The Virtues of Engineering Practice: An Investigation of Professional Codes of Ethics in Engineering

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ABSTRACT - In this paper, we analyze three prominent professional engineering codes of ethics (NSPE, IEEE, and SHPE) to identify the virtues of engineering practice. This preliminary investigation by four raters (three engineers and one philosopher) revealed six prominent virtues - *Responsibility*, *Integrity*, *Honesty*, *Trustworthiness*, *Teamwork*, and *Fairness*. As an opportunity for future work, we believe there are missing virtues (e.g., *Bravery*, *Leadership*, *Curiosity*, *Creativity*, *Perseverance*, *Hope*, *Love of Learning*) that should be made more visible to the practice of engineering and thus engineering code of ethics. Identifying the virtues of engineering practice can inform engineering ethics education and broaden the ethics perspective by introducing virtues and virtue ethics to the education of future engineers. A virtue ethics lens offers a richer understanding and more humanistic perspective to ethical dilemmas facing engineers every day. Implications for engineering education and engineering practice are discussed.

Keywords - Engineering Ethics, Virtue Ethics, Character Education, Engineering Codes of Ethics, NSPE, IEEE, SHPE

I. INTRODUCTION

Technological advancements require the highest standards of ethical reasoning and ethical practice. This is evident is not only technological failures and ineffective practices that have led to unethical technologies, but also evident with individuals and organizations that embody unethical practices and standards. Engineers play a critical role to both technological advancements that better society and to high standards of ethical practice for benefiting public welfare. Many engineering professional societies have established codes and standards to guide engineering professionals with both technical matters and ethical matters. Professional code of ethics will be the focus of our investigation in this paper.

Engineering ethics is professional ethics and thus it is of no surprise that engineering codes of ethics serve as a starting point for many engineering educators to instill the importance of engineering ethics to engineering students (Harris et al., 1996). Davis (2017) has argued that "a code of professional ethics is central to advising individual engineers how to conduct themselves, to judging their conduct, and ultimately to understanding engineering as a profession."

Broadly defined, codes of ethics are general guidelines to ethical and professional conduct. Codes of ethics serve to help professionals (a) understand and uphold ethical and professional

conduct, (b) ensure public welfare and social responsibility is a foremost priority, and (c) understand the responsibility they have as competent and ethical professionals. Similar to other professional standards (e.g. medicine, law), engineering codes of ethics communicate expectations of competence and character, two critical facets that embody the professional engineer licensure process. According to Luegenbiehl, "codes of ethics have a significant place in the history of the engineering profession, but *in their present form* [emphasis added] they have perhaps outlived their usefulness" because so many of them are now outdated and not being used (Luegenbiehl, 2017). This points to the need for codes of ethics in engineering to be updated so that they are current and being used to teach and uphold the values and virtues of the profession. Engineering codes of ethics served a purpose in their infancy to enable aspirations of professional status and many were modeled on examples provided by other professions (e.g. law, theology, and medicine) (Luegenbiehl, 2017). Revisiting and updating engineering codes of ethics is thus an essential step to professional responsibility, status, education, and accountability.

Codes of ethics exist across many engineering professional societies and vary globally even among similar professional societies. In the United States alone, there are over 100 engineering professional societies. Some of the biggest ones, by membership, are the Institute of Electrical and Electronics Engineers (IEEE), American Society of Mechanical Engineers (ASME), American Society of Civil Engineers (ASCE), etc. Other prominent engineering professional societies (but not necessarily the largest by membership) include the National Academy of Engineering (NAE), the National Society of Professional Engineers (NSPE), and the Order of the Engineer. Codes of ethics even vary globally for similar professional societies. AlZahir and Kombo examined the compatibility of the IEEE code of ethics against thirty two international codes of ethics of professional engineering societies in Africa, Asia, Australia, Europe, and Latin America. They discovered that only four countries had adopted the IEEE code of ethics as is and the majority of countries (N=28) had variations that reflected sociopolitical and cultural differences (2014).

A global professional code of ethics for engineers would be great but unfortunately does not exist. The most prominent U.S. code of ethics for engineers is the one developed by the National Society of Professional Engineers (NSPE), as it represents licensed professional engineers. Please note that licensure for engineers is not a requirement for most engineering disciplines. The majority of licensed Professional Engineers (PEs) are civil engineers. Industry exemptions have inhibited most of the other engineering disciplines from enforcing the PE as a licensure standard. What this means is that each engineering professional society sets its own code of ethics and follows its own process to make updates. As an example, ASCE (Civil Engineers) established their code of ethics in 1914, borrowing considerably from the 1912 Institution of Civil Engineers, London (Griggs, 2009). The ASCE code of ethics has been updated several

times and currently represents both standards around ethics and professional conduct (Griggs, 2009). Opportunities for updating the ASCE code of ethics have been advocated (Griggs, 2009).

