2015

WHAT IS IT TO BE AN ETHICAL ENGINEER? A PHENOMENOLOGICAL APPROACH TO ENGINEERING ETHICS PEDAGOGY

Valorie Troesch
Michigan Technological University

Follow this and additional works at: https://digitalcommons.mtu.edu/etds
Part of the Education Commons, and the Philosophy Commons

WHAT IS IT TO BE AN ETHICAL ENGINEER?

A PHENOMENOLOGICAL APPROACH TO ENGINEERING ETHICS PEDAGOGY

By

Valorie Troesch

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In Rhetoric, Theory and Culture

MICHIGAN TECHNOLOGICAL UNIVERSITY

2015

This dissertation has been approved in partial fulfillment of the requirements for the Degree of DOCTOR OF PHILOSOPHY in Rhetoric, Theory and Culture.

Department of Humanities

Dissertation Advisor:	*Ann Brady*
Committee Member:	*Scott Marratto*
Committee Member:	*Abraham Romney*
Committee Member:	*Susan L. Amato Henderson*
Committee Member:	*Jean-Celeste Kampe*
Department Chair:	*Ronald L. Strickland*

To my husband Keith
for keeping the home fires burning and the technology working

To my friend Sue
for our late night conversations during law school, when we were certain we would change the world

To my mother Pearl
who always believed there was nothing her children could not do

“Nobody said not to go.”

Emily Hahn

Table of Contents

List of Tables

Acknowledgements

I thank my dissertation committee members – Dr. Ann Brady, Dr. Scott Marratto, Dr. Abraham Romney, Dr. Susie Amato-Henderson, and Dr. Jean Celeste Kampe – for all their time, commitment, mentoring, and advice. I am more knowledgeable and this dissertation is, without any doubt, better because of their guidance. In particular, I thank my chair, Dr. Ann Brady. I've told her often, but it bears repeating here, that I would not likely have written this dissertation but for her teaching of HU5003, where everything – collectively – finally made sense.

I also thank my comprehensive exams committee – Dr. Ann Brady, Dr. Patricia Sotirin, and Dr. Syd Johnson. Thank you for your guidance and for steering me in the right direction. As I look back now, I marvel at and am grateful for your optimism and faith in me.

Abbreviations Used

ABET	Formerly: Accreditation Board for Engineering and Technology. Now: ABET (no longer an acronym)
DIT	Defining Issues Test
DIT-2	Defining Issues Test-2 (successor to DIT)
E.C. 3(f)	ABET's Accreditation Engineering Criterion 3(f): an understanding of professional and ethical responsibility
ESSQ	Ethical Sensitivity Scale Questionnaire
JEE	Journal of Engineering Education
NSF	National Science Foundation
NSPE	National Society of Professional Engineers
SEED	Survey of Engineering Ethical Development
STEM	Science, Technology, Engineering, and Mathematics

Abstract

Two concerns are prominent in engineering ethics pedagogy and, together, pose a conundrum for ethics educators: 21st century technologies raise daunting ethical questions that require a strong engagement with and understanding of ethics by engineers; at the same time, however, engineering students don't care much about studying ethics. Ethics instruction, however, seems nonresponsive to these issues. It continues to rely on Western ethical theories using case studies to analyze professional engineering conduct. And, although instructors want better student learning outcomes, assessment continues to use quantitative measures of ethical knowledge and ethical reasoning skills which disregard students' emotional engagement with ethics and underestimates ABET's Engineering Criterion 3(f) which requires that engineering students have an understanding of professional and ethical responsibilities. In the end, dissatisfaction with instruction and student learning outcomes persists.

Given the epistemological foundations of engineering – that engineering is applied science using knowledge that is universal, objective, certain, and discoverable through reason – it is unsurprising that engineering ethics is taught the same way science is taught using a linear, positivistic, problem-solving approach that assumes reason will yield correct and usually quantitatively determined answers to ethical questions. In this dissertation, I argue that, contrary to the dominant thinking passed on to generations of students that engineering is applied science and, as such, largely ethically neutral beyond safe and efficient design, the practice of engineering actually arises from a contingency model of knowledge and is, correspondingly, imbued with both uncertainty

and ethics. I contend that the way we teach engineering ethics must change if we expect different learning outcomes from undergraduate engineering students.

In this research, I introduce an engineering ethics pedagogy informed by phenomenology, the study of human meaning from the standpoint of experience. Students are asked to research the phenomenological question, "what is it to be an ethical engineer?" and employ principles of hermeneutic phenomenology to interpret and understand that experience. Quantitative measures test changes in students' ethical sensitivity and ethical reasoning skills, and qualitative methods informed by philosophical hermeneutics are used to assess changes in students' emotional engagement with ethics and their understanding of professional and ethical responsibilities.

I draw two principal conclusions from my work on this project. First, a one-credit ethics course using a phenomenology-informed engineering ethics pedagogy can contribute to undergraduate engineering students' improved ethical sensitivity, ethical reasoning skills, emotional engagement with the study of ethics, and understanding of professional and ethical responsibility. Second, qualitative assessment revealed that we educators of engineering ethics are not attuned to what is important to our undergraduate engineering students. While we are intent on imparting ethical knowledge, our students worry about how they will fit into the world of engineering as ethically competent professionals when they move from undergraduate student to practicing engineer. This is a gap we must fill if we expect our students to graduate with an understanding of their professional and ethical responsibilities. A phenomenological approach to engineering ethics education – where students are given the opportunity to investigate, encounter, and understand the real, lived experience of what it is to be an ethical engineer – can help fill this gap.

