imagination that can facilitate a commitment to principles of ethical engineering practice among undergraduates. As such, reflection on the novel's implications for ethical techno-science would be worth integrating into engineering curricula at other institutions that share a dedication to preparing thoughtful, conscientious, socially responsible engineers of tomorrow.

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