When one begins to examine engineering codes of ethics, even in the midst of each professional society having its own version, clear ethical standards become visible quickly - social responsibility (e.g., public welfare), honesty, integrity, competence, etc. **A systematic review of the engineering codes of ethics from a virtue ethics lens has not been conducted, to the best of the authors' knowledge. Thus, the purpose of this paper is to conduct a preliminary investigation aimed at identifying the virtues of engineering leveraging codes of ethics as a starting place**. The four guiding research questions of this paper are as follows:

(1) RQ1 - What are the virtues embedded within prominent engineering codes of ethics?
(2) RQ2 - How do the virtues across prominent engineering codes of ethics compare?
(3) RQ3 - What virtues are not part of engineering codes of ethics?
(4) RQ4 - What are the implications of our findings to engineering ethics education?

Engineering ethics is not only required of engineering professionals, but is also expected of all ABET accredited engineering programs. Because codes of ethics serve as a foundational starting point for many engineering educators to teach engineering ethics, we believe that this paper will help engineering educators support student learning. Further, because engineering codes of ethics must continue to evolve and remain relevant and current to engineering professionals, we also believe that findings from this paper have the potential to inform future iterations of engineering codes of ethics.

Whereas deontology and consequentialism are the two ethical lenses more prominently grounding engineering ethics, virtue ethics has been identified as a significant and essential ethical lens to be part of engineering ethics courses and learning (Pierrakos et al., 2019; Frigo et al., 2021). A virtue ethics lens will ground our investigation herein.

II. METHODS

While most engineering societies have codes of ethics, for this investigation, we selected only a subset of the available codes. First, we selected the National Society of Professional Engineers (NSPE) Code of Ethics, one of the more prominent and widely used, and representing a cross-disciplinary engineering society constituted primarily by licensed PEs. Second, we selected the Code of Ethics of the Institute of Electrical and Electronics Engineers (IEEE), one of the largest engineering professional societies in membership, and representing a large discipline-specific society that has international reach. Lastly, we selected the Code of Conduct and Ethics Policy of the Society of Hispanic Professional Engineers (SHPE), which is a cross-disciplinary society

whose membership is primarily constituted by licensed PEs who also belong to an underrepresented demographic group within engineering.

Next, we selected a well-known and broadly accepted list of 24 character strengths, developed by the VIA Institute of Character (Peterson & Seligman, 2004). While there is no universal list of virtues, the 'character strengths' identified by the VIA can also be regarded as a list of virtues, representing positive, and sometimes aspirational, aspects of an individual's personality that positively affect everyday actions and thoughts. Developed by a team of psychologists and other scholars, the VIA's list of 24 character strengths (www.viacharacter.org/character-strengths) is supported by years of research and offers definitions and examples of character strengths in action. Working from this list, we carried out a preliminary inspection of the three codes, to discern whether they might include possible strengths central to *engineering practice* but not captured by the VIA, which was developed through a broader lens. Next, we developed a preliminary set of definitions for all the character strengths in our list, defining the strengths borrowed from VIA's list based on the definitions available on the organization's website (see the link above), and drafting similar-style definitions for strengths that we added beyond the VIA 24. We then narrowed our list to only traits for which an explicit justification as a strength *of character* could be made. For example, *Competency* is an important trait for a practicing engineer, but is not a strength *of character*. *Loyalty* to employer and client is also an important trait, but based on the VIA definition of *Teamwork*, instances of loyalty most commonly fall under the *Teamwork* character strength. Thus, our final working list of character strengths included *Empathy*, *Integrity*, *Responsibility*, *Service*, and *Trustworthiness*, in addition to the VIA 24 (see Table 1).

Next, our interdisciplinary research team, constituted by three engineers of differing disciplinary backgrounds and a philosopher who specializes in research on character, agreed on a streamlined set of definitions for each of the 29 character strengths (also Table 1) that also ensured relevance to engineering practice. The goal was to promote a common understanding of each character strength in the list among every member of our team, to reduce subjectivity in the next steps of our analysis. Then, all four members of our team independently mapped each statement in each of the three codes to one or more character strength from our list of 29. In the case of the NSPE code of ethics, mapping was restricted to the six fundamental canons and nine professional obligations, in part because the five rules of practice are verbatim reiterations of the first five fundamental canons.

Table 1. Working list of 29 character strengths: the 24 listed by the VIA Institute of Character, and 5 added by our team (*).

