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Review Article

Assessment of the Ethics of Patent and Legal Work in Engineering Practice

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ABSTRACT: Engineers have increasingly become involved in startup companies, making both business and engineering decisions. This shift has also brought engineers into closer collaboration with marketing and business professionals, even in larger firms with highly integrated product development cycles. Despite this growing intersection, engineering ethics and Science and Technology Studies (STS) have usually been separate fields, but this paper suggests that combining the two can be very helpful. STS can improve engineering ethics by looking at the wider social and ethical issues in technology design, helping to understand how technologies are made. On the other hand, engineering ethics can help STS by offering clearer ethical guidelines and standards to follow when studying technology. The study highlights the challenges engineers face when balancing technical, legal, and business considerations, often leading to ethical dilemmas. Engineers are expected not only to solve technical problems but also to meet broader expectations, which can sometimes conflict with the highest design standards. These pressures may drive engineers toward unethical or even illegal behavior. Factors influencing these decisions include the values of the profession, the individual engineer, the employing organization, and broader socio-economic pressures. Moreover, the paper discusses the ethical challenges surrounding patenting, particularly within the context of the patent system, which often frames ethical questions in a limited way. Until the patent system addresses a wider range of ethical considerations, it will continue to face criticism, potentially undermining its legitimacy.

KEYWORDS: Design, Decision-Making, Ethical Behaviour, Loyalty, Product.

INTRODUCTION

Engineering ethics plays an important role in the practice and education of engineering and engineering management. However, the complexity of the systems in which ethical decisions are made is often overlooked. Rather than simply focusing on the importance of acting ethically or analyzing specific situations, there is a growing need to understand the system that surrounds ethical decision-making in engineering. While engineering failures often result from errors in design or implementation, rather than ethical lapses, there are still examples where ethical decisions or compromises contributed to disastrous outcomes [1]. For instance, engineers involved in the design and construction of buildings with inadequate steel reinforcements, such as the ones built by certain Japanese firms, or the levee failures in New Orleans, may have made decisions that compromised safety, even if their errors were not driven by unethical intentions. These examples underline the necessity for a comprehensive understanding of engineering ethics that extends beyond individual actions to include the broader systems, pressures, and contexts that influence engineers' decisions [2].

The goal of engineering ethics is not just to instruct engineers on how to act ethically but also to develop a more systematic and holistic understanding of the ethical challenges they face. The complexity of the modern engineering environment requires that ethics be approached as a system, considering the various factors that influence ethical decisions. Given that engineering traditionally relies on modeling techniques to predict and analyze complex systems, it seems logical to apply similar tools to understand the ethical landscape in which engineers work [3]. This approach seeks to explore and describe the broader system of ethics in engineering, focusing on how various factors intersect and contribute to ethical decision-making. In today's competitive global business environment, engineering ethics faces new challenges. Global trade and market deregulation have intensified competition, and companies are under pressure to deliver high-quality products quickly and efficiently [4]. The rise of lean manufacturing, popularized by Japanese companies in the 1980s, has set new standards in industries around the world. However, the drive for efficiency and cost reduction can sometimes lead to compromises in product safety and quality. Engineers working in such environments may face ethical dilemmas where business pressures conflict with professional standards for safety and quality [5]. While factors like smaller lot sizes and inventory levels often lead to improvements in quality, the increasing speed of product development and the focus on cutting costs can put engineers in situations where ethical decision-making becomes more difficult.

Ideally, customers should know exactly what quality and safety they are getting when they purchase a product, allowing the market to function efficiently. However, the very nature of engineering means that defects or failures may not become apparent until long after a product has been sold. This gap between purchase and failure creates a market failure, which is often addressed through government regulations and professional standards [6][7]. These laws and regulations are designed to protect consumers and ensure that products meet minimum safety and quality standards. For instance, safety standards set by government agencies and professional bodies are essential in high-risk industries, and the threat of lawsuits can provide a strong incentive for companies to maintain safety standards. In many cases, the engineering profession itself sets these standards, and they are enforced through legal channels. Without these regulatory mechanisms, companies that prioritize quality and safety would often be undercut by competitors willing to cut corners.

Despite these regulations, engineers sometimes find themselves in situations where they are asked to compromise on safety or quality. This may occur when companies prioritize cost-cutting over long-term reliability or when engineers are pressured to meet tight deadlines. In such situations, engineers must be aware of their legal obligations to customers, especially regarding product safety and fitness for purpose [8]. For example, under common law, a product must be fit for its intended use, and engineers have a responsibility to ensure that products are safe and effective. In the case of defective products, the legal principle of implied warranty ensures that customers can expect the products they purchase to perform as promised. If engineers are asked to design a product that does not meet these basic standards, they may be violating the law, even if the company insists on such compromises [9] [10]. The issue of product liability also plays a central role in engineering ethics There are three main product liability theories: contractual, due care, and strict liability, with the contractual theory stating that products should be safe because they are expected to work as intended. If a product is found to be defective or unsafe, the seller may be held liable for any harm caused. These theories provide a legal framework for understanding the responsibilities of engineers and companies in ensuring that products are safe for consumers.