Introduction

The ancient Greeks left us with an ambivalent – and often contentious – legacy that contrasts two kinds of knowledge – one generally associated with Plato and Aristotle which holds that knowledge is universal, transcendent, unchanging, objective, certain, and discoverable through reason, and a second originally associated with the Greek Sophists which holds that knowledge is changeable, contingent, constructed, shaped by values and ideology, and perhaps unknowable at all. This dualism, which has persisted for over two and a half millennia, accounts for differences in how we understand, value, and use knowledge. The former, which includes scientific and technological knowledge, is understood as objective, provable, quantitative, and governed by first principles. By this view, the universe is a highly ordered place and knowledge, as part of that universe, is ordered as well. There is a place for everything and everyone, and pursuit of this order and knowledge of it are the highest good for humans to pursue. This is also an exclusionary position because its adherents often argue that anything else – things that cannot be proven or known with certainty – is simply not knowledge. In his day, Plato labeled these other practices “rhetoric” and mocked them as “cookery,” “flattery,” “routine,” and “irrational” – a pejorative characterization of rhetoric that holds today. Over time, this first view of knowledge prevailed and, importantly, was privileged because it was and is perceived as trustworthy, credible, certain and, therefore, true.

During the Enlightenment and the ensuing age of industrialization, this view of knowledge was used to justify a sweeping and enduring shift in the classic ancient Greek conception of the universe. Certainty was endorsed as the absolute criterion for

knowing what is true and real – Descartes's *"Cogito ergo sum"* characterizes this as well as any other Western thinker. With the continuing discovery of human capability to use the principles of science to dominate nature and utilize the Earth's resources in ways previously unknown, people started to see the world as a place for them to control and use as they please without much regard for the order of things or the consequences. This contrast between modern technology and Greek craft is part of Heidegger's message in his mid-20th century lecture, *The Question Concerning Technology.* Thus began the movement toward a view of science as ethically neutral, a view that was extended to the professions and technologies that use science as well (Goldman).

The professions that are concerned with or employ science and technology – principally STEM (science, technology, engineering, and mathematics) fields – are, not surprisingly, privileged by a world that values certainty and reason. And this attitude of privilege extends to the education and preparation for entering these professions. Engineering programs, in particular, have been and remain firmly entrenched in the position that, because scientific and technological knowledge is both privileged and particular to certain professions, engineering students should be concerned with studying the things that will help them develop engineering skills (Colby and Sullivan, Bucciarelli). Further, because it employs ethically neutral science knowledge, engineering is declared a largely ethically neutral profession outside safe and efficient design; beyond this, ethical decisions should be left to others such as managers and policy makers (Goldman). Thus, the thinking goes, engineering students have little need for and should not be expected to study non-scientific knowledge such as rhetoric or ethics unless it

contributes to the technical skills of engineering (see Michael Davis, “Rhetoric, Technical Writing, and Ethics”; Russell; Latour).

This thinking was confronted head-on when, in 2000, ABET adopted Engineering Criterion 3(f), a new accreditation requirement that students who graduate from accredited undergraduate engineering programs must have “an understanding of professional and ethical responsibility.” This deceptively modest mandate upset the longstanding tradition of engineering education’s resistance to non-scientific coursework for engineering students and undermined its deep-rooted position that engineering students have little need for this type of knowledge or skill. Engineering programs now had to find ways to provide their students with the requisite understanding of professional and ethical responsibility and prove it to ABET. Engineering programs have had 15 years to contend with EC 3(f) and, by most accounts, actual outcomes for students remain unsatisfactory (see, for example, Colby and Sullivan). Ethical reasoning skills of undergraduate engineering students are below those of their peers (Carpenter, Harding, and Finelli). Most engineering students do not think that the study of ethics is important and do not want to take ethics coursework (Newberry); engineering faculty for the most part do not want to and do not know how to teach ethics (Pine); intended learning outcomes for students are vague; and assessment of student outcomes for ethics is often nonexistent or meaningless (Colby and Sullivan).

More recently, two concerns have come to dominate the discussion in engineering ethics pedagogy and, together, pose a conundrum for ethics educators: 21st century technologies raise daunting ethical questions that require a strong engagement with

ethics by engineers (Pine); yet engineering students still don't care much about studying ethics (Newberry). Most ethics education researchers agree that these concerns are not being adequately addressed by current ethics pedagogical practice (see, for example, the study by Colby and Sullivan). Nevertheless, although there is some tinkering here and there, ethics instruction has not changed and is still premised on the assumptions, first, that ethics must be taught as science knowledge is taught using a linear, objective, positivistic, problem-solving approach that assumes pure reason will yield correct and usually quantitatively determined answers to ethical questions and, second, that learning outcomes for ethics knowledge must be quantitatively measurable for assessment purposes.

In this Introduction, I make several broad assertions about the epistemological foundations of engineering, the attitudes and approaches of engineering programs toward engineering ethics education and assessment, and the student outcomes being achieved. These claims may seem harsh and perhaps unjustified at this point, particularly to an engineering audience. But I explain and support each claim in later chapters of this dissertation where full contexts and nuances pertaining to these thorny issues are addressed and clarified. I ask the reader's patience, indulgence, and continued reading.

In this dissertation, I will argue that the prevailing traditional approach to engineering ethics pedagogy does not adequately prepare students for the ethical responsibilities of engineering practice. Briefly, my arguments are:

The claim that the profession of engineering is ethically neutral is mistaken. To the contrary, engineering design practice is imbued with ethics (Bunge, Bucciarelli). Engineering design is driven by uncertainty and value judgments such that engineers are not mere technicians who design things in isolation from consequences in the world. Although history has managed to convince us otherwise so that engineering continues to be perceived as an ethically neutral science, engineering is much more accurately characterized as a sophistic or contingency form of knowledge and practice (Goldman).