Appreciation of beauty - Noticing and appreciating beauty, excellence, and/or skilled performance, in all domains of life.	**Humility** - Accurately evaluating your accomplishments and having an awareness of your mistakes, gaps in your knowledge, or imperfections.	**Prudence** - The ability to see the long-term consequences of your actions, having practical wisdom.
Bravery - Facing your challenges, threats, or difficulties, rather than avoiding them.	**Humor** - The ability to offer the lighter side of things to others, especially in instances of adversity, allowing oneself to sustain a good mood.	***Responsibility** - Being accountable for your actions and having a duty toward others, who can trust you to complete your tasks.
Creativity - Thinking of new ways to do things that offer a positive contribution.	***Integrity** - Exhibiting a consistent and uncompromising adherence to strong moral and ethical principles and values.	**Self-regulation** - Having a good level of confidence in your belief that you can be effective in your pursuits and are likely to achieve your goals.
Curiosity - Gaining fulfillment in the journey toward an answer, engaging in a new experience, or learning a new fact.	**Judgment** - Making rational and logical choices, weighing the evidence fairly, and analytically evaluating ideas, opinions, and facts.	***Service** - An incorruptible sense of commitment to the public's interests.
***Empathy** - The ability to understand and share the feelings of others.	**Kindness** - Being generous and compassionate with others, and believing others are worthy of attention and affirmation for their own sake as human beings.	**Social intelligence** - An awareness of the motives and feelings of yourself and of others.
Fairness - Treating people justly and without personal bias, while recognizing that 'fair' for one person may not be the same as 'fair' for another.	**Leadership** - The ability to organize and encourage a group to get things done, while maintaining good relations in the group.	**Spirituality** - A belief that there is a dimension to life beyond human understanding.
Forgiveness - To extend understanding toward those who have wronged us and let go of the painful feelings associated with an offense.	**Love** - Valuing close relationships with others, and contributing to that closeness in a warm and genuine way.	**Teamwork** - Being committed to contributing to the team's success and possessing a sense of social responsibility.
Gratitude - Feeling a deep sense of thankfulness in life, and taking the time to genuinely express thankfulness to others.	**Love of learning** - Having a desire to learn just for learning's sake, and to expand their fund of knowledge.	***Trustworthiness** - Being dependable and perceived as truthful.
Honesty - Presenting yourself in a genuine and sincere way, speaking the truth, and taking responsibility for your actions.	**Perseverance** - Being hardworking and finishing what has been started, despite barriers and setbacks.	**Zest** - Approaching a situation with excitement and energy.
Hope - Holding positive expectations about the future and focusing on the good things to come.	**Perspective** - The ability to see the bigger picture in life, to see the system as a whole.	

III. RESULTS AND DISCUSSION

Our results herein showcase the compilation of mappings by our four-rater team. The compilation of all four rater lists into one was conducted in a manner such that every character strength identified by any member of our team was retained in our final lists, while also accounting for the frequency of identification (a maximum frequency of four, with four team members). Our compiled results are available in Tables 2-4, respectively mapping to the NSPE, IEEE, and SHPE Codes of Ethics. The numbers in parentheses indicate the frequency of identification; where no number is indicated, the associated strength was identified by only one individual. The virtues in bold visually highlight strong rater alignment, demonstrating virtues that the majority (3 or 4) of the raters identified. The remainder of the results is organized around our research questions.

RQ1 - What are the virtues embedded within prominent engineering codes of ethics?

For the NSPE Code of Ethics, Table 2, seven virtues were highly endorsed by the four raters, and there was strong agreement among the four raters - Service, Humility, Honesty, Integrity, Trustworthiness, Teamwork, and Responsibility. Similarly, for the IEEE Code of Ethics, Table 3, six virtues were highly endorsed with high agreement among the four raters - Integrity, Responsibility, Service, Honesty, Humility, and Fairness. For the SHPE Code of Ethics, Table 4, six virtues were highly endorsed with high agreement among the four raters - Honesty, Integrity, Responsibility, Leadership, Teamwork, and Fairness. While the majority of the highly endorsed virtues are visible across all three Codes of Ethics, several other virtues were identified but did not necessarily show strong alignment amongst the raters - Empathy, Judgment, Perspective, Social Intelligence, Self-regulation, Prudence, Bravery, Curiosity, Creativity, etc. This points to an opportunity for our team and future work to align better on definitions in advance of undertaking a code analysis, which would improve on our methodology. We do not suggest that these outlier virtues do not belong in engineering, in fact many of them do, but there is not strong alignment amongst our team of raters that these outlier virtues were clearly visible in the three Codes of Ethics. This could also present a future opportunity to engage a larger, more diverse panel of raters.

Table 2. Compiled results for the fundamental canons and professional responsibilities in the code of ethics of the NSPE. **Bold** font visually highlights instances of 3 or 4 rater alignment.