In addition to these legal considerations, engineers must also navigate the complex relationship between ethics and technology design. The field of science and technology studies (STS) offers insights into how ethical issues arise in technology design, particularly when it comes to engineering decisions that have significant social, environmental, or health impacts. As engineers become more involved in designing technologies that affect society, the ethical questions they face grow more complex. The decisions made during the design process can have long-lasting effects on the environment, public health, and safety, making ethical reflection an essential part of engineering practice [11]. The relationship between external regulations and internal responsibility is another key area of focus in engineering ethics. Engineers must balance the demands of external oversight, such as regulations and safety standards, with their professional autonomy and responsibility to act in the best interests of society. One approach to resolving this tension is the concept of “shared responsibility,” which recognizes that both engineers and the broader sociotechnical context in which they work share responsibility for the ethical outcomes of their decisions [12]. By fostering an environment that supports ethical decision-making, engineers can be empowered to act in ways that prioritize safety and public welfare while still meeting business and regulatory requirements.

The integration of engineering ethics into the design process is critical for addressing the ethical challenges that arise in technology development. Ethical reflection must not be seen as a separate or after-the-fact consideration but should be embedded within the design process itself. By anticipating the potential social and environmental impacts of new technologies, engineers can make more informed and ethical decisions [13]. As the field of engineering continues to evolve, ethical reflection must become an integral part of the practice, helping engineers navigate the complex and often conflicting pressures they face in their work.

LITERATURE REVIEW

Duda *et al*. [14] examined that the field of ethics in software engineering aims to establish clear guidelines on what is morally right when dealing with issues created or influenced by computer technology. Efforts to create ethical standards for software engineers led to simple rules like "do not steal others' intellectual property" and "respect property rights, including patents." However, real-life situations are rarely as straightforward as these rules suggest. Many times, software engineers face situations with unclear boundaries, especially when it comes to copying software code. Their study explores whether software engineers follow existing ethical standards related to intellectual property rights and the practice of copying code.

Shmatkov *et al*. [15] discussed the application of copyright plays an important role in attracting venture financing and public offerings of shares, but it is often overshadowed by the focus on patents. Unlike patents, which are industry-specific, copyright applies globally as soon as a work is published and can be used commercially across various industries, from finance to energy. Copyright can complement patent and trademark protection, making a company more attractive to investors. The article also discusses ways to prevent copyright infringement within a company. Through the statistical analysis of the largest global companies, the study shows that copyright registration is common across industries, not just in creative sectors. It highlights the importance of copyright registration and shares an example from the electric power industry. The article emphasizes that managing copyright infringements, such as illegal use of images, is crucial for protecting a company's assets. A system for managing fair use internally, combining legal, educational, and practical strategies, has proven effective in reducing copyright violations within an engineering company.

Umbrello *et al*. [16] described that in the past few decades, different methods have been created to deal with the challenges of predicting and responding to the impacts of new technologies. Although many of these methods have some similarities, they each have their limitations. This paper focuses on one specific approach called Anticipatory Ethics for Emerging Technologies (ATE), which was designed to address gaps that other approaches might miss. However, the ATE approach also has areas that need improvement, particularly in how it defines what to analyze and at what levels. Their paper is based on research that studied the ethical, legal, and social effects of technologies such as climate engineering, digital reality, and brain-related technologies. The goal is to better understand and address the challenges posed by these rapidly developing technologies.

McTeague *et al*. [17] stated that patent databases are an important but underused resource in engineering design. Analyzing individual patent documents can be difficult because they are often complex and contain technical language that can be hard to understand. However, new computational methods may soon allow us to automatically reformat and simplify patent documents, making them easier for engineers to read and use. For these methods to be effective, the models help us understand the challenges engineers face when analyzing patents and provide a framework for identifying ways to improve the presentation of patent information. By applying these cognitive models, can create tools that simplify patent analysis and make patent databases a more valuable resource for engineering design.