Nonetheless, engineering education programs continue to operate as if ethical training for engineering students requires little more than doing what is needed to secure ABET accreditation. There remains widespread conviction among faculty – and a corresponding indoctrination of students – that the ethics of engineering are limited to the efficient design of safe products. Several consequences follow from this assumption. First, the learning outcomes established by engineering programs for undergraduate engineering students reflect this assumption and appear to be accreditation-driven and not motivated by a commitment to prepare students as much as possible for the authentic experience of being an ethical engineer in the world they enter on graduation. Although educators argue that they want engineering students to care about making ethical decisions, the objectives and performance indicators established by engineering programs do not reflect this outcome.

Second, because most engineering ethics coursework is modeled on science instruction methods using standardized case studies, students expect that engineering ethics problems have unambiguous answers that can be resolved by the application of rules

and quantitative decision methods (Burbules, Wike, Harris). Engineering students *may* improve their ethical reasoning skills (the ability to apply ethical principles to sets of problems) – though the evidence here does not strongly support this outcome – but they certainly do not improve their sense of the importance of ethics, their awareness of the potential scope and ambiguity of professional and ethical responsibility, and their understanding of and commitment to being ethical engineers (Conlon and Zandvoort). The myth that the sole function of engineers is to work as individual isolated agents (alone or as a team unit) whose ethical decisions are limited to matters involving safe and efficient designs is thereby perpetuated (Herkert "Ways of Thinking about and Teaching Ethical Problem Solving: Microethics and Macroethics in Engineering").

Third, engineering program assessment methods and data to establish that graduating engineering students actually have "an understanding of professional and ethical responsibility" are frequently vague and unreliable (Colby and Sullivan). I argue that ABET's Engineering Criterion 3(f) is severely underestimated by most engineering programs. The mandate has two requirements: an understanding of professional responsibility and an understanding of ethical responsibility, a much broader obligation than is generally undertaken by engineering programs. But engineering programs and engineering faculty perceive ethics as something that is not assessable, and this attitude is reflected in both assessment methods and resulting data, making it nearly impossible to know if the criterion is being achieved.

My dissertation research aims to address these concerns. I propose and test (1) a phenomenological approach to engineering ethics pedagogy that can improve not only

students' ethical reasoning and sensitivity but also their emotional engagement and their understanding of professional and ethical responsibilities, and (2) a qualitative methodology to assess whether this engagement and understanding are being achieved by students.

The Research Idea

This research project was borne of my own frustration with the tedium of teaching undergraduate engineering ethics at Michigan Technological University. Early on, I understood that most students signed up for my one-credit 3000-level elective class because they realized, in their final year as undergraduates, that they were one credit short to graduate. Each year, I surveyed the class and learned that this was their prime motivation for taking my ethics class. They expected the class to be easy and boring. And I made certain it met their expectations.

I did this by teaching ethics the way it is usually done. I assigned a standard engineering ethics textbook with a traditional approach to ethics instruction that draws on the three main Western ethical theories: deontology (rules), consequentialism (utilitarianism), and virtue ethics. The platform universally employed to teach students how to apply ethical knowledge is the case study and, typically, students use some version of a heuristic to work through a step-by-step, linear ethical decision-making process to arrive at and justify the "correct" ethical decision. Case studies in engineering ethics are plentiful and classic: the space shuttle Challenger and Columbia disasters, the Ford Pinto gas tank explosions, the Hyatt Regency skywalk collapse, the Bhopal chemical spill, to name a few of the most well-known, as well as fictional depictions of ethical dilemmas in made-

for-the-engineering-classroom films such as *Henry's Daughter, Gilbane Gold,* and *Incident at Morales*.[1] Ethical decision-making models specify a multi-step process that defines the problem, identifies available alternatives, evaluates the alternatives (applicable rules, stakeholder consequences, costs and benefits, etc.), makes the decision, implements the decision, and evaluates the impact of the decision.

Dutifully, my students applied this ethical knowledge to the assigned case studies, identified what the engineers did wrong, and came up with the right ethical decisions. Each student's written explanation of the decision-making process and how it was applied in a particular case was nearly identical to every other student's explanation. Their responses were, I thought, remarkably similar to a mathematics assignment in which there is usually only one way to solve the problem correctly, and the student must solve the problem that way or the answer is not correct. This made grading easy, of course, but the teaching and the student work products were rote and unimaginative. So, even if this teaching experience was uninspiring to me and to my students, I supposed that, if they could identify ethical issues, resolve them, and provide a rationale for their decisions, they must be "getting it." Learning objective accomplished.

In a recently discovered essay written by Isaac Asimov and published in *MIT Technology Review*, Asimov asks how people get new ideas. He suggests that creative people are those who are "capable of making a connection between item 1 and item 2 which might

---

[1] These three films were produced for use in engineering ethics instruction by the National Institute for Engineering Ethics online at www.niee.org. Each film is a fictional depiction of multiple and often escalating ethical problems that arise in engineering practice. The films include suggested discussion questions and extended analyses of recommended ethical decision-making considerations and processes.

not ordinarily seem connected" (Asimov n.p.). In the case of my engineering ethics class, two unrelated things happened – coincidentally – to trigger the idea that engineering ethics could and should be taught differently and that I should reexamine my expectations of student learning outcomes. First, as part of my own commitment to staying abreast of the field of engineering ethics education, I read an article written by Byron Newberry entitled, "The dilemma of ethics in engineering education." Newberry, an engineering professor who teaches ethics as part of his engineering design course, argues that engineering students should achieve higher levels of moral development. He observed that his engineering students were adept at applying ethical principles to sets of problems – what he termed intellectual engagement and particular knowledge (or ethical reasoning) – but that his students failed to emotionally engage with the study of ethics. He defined emotional engagement as "developing a student's desire, on an affective level, to recognize, to care about, and to resolve ethical issues" (344). Year after year, his students performed well on their ethics assignments and actively participated in class discussions but, nevertheless, they consistently rated the ethics part of the class as "the least interesting, the least useful, and the most trivial" (347). This was a key insight. Newberry was describing my students.