NSPE Fundamental Canons and Professional Obligations	
Canon 1 - Hold paramount the safety, health, and welfare of the public.	**Service** (4), Responsibility (2)
Canon 2 - Perform services only in areas of their competence.	**Humility** (4), Self-regulation, Empathy, Fairness, Judgment, Perspective, Social intelligence, Integrity, Honesty, Trustworthiness
Canon 3 - Issue public statements only in an objective and truthful manner.	**Honesty** (4), **Integrity** (3), Trustworthiness (2), Fairness, Responsibility
Canon 4 - Act for each employer or client as faithful agents or trustees.	**Trustworthiness** (3), **Teamwork** (3), **Responsibility** (3), Social intelligence
Canon 5 - Avoid deceptive acts.	**Honesty** (3), Trustworthiness (2), Fairness, Integrity, Responsibility
Canon 6 - Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.	**Integrity** (4), **Responsibility** (4), Honesty (2), Prudence, Bravery, Trustworthiness, Teamwork
Obligation 1 - Engineers shall be guided in all their relations by the highest standards of honesty and integrity.	**Honesty** (4), **Integrity** (4), Responsibility, Trustworthiness
Obligation 2 - Engineers shall at all times strive to serve the public interest.	**Service** (4), Responsibility, Bravery
Obligation 3 - Engineers shall avoid all conduct or practice that deceives the public.	**Honesty** (4), Integrity (2), Trustworthiness (2), Bravery, Fairness, Responsibility
Obligation 4 - Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve.	**Teamwork** (4), **Trustworthy** (3), Responsibility (2), Honesty
Obligation 5 - Engineers shall not be influenced in their professional duties by conflicting interests.	Fairness (2), Honesty (2), Integrity (2), Responsibility (2), Self-regulation, Teamwork, Social intelligence, Perspective, Judgment, Trustworthiness, Bravery
Obligation 6 - Engineers shall not attempt to obtain employment or advancement or professional engagements by untruthfully criticizing other engineers, or by other improper or questionable methods.	**Honesty** (4), **Integrity** (4), Fairness, Responsibility, Trustworthiness
Obligation 7 - Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.	**Honesty** (3), **Integrity** (3), Responsibility (2), Trustworthiness (2), Bravery (2), Fairness, Judgment
Obligation 8 - Engineers shall accept personal responsibility for their professional activities, provided, however, that engineers may seek indemnification for services arising out of their practice for other than gross negligence, where the engineer's interests cannot otherwise be protected.	**Responsibility** (4), Honesty, Integrity, Judgment, Trustworthiness
Obligation 9 - Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interests of others.	**Honesty** (4), **Integrity** (4), Fairness (2), Responsibility, Humility

Table 3. Compiled results for the code of ethics of IEEE. **Bold** font is used to visually highlight instances of 3 or 4 reader alignment.

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:	**Integrity** (3), **Responsibility** (3), Honesty, Prudence, Service, Teamwork
I. To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.	**Integrity** (4), **Responsibility** (4), Honesty, Humility, Trustworthiness
1. to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment;	**Integrity** (4), **Service** (4), Bravery (2), Honesty (2), Empathy, Fairness, Judgment, Perspective, Social intelligence, Responsibility, Trustworthiness
2. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;	**Service** (4), Honesty (2), Social intelligence (2), Creativity, Curiosity, Fairness, Hope, Love of learning, Integrity, Perspective, Prudence, Responsibility, Trustworthiness
3. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;	**Honesty** (4), Fairness (2), Self-regulation, Teamwork, Social intelligence, Perspective, Responsibility, Integrity, Trustworthiness, Service
4. to avoid unlawful conduct in professional activities, and to reject bribery in all its forms;	**Integrity** (4), Honesty (2), Bravery, Fairness, Responsibility, Service, Trustworthiness
5. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others;	**Honesty** (4), **Humility** (4), **Responsibility** (3), Fairness (2), Trustworthiness (2), Bravery, Integrity, Judgment, Love of learning, Perseverance, Teamwork
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;	Honesty (2), Humility (2), Love of learning (2), Responsibility (2), Bravery, Integrity, Trustworthiness
II. To treat all persons fairly and with respect, to not engage in harassment or discrimination, and to avoid injuring others.	**Fairness** (4), **Integrity** (3), Empathy, Kindness, Responsibility, Service, Social intelligence
7. to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;	**Fairness** (4), **Integrity** (3), Empathy, Responsibility, Service, Social intelligence