DISCUSSION

The Ethics of Intellectual Contribution in Drug Design and Cumulative Scientific Knowledge

The drug design process is rarely a product of entirely novel thinking; rather, it builds upon the accumulated knowledge and intellectual labor of previous scientists. Each stage of drug development is shaped by the discoveries made by predecessors, whose contributions are often overlooked when awarding market value or patent rights to the final inventor. Hettinger's argument encapsulates this dilemma, suggesting that rewarding a single individual or entity for a small modification, based on the work of many, fails to acknowledge the broader intellectual labor that made such advancements possible [18]. This is particularly evident in the pharmaceutical industry, where patent law plays a central role in determining ownership and financial rewards for new medications. In many cases, patents are granted to the final developer, typically a pharmaceutical company, giving them exclusive control over the medication, even though pivotal advances in basic science or early-stage translational research, which may not be patentable, were instrumental in bringing the drug to market. Patent law aims to ensure that inventions meet criteria such as novelty and non-obviousness, in theory protecting against the trivialization of scientific progress. However, this legal framework does not account for the extensive and often collaborative intellectual contributions made by countless scientists over time.

This issue raises ethical concerns about the fairness of awarding patents and the market value tied to them, especially when many individuals contribute to the development of scientific knowledge. As in Hettinger's analogy, rewarding the last person in the process for a small modification to a product of many others' work is akin to awarding full credit for lifting a car to the last person who joins the effort [19]. To address this, patent systems may need to reconsider how credit and financial rewards are allocated to better reflect the collaborative nature of scientific and technological advancements.

The Rights, Duties, and Moral Basis of Loyalty in Engineering Organizations

The relationship between employed professionals, their rights and duties, and the moral basis of loyalty within organizations is a complex and changing issue in engineering ethics. More researchers are examining how much freedom individuals should have within organizations, questioning the old ideas of professional loyalty and control. These studies challenge the basic beliefs about how organizations work and look at different ways of organizing that could better support ethical responsibilities in engineering [20]. The findings revealed that regardless of whether a company emphasized professional identification or ignored it, engineers did not seem to perceive their professional identity as a distinct source of duties and obligations. This suggests that the typical notion of professional allegiance, where engineers are seen as having a primary loyalty to their profession, no longer aligns with the realities of corporate environments.

The research points to the increasing difficulty of maintaining professional allegiance in the face of the diverse roles engineers occupy within corporate structures. Instead, the authors argue for a new conception of engineering ethics that accounts for the bonds between engineering practice and corporate activity, while still upholding moral and social responsibility. One area of growing importance within this debate is the issue of whistleblowing. Philosophers, behavioral scientists, and legal scholars have carefully examined the responsibilities of engineers when they encounter unethical practices within their organizations, including questions about safety, risk assessment, and due process. The role of professional associations in supporting engineers who face ethical conflicts with their employers has also come under scrutiny. These associations should provide guidance and protect individuals who are asked to compromise their ethical standards. As engineering continues to evolve within organizational contexts, the nature of professional duty and the moral responsibilities of engineers will remain critical areas of study and debate.

Model of Forces Shaping Ethical Behaviour of an Individual Engineer

The ethical behavior of an engineer is shaped by a complex interplay of various forces at both the macro and micro levels. The first model examines the ethics of the engineering profession from a broad, macro-ethical perspective, addressing general ethical standards and norms that govern the profession as a whole as shown in Figure 1. However, in practice, engineers operate within specific contexts, serving particular clients or employers, which brings us to the second, micro-ethical model. This model focuses on the individual engineer and the various forces influencing their ethical decisions on a personal level. The second model incorporates elements from the first, especially the ethics level of the engineering profession, which shapes the individual's ethical behavior.

The ethical decisions made by an engineer are not only affected by their adherence to professional standards but also by their personal moral development and character. This personal aspect is crucial, as the engineer's ability to take risks, the ethical climate of their employing organization, and the customs within the engineering culture play significant roles in shaping their decisions.