I returned to the classroom and asked my students about the curriculum materials we had been using. That seemed as good a place to start as any. I was honestly surprised to learn that nearly everything in my course was a repeat of the condensed version they received in first year Engineering Fundamentals coursework, including the films, and that whatever standard case studies had not been included in Engineering Fundamentals had been covered in other engineering classes. Nothing I presented was new. When I

asked about the importance of engineering ethics to them, students said that ethics was not interesting and that, although engineers have a professional obligation to protect the public health and safety, engineering ethics was not all that complicated – just follow the NSPE Code of Ethics, use decision models to arrive at a proper decision, and report anyone who engages in unethical conduct. These responses seemed to confirm Newberry's observations. The question, however, was where to go from here. How could I get my students to care about engineering ethics and being ethical engineers?

The second thing to happen was that, as a beginning PhD student in Humanities, I was introduced to phenomenology, a philosophy that is concerned with the ontological question of being. Phenomenology is a philosophy that studies essences. It holds that human consciousness is consciousness of *something*, that people are thinking experiencing subjects who are not mere physical objects that respond to stimuli explainable by objective science but who are in the world and interact with the world to both give and derive meaning from it. We are, as Merleau-Ponty wrote, *embodied subjects* (Merleau-Ponty). Phenomenology is grounded in the real, lived world of experience. Similarly, phenomenological research seeks to discover and describe the essences of human phenomena, of human experience. Phenomenology does not seek a scientific, theoretical, or causal explanation of experience but, instead, describes the phenomenon and interprets it in order to express a general understanding about the essence of the experience (Orbe; van Manen, *Researching Lived Experience*). Phenomenology is particularly useful to study professional experience because "it tries to place the researcher in the perspective of the research participants in order to understand their experience and feelings, thus unveiling what it means, from their point

of view, *to be in the situation within the experience*" of that person (Sadala and Adorno 288, emphasis in original). In other words, to understand and find meaning in that experience, to care about it.

In the spring of 2011, I made the connection between item 1 and item 2 and then posed this question: could studying engineering ethics from a phenomenological perspective – where students investigate and discover the essences of what it is to be an ethical engineer within the everyday lived experience of engineering practice – result in stronger emotional engagement by students with the study and practice of ethics? Could such an approach possibly make them care more about engineering ethics, making ethical decisions, and being ethical engineers? A brief search of the literature disclosed no research about this approach to engineering ethics pedagogy. Either this was a creative and novel idea with the potential to help transform engineering ethics education and therefore worth exploring, or good reasons existed why this research had not already been done. So the first question for my research materialized: could a phenomenological approach to engineering ethics pedagogy make a difference in students' emotional engagement and understanding of professional and ethical responsibilities?

The Context to Go Forward: A Rudimentary Pilot Study

When ENT3958, Ethics in Engineering Design, was offered in the fall semester of 2011, I had fully redesigned the course to attempt a sort of phenomenological approach to engineering ethics instruction. I no longer used a text because I could not find one that adopted the approach I had in mind. Instead I asked myself what materials the students

could read and what activities could they pursue that would help them discover and understand what it means to be an ethical engineer. I collected a set of writings from a wide range of authors that addressed, for example, culturally comparative engineering ethics, engineering values, and the relationship between ethics and technology. Aside from a brief review in class of ethical theories, there were no assigned readings on ethical theories, case studies, or decision models. I concluded that the best way to find out about being an ethical engineer would be to talk to engineers, so my assignments also required students to interview a practicing engineer (or one who had worked outside academia for some period of time) about what it is to be an ethical engineer. The principle work product of the students would be an essay in which the students take into account and reflect on all their work from the semester and use it to describe how they interpret and understand the everyday lived experience of what it is to be an ethical engineer.

I also wanted to assess whether this approach increased student engagement with and understanding of ethics. The instrument I chose was the Defining Issues Test-2 (DIT-2), a widely used measure of ethical reasoning skills (Rest et al.; Thoma). The DIT-2 is a multiple choice test consisting of a set of five (non-engineering) scenarios presenting various ethical dilemmas without obviously right answers. I administered the DIT-2 as a pre-test during the first week of the semester and as a post-test at the end of the semester. I selected the DIT-2 in part because it was used by many others to measure ethical reasoning of engineering students but, beyond that, I did not fully understand – at that time – that it wasn't designed to measure anything more than ethical reasoning

skills, whereas I was concerned with emotional engagement. But, it turned out, using the DIT-2 was a good enough place to begin.

At this point, I need to diverge a bit and discuss an ethics study that was occurring concurrently at Michigan Tech but about which I was then unaware, the Survey of Engineering Ethical Development (SEED) project.[2] This project conducted a nationwide assessment of the ethical development (ethical knowledge, reasoning, and behavior) of undergraduate engineering students. A total of over 4,000 undergraduate engineering students from 18 institutions, including Michigan Technological University, participated in the SEED study.[3] Questions from the Fundamentals of Engineering Exam were used to measure ethical knowledge, the DIT-2 was used to measure ethical reasoning skills; and a survey of various volunteer and pro-social or anti-social activities in college and high school was used to measure ethical behavior.

Results from the SEED study were ready for dissemination in late 2011 and each participating university was invited to a workshop to receive results and participate in a

---

[2] SEED was a multi-year project funded by the National Science Foundation (EEC# 0647460, 0647532, and 0647929) and headed by Principal Investigators from Lawrence Technological University, California Polytechnic State University, and the University of Michigan (Finelli et al., “An Assessment of Engineering Students’ Curricular and Co-Curricular Experiences and Their Ethical Development”; Harding, Carpenter, and Finelli). The study was intended to measure student ethical development across all undergraduate engineering years and does not differentiate by or account for the level or degree of ethical education students have received. In this respect, the SEED study offers a broad snapshot – an average – of the current ethical development of U.S. undergraduate engineering students at the 18 participating institutions.