8. to not engage in harassment of any kind, including sexual harassment or bullying behavior;	**Fairness** (3), **Integrity** (3), Empathy, Kindness, Responsibility, Service, Social intelligence
9. to avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors or any other verbal or physical abuses;	**Honesty** (3), **Integrity** (3), Fairness (2), Empathy, Kindness, Responsibility, Social intelligence
III. To strive to ensure this code is upheld by colleagues and co-workers.	**Responsibility** (4), Bravery (2), Teamwork (2), Honesty, Integrity, Leadership, Trustworthiness
10. to support colleagues and co-workers in following this code of ethics, to strive to ensure the code is upheld, and to not retaliate against individuals reporting a violation.	**Integrity** (3), **Responsibility** (3), Fairness (2), Bravery, Honesty, Leadership, Teamwork, Trustworthiness

Table 4. Compiled results for the code of ethics of SHPE. **Bold** font is used to visually highlight instances of 3 or 4 reader alignment.

SHPE Representatives shall always abide by and conform to the following Code in their respective capacities:	Integrity (2), Teamwork, Responsibility
1. Each SHPE Representative shall comply with all aspects of the Code and all other rules of SHPE (including but not limited to the organization's Articles of Incorporation, Bylaws, Policies and Procedures, provisions within the Employee Handbook if applicable, etc.). SHPE Representatives will at all times, obey any/all applicable federal, state and local laws and regulations.	**Integrity** (3), Honesty, Responsibility, Teamwork, Trustworthiness
2. SHPE Representatives will conduct the business affairs of SHPE in good faith and with honesty, integrity, due diligence, and reasonable competence.	**Honesty** (4), **Integrity** (4), Humility (2), Responsibility, Service
3. Except as authorized and directed by the CEO and/or National Board Chair, a SHPE Representative shall not share, copy, reproduce, transmit, divulge or otherwise disclose any confidential information (defined as but is not limited to, any data or information that is proprietary, is a trade secret, or gives SHPE a competitive advantage) related to the affairs of SHPE. Each SHPE Representative shall uphold strict confidentiality of all meetings and other deliberations and communications.	Responsibility (2), Teamwork (2), Trustworthiness (2), Integrity, Honesty, Service
4. SHPE Representatives will exercise proper authority and good judgment in their dealings with members, volunteers, stakeholders (e.g., representatives of SHPE's Industry Partnership Council) vendors, and the general public and will respond to the needs of the members, volunteers and other stakeholders in a responsible, respectful and professional manner.	**Responsibility** (3), Judgment (2), Service (2), Fairness, Honesty, Integrity, Leadership, Teamwork

5. SHPE Representatives shall not use or otherwise abscond with any data/information provided by SHPE or acquired by the SHPE Representative's as a consequence of the SHPE Representative's service to SHPE in any manner other than in furtherance of his or her duties/responsibilities to SHPE. SHPE Representatives shall not misuse or abuse or damage SHPE property or resources; and shall at all times keep SHPE's property and resources secure; and shall prohibit any unauthorized person to have or use such property or resources.	**Responsibility** (4), Trustworthiness (2), Integrity, Honesty, Service, Teamwork
6. SHPE Representatives will perform their assigned duties in a professional and timely manner pursuant to the National Board of Directors and CEO's direction and oversight. The National Board of Directors is responsible for governance of the organization, and direction and oversight of the National Board of Directors and the CEO. The CEO is fully responsible for oversight, direction, and management of all staff and any/all remaining SHPE Representatives. .	**Responsibility** (3), Teamwork (2), Integrity, Honesty, Service
7. Upon termination, expiration, and/or completion of service (i.e., termination of employment, agreement, and/or contract, retirement or expiration of National Board Member term limit, completion of a volunteer term) the SHPE Representatives will promptly return to SHPE any/all "property" (including but not limited to data/information, documents, electronic and /or hard/physical files, reference materials, and any/all other property and resources provided to the SHPE Representative during his/her term of employment, service, and/or engagement. Return of such property will not release the SHPE Representative from any/all continuing obligations and common law duties of confidentiality with respect to confidential information acquired/obtained as a consequence of his or her tenure with SHPE.	**Responsibility** (3), Honesty (2), Trustworthiness (2), Integrity, Responsibility, Teamwork
8. SHPE Representatives shall lead by example in serving the needs of SHPE and its Members, and in representing the interests and ideals of STEM-related industries at large.	**Leadership** (3), Integrity (2), Responsibility (2), Teamwork (2)
9. SHPE Representatives shall not solicit or persuade or attempt to persuade: 1) any employee of SHPE to leave their employment with the organization or to become employed by another entity; 2) any Member, exhibitor, advertiser, sponsor, subscriber, vendor/supplier, contractor, or any other person or entity to terminate, curtail or not enter into a relationship with SHPE; or 3) any donor or sponsor to reduce the monetary contribution or other benefits to SHPE.	**Responsibility** (3), **Teamwork** (3), Integrity, Honesty, Trustworthiness
10. SHPE Representatives shall act in the best interests of SHPE at all times and not for personal or third-party gain or financial enrichment. When encountering potential conflicts of interest, SHPE Representatives will identify and disclose the conflict and, as required, remove himself or herself from any/all discussion and/or voting on the matter. Specifically, SHPE Representatives shall:	**Integrity** (3), Honesty (2), Responsibility (2), Trustworthiness (2), Fairness, Leadership, Self-regulation, Teamwork