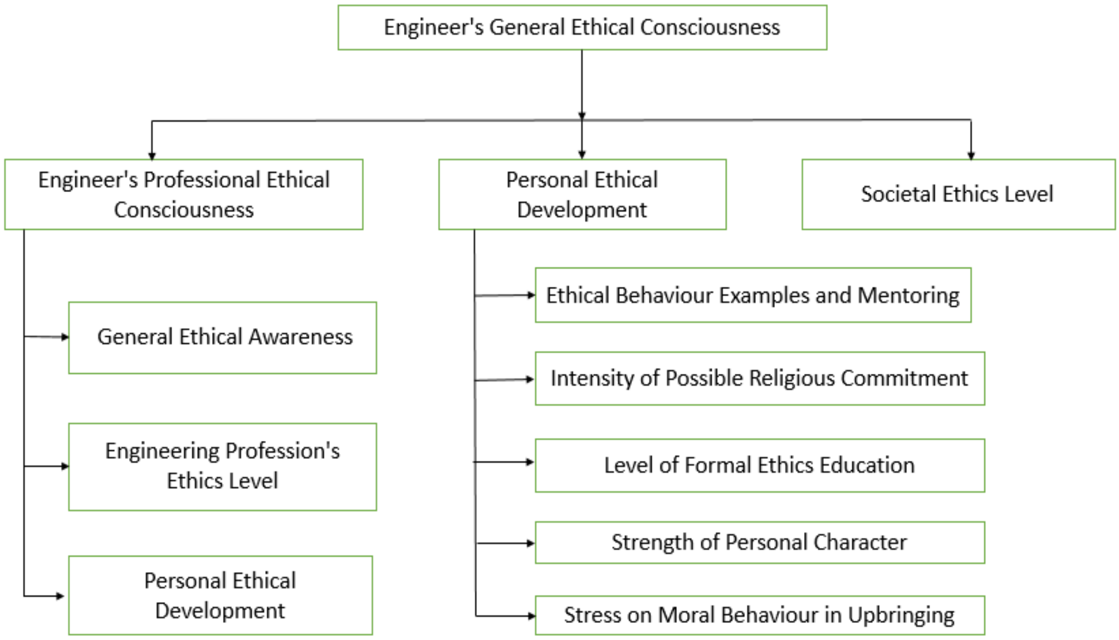

Figure 1: Illustrates the factors influencing an engineer's general ethical awareness and decision-making.

For instance, a civil engineer's choices may have life-or-death consequences, such as in the case of a bridge design failure, while an electrical engineer might face less direct safety issues but may still work on critical technologies like GPS systems that affect public safety. Furthermore, the nature of the specific situation such as the potential cost to the organization and the public visibility of the engineer's decisions, along with the possibility of sanctions, also influence ethical behavior. Thus, the ethical decision-making of an engineer is a dynamic process, shaped by both personal and external factors, including the broader profession, organizational culture, and the real-world impact of their work.

Integrating Engineering Ethics with Science and Technology Studies (STS)

This paper aims to connect engineering ethics with Science and Technology Studies (STS) by focusing on two main goals: first, to enhance engineering ethics by looking at technology from within, and second, to give STS a moral perspective. This approach helps bring both fields closer together to better understand the ethical challenges in technology and engineering. The study presented emphasizes the importance of understanding ethical issues in engineering design by examining the process and dynamics of design itself. By incorporating STS insights, which are often rooted in empirical research, the issue demonstrates how these perspectives can deepen ethical reflection. STS helps by offering a way to understand the design process that shows many points where ethical thinking can be applied.

The study explores two key conceptualizations of the design process. First, several authors consider engineering design as an activity embedded in and shaped by broader sociotechnical networks [21]. For example, Henderson's work draws on actor-network theory to argue that designing is not just a solitary task but one that involves the creation of new sociotechnical networks. Successful engineers, therefore, are those who can navigate and build these networks effectively. Henderson further emphasizes the role of local, contingent factors in shaping design outcomes, using the example of straw bale building standards in Arizona and New Mexico to illustrate how ethical values vary across regions and influence design decisions. Similarly, the specific structure of the sociotechnical networks in which engineers operate can significantly influence their moral imagination. The ethical challenges faced by engineers are not only about specific issues they encounter but also about how the organizations and networks they work within shape their ethical decision-making [22]. It is a broader focus on engineering about its social environment highlights how engineers' actions are inevitably influenced by the networks and structures they work within, thus framing engineering as a socially situated and ethically charged practice.

CONCLUSION

The legal status of software, involving both copyright and patent law, remains complex due to its evolving nature. Software can now be copyrighted, and both algorithms and software may be patented as methods or apparatus. However, patents may be denied for software that simply automates tasks previously done manually, especially if those tasks are seen as a "way of doing business." This legal ambiguity highlights the need for clarity in the legal framework governing software and its development. Additionally, research in engineering ethics should be combined with real-world studies of the engineering design process. STS (Science, Technology, and Society) research is instrumental in understanding the moral implications of engineering design, emphasizing the influence of the sociotechnical context, the organizational structure, and the resulting artifacts. These factors shape the social consequences of engineering work and determine the ethical responsibilities of engineers. If engineering ethics is to address the moral questions posed by technological developments, it must be informed by STS research that closely examines the dynamics at play. Furthermore, while assessing the impact of engineering ethics education on students can be challenging, focusing on real-world ethical issues and the complexities of engineering judgments is likely to shape students' attitudes toward ethical responsibility in the workplace. In this way, engineering ethics education can prepare future engineers to engage thoughtfully and responsibly with the moral dilemmas they will encounter in their professional careers.

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