[3] The participating institutions were: Doctoral (Very High Research): Iowa State University, Pennsylvania State University, Purdue University, University of California at San Diego, University of Michigan, University of Texas at Austin; Doctoral (High Research): Michigan Technological University, Missouri University of Science and Technology, North Carolina A & T University, North Dakota State University, University of North Carolina at Charlotte; Master’s: California Polytechnic State University, Lawrence Technological University, Tennessee Technological University; Bachelor’s: Bucknell University, The Cooper Union for the Advancement of Science and Art, Ohio Northern University, Rose-Hulman Institute of Technology

dialog about how engineering ethics education could be improved. All the principals involved in the project from Michigan Tech declined to attend and so, eventually, the invitation made its way to me in my capacity as an instructor of engineering ethics. I accepted and attended the workshop. I left the workshop with two new pieces of knowledge: first, the SEED study found that "The mean Michigan Tech P and N2[4] scores are significantly different from *students at all other institutions,* indicating those students, on average, have higher levels of moral development than Michigan Tech students" (Carpenter, Harding, and Finelli 44, emphasis in original). This was shocking, embarrassing, and troubling information. However, although Michigan Tech students performed below the DIT-2 averages compared to the other 17 universities, the mean DIT-2 scores for all engineering students at all of these schools were still at the low end of national norms for all college-aged students (Table I.1).[5] Thus the workshop focus was to identify best practices for improving engineering ethics education. Second, except for the facilitator who also served as one of the project's principal investigators, I was the only non-engineering faculty member at the workshop, and the implications of this became apparent during our discussions on how engineering education could be improved. All the attendees were dismayed by the SEED results and there was consensus that engineering ethics education had to somehow change. Nonetheless, recommendations on best practices could be summarized as "obviously, we have to do more of what we have been doing." I was in the middle of my pilot engineering ethics course with no results on student outcomes to report, but I described the redesigned

[4] The N2 and P scores are the two quantitative measures of a subject's ethical or moral reasoning skills. The N2 was developed and became part of the DIT-2, which was the successor to the original DIT. The N2 score is represented as being a better indicator of ethical reasoning skills, although the P score is still used.
[5] Michigan Tech students were on par with their peers in terms of ethical knowledge and in terms of their pro- and anti-social behaviors in high school and college (Carpenter, Harding, and Finelli).

course and what I hoped to achieve with it. I suggested that, if assessment results were positive – and I wouldn't know this until the end of the semester – this could be a promising approach for engineering ethics education. The reception was one of unequivocal and unanimous skepticism and, in some cases, outright dismissal. I left with the impression that the *status quo* in engineering ethics education will not be easily challenged or changed, even in the face of research such as the SEED study that *suggests* what we are doing is not adequate.

The semester ended and the results of the pre- and post- DIT-2 test scores arrived. They showed that the ethical reasoning skills of my students improved by 23% (mean N2 scores) and by 19% (mean P scores) (Troesch). I was stunned by these results. Table Intro.1 shows the comparisons of mean pre- and post-test P and N2 scores for my class (ENT3958), the SEED project scores for Michigan Tech students, for all other students participating in the SEED study, and the national norms for all college-aged students.

Table Intro.1
DIT-2: A Comparison of Ethical Reasoning Scores

DIT-2 Score	ENT 3958		NSF SEED Project		DIT-2 National Norms for College-Aged Students[6]
	Pre-Test (n=20)	**Post-Test** (n=16)	MTU (n=238)	17 Other institutions (n=~3700)	
P Score	30.10	35.75	29.9	32.9	P scores range from 32.2 to 37.8, increasing with age during college.
N2 Score	28.59	35.28	29.7	32.4	N2 scores range from 31.1 to 36.9, increasing with age during college.

[6] Norms for the DIT-2, including standard deviations, are periodically reported by the University of Alabama Center for the Study of Ethical Development (Chung et al.; Dong; Bebeau and Thoma). Standard deviations are not given in this table because no standard deviations were provided in the SEED Report delivered to Michigan Technological University.

The mean pre-test N2 and P scores for my students were consistent with the overall mean scores of Michigan Tech students in the SEED study, in other words, below average. This was particularly concerning because my students were all preparing to graduate and, based on age alone, should have performed above the average of students from across all grade levels. However, post-test P and N2 scores for my students were substantially higher than the scores for both Michigan Tech students and students from the other 17 institutions in the SEED study and were much more in line with the national norms for all college-aged students.

These results were encouraging, but several qualifications must be noted to place them in context. First, students in the SEED project and in the national DIT-2 database took the DIT-2 only once as contrasted to the pre- and post-test structure of ENT3958. The SEED and national norms scores do not take into account and do not try to account for any ethics instruction students may or may not have received. There was no intervention (ethics instruction) introduced and the impact of ethics instruction was not tested as part of the SEED study. Second, the SEED students were from across the entire spectrum of undergraduate education, from first through final years, whereas my students were nearly all seniors. Third, as to the ENT3958 results, the number of subjects – the class size – was small. Only 20 students completed the pre-test and, of those, only 16 completed the post-test. The project design was quasi-experimental in that there was no random selection of participants. To begin, enrollment in the ethics course is a self-selecting process. Additionally, participation in the DIT-2 was voluntary and anonymous, and that could impact results (this was true of the SEED test as well; out of the ~800 students invited from Michigan Tech to participate, only 238 actually took the test).

Fourth, there were no control groups of students for comparison to the ENT3958 students; there was no group that took no ethics course at all and there was no group that took an ethics course with traditional instruction methods. So, without knowing how these two control groups might perform on pre- and post-tests under comparable conditions, it's not possible to conclude with certainty that the improved DIT-2 scores were caused by instructional method.