avoid placing (and avoid the appearance of placing) one's own self-interest or any third-party interest above that of SHPE; while the receipt of incidental personal or third-party benefit may necessarily flow from certain organization activities, such benefit must be merely incidental to the primary benefit to SHPE and its purposes;	Responsibility (2), Teamwork (2), Trustworthiness (2), Honesty, Integrity, Service, Self-regulation
not abuse their position and/or title within SHPE by improperly using their status or SHPE's staff, services, equipment, resources, or property for their personal or third-party gain or pleasure, and shall not represent to third parties that their authority as a SHPE Representative extends any further than that which it actually extends; • not engage in any outside b	**Integrity** (3), **Responsibility** (3), Honesty (2), Self-regulation (2), Teamwork (2), Trustworthiness (2)
not engage in any outside business, professional, or other activities that will directly or indirectly adversely affect/impact SHPE;	Responsibility (2), Teamwork (2), Honesty, Judgment, Self-regulation, Trustworthiness
not engage in or facilitate any discriminatory or harassing behavior/actions directed toward SHPE Representatives, event attendees, exhibitors, advertisers, sponsors, vendors/suppliers, contractors, or others in the context of activities relating to SHPE;	**Fairness** (3), Integrity (2), Honesty, Kindness, Responsibility, Teamwork
not solicit or accept gifts, gratuities, free trips, honoraria, personal property, or any other item of value from any person or entity as a direct or indirect inducement to provide special treatment to such donor with respect to matters pertaining to SHPE without fully disclosing such items to the National Board Chair and the CEO; and	**Integrity** (3), Honesty (2), Bravery, Fairness, Self-regulation
provide goods or services to SHPE as a paid vendor to the organization only after full disclosure to, and advance approval by, the National Board Chari and the CEO, and pursuant to any related procedures adopted by the organization.	**Honesty** (3), **Responsibility** (3), Integrity, Self-regulation, Teamwork, Trustworthiness

RQ2 - How do the virtues across prominent engineering codes of ethics compare?

In answering this research question, we put together a visual representation that can help us compare the virtues across the three Codes of Ethics. Figure 1 shows the number of unique occurrences of the identified virtues in statements in each of the three Codes of Ethics (NSPE, IEEE, and SHPE) as well as across all three (e.g., combined category). This figure reveals that all three Codes of Ethics map to *Responsibility*, *Integrity*, and *Honesty* as the top three endorsed virtues with the next tier of high frequency virtues being *Trustworthiness*, *Teamwork*, and *Fairness*. Thus, we see that there is strong alignment across the top six virtues across the three Codes of Ethics. The top five character virtues by number of occurrences across all three codes (counted once per statement) are: *Responsibility* (44), *Integrity* (41), *Honesty* (38), *Trustworthiness* (30), and *Teamwork* (23).

Differences amongst the three Codes of Ethics are revealed across virtues like *Bravery*, *Social Intelligence*, *Empathy*, *Leadership*, etc. *Bravery*, for example, has multiple occurrences in the NSPE and IEEE Codes of Ethics but only one within the SHPE Code of Ethics. *Social Intelligence* has several occurrences in the IEEE Codes of Ethics but none in the SHPE Code of Ethics. In fact, additional virtues that were identified in the NSPE and IEEE Codes of Ethics but non-existent in the SHPE Code of Ethics were the following - *Empathy*, *Perspective*, *Love of Learning*, *Prudence*, *Creativity*, *Curiosity*, *Perseverance*. Because of this, the raters perceived the SHPE Code of Ethics as reflecting more legal statements and standards rather than aspirational ethical standards.

RQ3 - What virtues are not part of engineering codes of ethics?

Of the 29 professional character strengths (Table 1), there were eight not identified by any of the raters for any of the codes: *Appreciation of Beauty*, *Humor*, *Gratitude*, *Love*, *Forgiveness*, *Hope*, *Zest*, and *Spirituality*. While these virtues are not necessary to define the character landscape of an engineer, these omissions should not imply that these character virtues are not desirable. There are three virtues that surprisingly only appear once across the three codes analyzed - *Curiosity*, *Creativity*, and *Perseverance.* This surprised us because we all recognized how essential these virtues are to the practice of engineering and yet they are almost non-existent in the three engineering Codes of Ethics that we investigated.

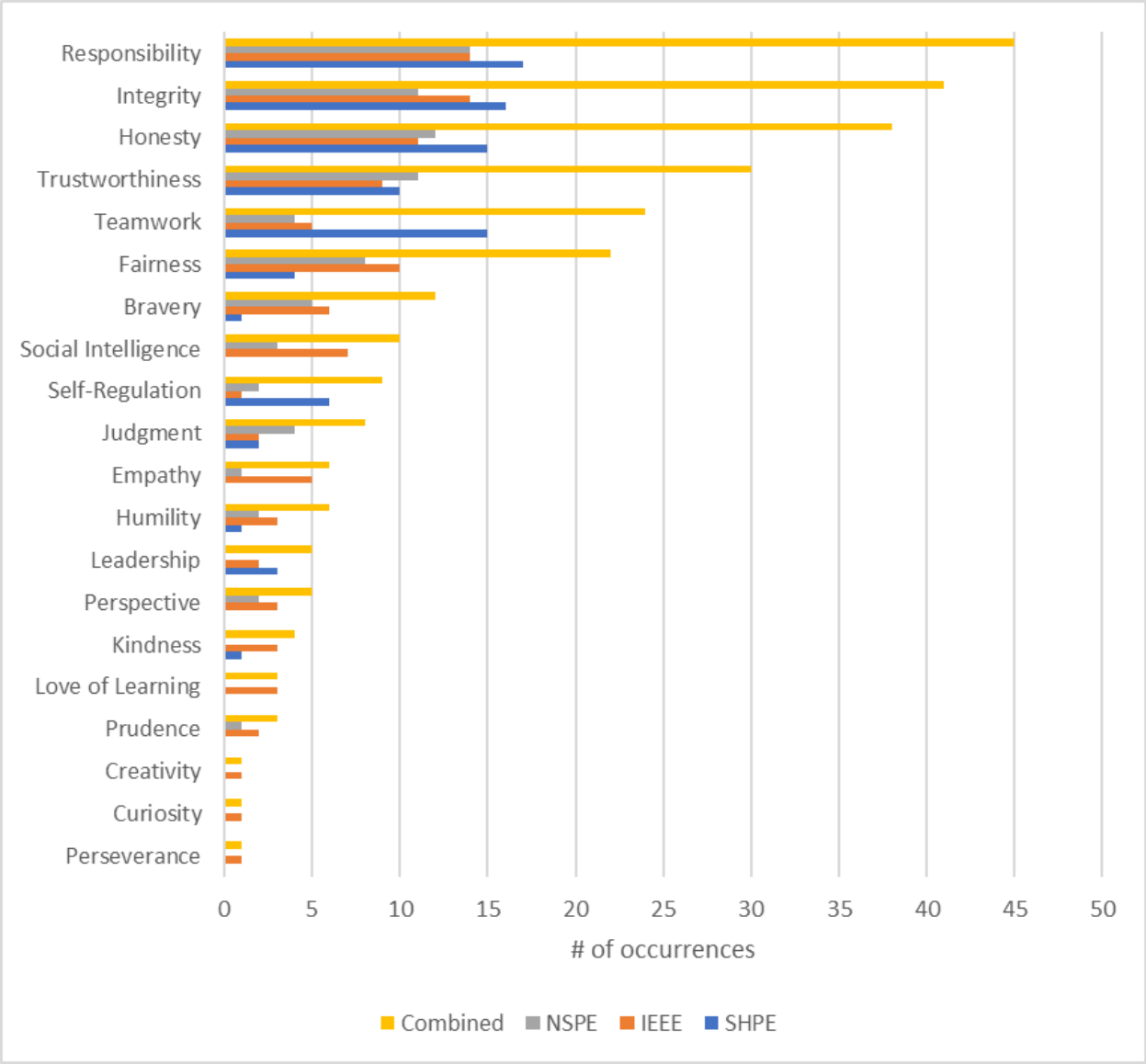

Figure 1: Number of occurrences of the identified virtues in each of the three Codes of Ethics (NSPE, IEEE, SHPE) and combined.

V. CONCLUSIONS

Engineering ethics is not only an essential part of engineering education, but a required component of all ABET accredited engineering programs. Many engineering educators use codes of ethics to introduce engineering ethics to undergraduate engineering students. Yet, to the best of our knowledge, no other study has attempted to identify the virtues embedded in these engineering codes of ethics, the most prominent being the NSPE Code of Ethics. A virtue ethics lens offers educators a unique and important perspective in teaching engineering ethics.