Perhaps the most important challenge to me was measuring student learning outcomes. I used the DIT-2 as the measure of improvement but this test is intended to measure ethical reasoning skills, not emotional engagement or understanding of professional and ethical responsibilities. And it was student emotional engagement and understanding of ethics that I hoped to improve and measure. So, although it was good news that my engineering students' ethical reasoning skills had improved to levels higher than their engineering peers at Michigan Tech and more in line with their engineering and non-engineering peers nationally, this was not the principal outcome that I wanted to study and measure. The definition and measurement of emotional engagement with ethics and understanding of professional and ethical responsibilities, it turns out, would be the most complex and difficult problem I had to face. This became the second research question I address in this project.

When I conceived this idea to design an engineering ethics course using phenomenological principles and methods, I thought my project – in both theory and implementation – was relatively uncomplicated. Over the past three (nearly four) years, I've come to understand how naive I was. Creating an engineering ethics pedagogy that

emotionally engages students in the study and practice of ethics and that improves their understanding of professional and ethical responsibilities requires us to ask and deliberate some fundamental questions. Failure to do so will leave us in no different place and with no better student outcomes. Indeed, part of the reason why engineering ethics instruction does not significantly change may be because these questions are not being engaged in meaningful, useful ways. I suggest that the most central set of questions is: why do engineering students need to study ethics; what is it we want our engineering students to be able to do with the ethics instructions they get; and what should ethics education prepare them for? I further suggest that answers to these questions depend on who we ask – engineers or ethics scholars – and the answers are rooted in the millennia-old epistemological divide about the nature and privileging of knowledge, perhaps making agreement on any "best practices" for engineering ethics curriculum design next to impossible. Necessarily, this is where I begin my inquiry in Chapter One.

Overview of Chapters One through Six

Chapter One sets forth the theoretical background for my research. I begin with a critique of the epistemological foundation that is the historic context for the current state of engineering ethics education. I argue that the nature of knowledge in Western thought largely divides into a dualism that pits knowledge as universal, transcendent, unchanging, certain, eternal, and discoverable through reason against knowledge as constructed, contingent, temporary and changeable, uncertain, emerging from the intersections of competing and often conflicting community values, interests, and needs, shaped by ideology, and perhaps unknowable at all. From here, I argue that there is a

nexus between how we understand and value knowledge and how we teach engineering ethics. Because engineering practice is considered to be a productive knowledge or *technē* that uses the knowledge of science or *epistēmē,* the prevailing attitude is that engineering practice is, therefore, ethically neutral. Engineers are skilled designers of technology; ethics, though not completely irrelevant, is the province of managers and public policy makers. Although ABET mandated some sort of engineering ethics knowledge when it adopted Engineering Criterion 3(f) as a condition for engineering program accreditation, there remains widespread conviction and practice that meeting this criterion amounts to little more than introducing the students to the NSPE Code of Ethics and training them to apply this code to a variety of engineering design issues. I argue against this stance and claim that engineering is imbued with ethics and that engineering practice is largely driven by uncertainty and value judgments.

Assessment research shows that undergraduate engineering students are not prepared to face the ethical challenges they will face as practicing engineers. They lack strong ethical reasoning skills and they are not emotionally engaged with the study and practice of ethics. I argue that this is, in part, because of the way that engineering ethics is understood and the way it is taught. Accordingly, engineering ethics education should be designed so that graduating engineering students have a meaningful understanding of their professional and ethical responsibilities. I critique the ethics learning objectives that are established by engineering programs, and I examine the history of engineering ethics instruction in the context of three questions: (1) whether the emergence of ethical questions posed by modern technology is only a 21st century phenomenon, (2) whether engineering education should include the study of ethics, and, if so, (3) why current

engineering ethics pedagogy fails to adequately prepare our engineers for their professional and ethical responsibilities as engineers and citizens?

I conclude Chapter One with a brief review of the ontological and epistemological significance of rhetoric to engineering, philosophy, and engineering ethics. I argue that rhetoric is part and parcel of our being, and this is no less so for engineers. To practice engineering is to deal in contingency; to be an engineer, then, is essentially to be rhetorical, deliberative, and choice-making. Epistemologically, when science cannot provide an answer – as so often is the case - rhetoric is the necessary alternative that allows us to develop possibilities, deliberate, and make choices.

In Chapter Two, I introduce the first of my two research questions: can a phenomenological approach to engineering ethics pedagogy increase not only students' ethical knowledge and sensitivity but also their emotional engagement and understanding of their professional and ethical responsibilities? I propose that phenomenology – the study of experience – can inform the design of an engineering ethics pedagogy that will open the door for engineering students to discover, examine, and understand the experience of engineering practice in its broadest ethical contexts. By investigating the question, "what is it to be an ethical engineer?" students will improve ethical reasoning and sensitivity skills and also develop a relationship with ethics that will engage them in the study of ethics, commit them to the importance of ethical practice, and help them better understand their professional and ethical responsibilities. I review the underlying principles of phenomenology, examine and explain why phenomenology

has the potential to improve and perhaps transform undergraduate engineering ethics instruction, and present a phenomenology-informed curriculum design.

At its core, phenomenology seeks to gain a deeper understanding of the nature – the essences – of our everyday experiences, through which we acquire meaning. In my class, the focus is on real engineers, real-world ethical engineering practice, the everyday impact and meaning of personal and professional values, and the “everydayness” of engineering work and ethical practice. Coursework design uses principles and methods of hermeneutic phenomenology research in particular. Students focus on an investigation into the question of “what is it to be an ethical engineer?” Through readings, interviews, and discussions, they arrive at their individual interpretations and understandings of what that experience is and means.