In our preliminary investigation of mapping virtues to three engineering codes of ethics (NSPE, IEEE, and SHPE), our four-rater team (three engineers and one philosopher) made some important observations. First, we discovered that six virtues appeared in all three codes of ethics - *Responsibility*, *Integrity*, *Honesty*, *Trustworthiness*, *Teamwork*, and *Fairness*. While the number of occurrences of each of these virtues varied by code, these were the most prevalent virtues found. Other virtue occurrences were also identified; our rater team had a high degree of alignment on some of these virtues and not so much with others. This points to the opportunity for future work.

We were surprised that some virtues did not have a stronger presence in the three engineering code of ethics - *Bravery*, *Leadership*, *Curiosity*, *Creativity*, *Perseverance*, *Hope*, *Love of Learning*, etc. Take *Curiosity* as an example. Professional Engineer licensure requires continuing education for engineers annually and this is built on curiosity to keep learning and a curiosity to remain current with engineering knowledge. Similarly, ABET accreditation requires all programs to show attainment of student outcomes that map to several virtues. Student Outcome 7, as an example, states that graduates should demonstrate "an ability to acquire and apply new knowledge as needed, using appropriate learning strategies." Without curiosity as a virtue, it is hard to achieve this outcome. The curious student or engineer would want to engage in new knowledge seeking activities, even without prompting.

We do believe that professional codes of ethics should be updated regularly and believe that some of these virtues that are currently not strongly present (or not at all present) should be added. There are many implications for engineering educators, engineering units, and professional societies:

(1) Virtue ethics and a virtue investigation of engineering codes of ethics can and should have a more prominent role in engineering education.

(2) Virtue ethics and engineering codes of ethics can also help shape engineering cultures, such as engineering education. As an example of this, the authors' engineering department had identified several values and virtues (i.e. integrity, inclusion, compassion, growth, empowerment, joy, curiosity, creativity, resilience) to shape the department culture and learning environment. In reflection on the results of the mapping of the professional codes, it was evident that most of these departmental values and virtues were poorly represented in the codes of ethics. This is interesting given the need to stay current in the ever changing professional landscape of engineering.

(3) Professional societies should update their codes of ethics more regularly and ensure that these codes fully reflect the virtues of the profession. Engineering educators should also consider establishing or adopting codes of ethics to showcase the virtuous aspirations of

engineering professionals. It is not a coincidence that the licensure process in becoming a Professional Engineer requires support letters from other engineers as "character witnesses."

(4) The virtue ethics lens should be more strongly embedded in engineering education curricula and connections made to ABET accreditation requirements can strengthen the education of the next generation of engineers.

VI. LIMITATIONS & FUTURE WORK

While our investigation has offered new insights, we recognize that limitations exist in our methods that can be improved with future work. As an example, we noted variation in the virtues assigned by the four-rater team. Although we used a common set of definitions for the 29 professional character strengths used in this study, the raters were not always aligned on identifying the virtues mapping to each statement within the three codes. Some virtues were clearly stated in the statements themselves such as Obligation 1 of the NSPE code of ethics which states "Engineers shall be guided in all their relations by the highest standards of *honesty* and *integrity*." *Honesty* and *integrity* are explicit virtues intended by this statement and were selected by all four raters. However, *responsibility* and *trustworthiness* were also listed as virtues that a rater felt were implied by this statement. *Responsibility* appears at least once per NSPE obligation. While there are semantic differences between the terms "obligation" and "responsibility", they are often used interchangeably in practice. Virtues are also not mutually exclusive and relationships exist between them, even in their definitions. Here, *trustworthiness* is defined as "dependable and perceived as truthful" which has similarities to the partial definition of *honesty* of "speaking the truth". However, *trustworthiness* is not a necessary condition for one to embody *honesty*. This is just one example of how individuals can have different interpretations of the same statements and can identify implied virtues through perceived relations.

Thus, we believe that this study can be revised in a few key ways to address the observed variation and to limit the impact of outliers. First, further refinement of the virtue definitions could be done to provide better alignment. Second, the addition of more raters, such as more philosophers and engineers (including Professional Engineers and a more geographically and culturally diverse rater pool), could support a more complete investigation. Third, it may be prudent to have the raters repeat the exercise on non-consecutive occasions to identify variations in individual ratings. It would also be worthwhile to randomize statements when rating. Statements within the same code can be redundant during rating (which is why the NSPE rules were removed). Raters can also develop fatigue while rating and wane in focus over time, which may not provide equal treatment during rating. Future work could also target a more diverse set of engineering codes of ethics. In addition, polling of society members to better understand how

the membership as a whole regards their specific codes could provide insight into the perceived relevant importance of the codes as a defining feature of an engineer.

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