Chapter Three presents the methods I use to test my research questions. My research proposes to test (1) whether a phenomenological approach to engineering ethics pedagogy will increase students’ ethical knowledge and sensitivity and their ethical engagement with and understanding of their professional and ethical responsibilities, and (2) whether a qualitative methodology can be used to assess if this understanding is being achieved by students. The setting for my research is an engineering ethics course I taught during fall semester 2014. I provide a brief background of cognitive moral development theory examining primarily the theories of Piaget, Kohlberg, and Gilligan. These are the theories that informed the Defining Issues Test-2, which is the test designed to quantitatively measure ethical reasoning skills and the one I used in my research. I include a critique of the weaknesses and benefits of the DIT-2 and a

justification for its use in my research. Researchers and educators are increasingly concluding that ethical sensitivity may be a more important indicator of ethical decision-making and behavior than ethical reasoning as measured by the DIT-2. So I also consider work done by Narváez and others that was used to develop the Ethical Sensitivity Scale Questionnaire (ESSQ), which I used in my research to quantitatively measure ethical sensitivity skills of my students.

The third and key skill that I test is whether students gain an understanding of professional and ethical responsibilities when they take this course. I argue that ABET Engineering Criterion 3(f) is severely underestimated by most engineering programs. The mandate has two requirements: an understanding of professional responsibility and an understanding of ethical responsibility, a much broader obligation than is generally undertaken by engineering programs. I argue that, not only are engineering graduates not acquiring the requisite understanding of professional and ethical responsibility, assessment methods fail to disclose that failed outcome. My challenge – and my second research question - is to develop and test a qualitative method to assess students' understanding of professional and ethical responsibilities. I propose that Gadamer's philosophical hermeneutics, which identifies the conditions in which understanding takes place, can offer a framework for assessing whether students do come to an understanding of their professional and ethical responsibilities. I suggest four markers of understanding: (1) a foregrounded horizon wherein are found one's biases and prejudices, (2) an openness to engaging and placing those biases and prejudices at risk, (3) a dialogical encounter or conversation with a "text", and (4) interpretation and emergence of a new understanding or a "fusion of horizons." I propose that, if I can

interpretively locate evidence of these markers within the narratives written by students, I can reasonably conclude that students have achieved an understanding of their professional and ethical responsibilities. I then set forth a two-pronged qualitative research design for assessment: one grounded in hermeneutic phenomenology and the second grounded in philosophical hermeneutics. I analyze the qualitative data (student narratives) using both methods. Methods for ensuring trustworthiness are also discussed.

Chapter Four presents the findings from both the quantitative and qualitative research. Results from the pre and post-tests for the ESSQ that tests ethical sensitivity show no statistically significant change in scores. I discuss possible reasons and how a change in testing procedure, such as using paired comparisons, might yield different results. Results of the DIT-2 pre and post-tests, however, do show a statistically significant improvement in scores. I concluded that there is a correlation between the phenomenological approach to ethics instruction and improved ethical reasoning skills for undergraduate engineering students and, also, that there is a strong possibility that the instructional approach used in the course may have had some positive causal effect on this improvement in ethical reasoning skills. The most important outcome with the greatest relevance for engineering ethics instruction is that my research strongly suggests that a one-credit engineering ethics course can improve the ethical reasoning skills of undergraduate engineering students by a statistically significant margin. I discuss the limitations of the DIT-2 study and how these results compare with other studies that aim to test the impact of ethics instruction on engineering students.

Based on the narrative data using qualitative philosophical hermeneutics, I arrived at five findings: (1) Undergraduate engineering students enter their final year of studies ill-prepared for and with apprehensions about what it is to be an ethical engineer;
(2) Students recognize their “foregrounded horizons” and the traditions and values that shape these horizons, they gain a new wisdom about themselves, and they are open to putting their traditions and values at risk by encountering other points of view;
(3) Students understand that professional and ethical responsibilities are complex, broader than they previously thought, and not confined to the workplace; (4) Students begin to understand that engineers have special duties to the public, they begin to problematize technology and recognize that engineers do not operate as ethically neutral technicians; and (5) Students are developing a practice of reflection and questioning. Based on these findings and the supportive qualitative data, I conclude that my students on the whole have an understanding of their professional and ethical responsibilities such that they are prepared to begin their careers as novice engineers. Qualitative assessment revealed knowledge about my students that quantitative assessment or rubrics would not have revealed, such as their concerns and fears about ethical engineering practice. Finally, this philosophical hermeneutic approach allowed me to discover and assess the strengths and the weaknesses of the course. The chapter ends with a discussion of rigor and trustworthiness of this research and assessment project.

Chapter Five presents my concluding thoughts about my research, in three parts. First, I discuss the significance and implications of my work, including contributions of my work to knowledge. I have shown that hermeneutic phenomenology can be adapted to

undergraduate engineering ethics pedagogy by designing a course centered on student research into the question of what it is to be an ethical engineer and that this approach can result in quantitatively measured improvement in ethical sensitivity and ethical reasoning skills and in qualitatively measured achievement by students of an understanding of professional and ethical responsibilities. I have also demonstrated how philosophical hermeneutics can be used to qualitatively assess student understanding of professional and ethical responsibilities, and that this assessment approach can give us much more information about our students than other quantitative standardized assessment methods do. I argue for an interpretation of ABET's Engineering Criterion 3(f) that is far more complex and more demanding of our students than current traditional interpretations of that criterion by engineering programs.

Second, I make some recommendations based on the overall findings of my work, the most important of which is that engineering programs should consider making a one-credit ethics course mandatory for all undergraduate engineering students.

Third, I explore possibilities for future work, which include, for example, expanding the research to include control groups to test the impacts of varying approaches to ethics instruction, using paired comparisons where pre and post-tests are matched to each student, and using quantitative ethical reasoning tests designed specifically for engineering students. Importantly, future work includes continuation of ongoing re-design of the ethics modules used in my class and those being introduced into first-year Engineering Fundamentals courses and pursuing research testing with these students. Finally, I will continue to teach and to publish and disseminate results of this work.

Chapter One
Theoretical Background
Knowledge and the Engineering Ethics Curriculum

There is a nexus between how we understand and value knowledge and how we teach engineering ethics. Although the literature on engineering ethics education is growing exponentially, there is little written about this connection, and that is what I will address in this chapter. My argument is that engineering programs as a whole remain firmly entrenched in the position that scientific and technological knowledge is privileged, particular to certain professions, and ethically neutral. Ethics is, according to this view, largely outside the purview of engineering knowledge and practice except as it applies to efficiency and safety in engineering design. With these narrow exceptions, engineering students should not be expected to trade time spent studying and perfecting technical knowledge and skills for this mostly irrelevant non-scientific knowledge. Though it is veiled today in accreditation-motivated language that commits engineering programs to somehow address ethics education, this standpoint nevertheless continues to permeate mainstream engineering ethics pedagogy. It is manifested in the student learning outcomes that are set for engineering ethics instruction, the implicit demands that are placed on how engineering ethics is taught, and the ways in which student outcomes are assessed. The result is continuing and widely acknowledged dissatisfaction with the ethical competencies of engineering students. Yet, despite all the hand-wringing, engineering ethics pedagogy does not change. How did this come to be?

Knowledge: Necessity versus Contingency

"All men by nature desire to know."

Aristotle, from *Metaphysics, Book I (A)*

The debate about the nature of knowledge goes back at least 2500 years to the ancient Greeks. The life work of Plato and then Aristotle, two of the best known ancient Greek thinkers, was to understand and explicate what knowledge is, and they are among the first to make metaphysics the concern of their thought. Considering that the earth was then understood to be the center of the universe and that the gods were believed to be in charge of human fate, it is remarkable that these ancient philosophers conceived and wrote such complex, insightful, and enduring ideas. From their commitment to the pursuit of knowledge – and in particular, truth – emerged the chief epistemological debate of the day: whether knowledge is universal, transcendent, certain, unchanging, and discoverable through reason – the kind of knowledge and thinking pursued and taught by Plato and Aristotle – or whether knowledge is also constructed, contingent, changeable, uncertain, shaped by ideology, subject to debate and persuasion, and perhaps unknowable at all – the rhetoric practiced and taught by the Greek Sophists. This debate not only divided the thinkers and educators of ancient Greece but it characterizes a dualism in philosophical thought that has endured throughout the millennia and into the 21st century. Although the debate persists, history has certainly privileged the former, including in particular the knowledge of science and technology.

The legacy of this debate and its ensuing tensions have significance for engineering ethics education. My purpose here is to briefly trace the history of that legacy so we can better understand why engineering ethics instruction remains such a contentious issue. Plato and Aristotle argued that there are categories or taxonomies of knowledge and that

these various kinds of knowledge are accessible only to certain people and professions. Engineering is generally considered a *technē* (a technical skill requiring specific training) that uses *episteme* (scientific knowledge). The question of whether and to what extent engineering is and ought to be concerned with ethics has traditionally been answered that, as a *technē* employing *episteme*, engineering is ethically neutral. This remains the dominant stance of engineering and engineering education today. I will suggest in this chapter, however, that if we consider the knowledge and skills used in engineering, we can quite reasonably conclude that engineering practice is more accurately characterized by contingency, uncertainty, trial and error, values-balancing, probability, trade-offs, and debate and persuasion – the hallmarks of rhetoric. These are two very different views of engineering, and both have their roots in ancient Greek thought.

Plato and Aristotle: Technē, Epistēmē, and Phronesis

Plato and Aristotle understood knowledge as immutable, universal, and discoverable through reason. Through the voice of Socrates, they each identified taxonomies of knowledge. Plato calls the knowledge that informs human activity *technē*, art or craft, which is rational action*.* In multiple writings, Plato's conception of knowledge and *technē* is expressed as complex and multi-layered, including both quantitative and qualitative aspects, and encompassing a wide range of human activities from science to medicine to ship navigation to cabinet building to statesmanship. And, although the scope of *technē* is broad, there are, nevertheless, multiple classes of *technē* which serve different functions and which have their own sort of hierarchy. In *Plato's Theory of Texnh: A Phenomenological Interpretation,* Wild examines four categories of *technē:*

(1) knowledge for its own sake, that is, scientific knowledge, which is acquisitive rather than productive and which seeks to discover the nature of things through the philosophic process of dialectic inquiry; for Plato, this is principally mathematical knowledge;
(2) knowledge that includes scientific knowledge but that is also an art "of possession or conquest" such as hunting and power over other people by, for example, physical conquest in war or economic power;
(3) knowledge that includes scientific knowledge but that also includes making or producing such as craft; and
(4) knowledge that commands or directs, that is, statesmanship and education (Wild 268-273).

For Plato, these various types of *technē* are important in part because of who needs or can access them, and this is determined by one's natural position in society. In *The Republic*, Plato uses the allegory of the cave to demonstrate how pure knowledge – the forms or Truth – is accessible only to a few and that the superior knowledge is science (Plato, *The Republic of Plato*). He writes that people are naturally inclined to one of three positions in the ideal state: philosopher-king (guardian) the auxiliaries (soldiers), and producers (craftsmen) (357a-520a). Each of them uses knowledge but only the philosopher-king achieves access to the essences of the forms, which is accomplished through a process Plato calls the "dialectic" (533b). This process requires extensive education and is appropriate only for a select few.

Aristotle, a student of Plato, creates his own taxonomy of knowledge – "virtues of thought" – in *Nichomachean Ethics VI.* Each of Aristotle's five intellectual virtues is

concerned with reason and each “grasps the truth.” The highest, and accessible to the fewest, is wisdom (*sophia*). Wisdom combines the “most exact [form] of scientific knowledge with understanding to ‘grasp the truth about the origins’ ” (Aristotle, “Nichomachean Ethics” 6.61). Understanding (*nous*), grasps first principles about origins, the knowledge on which all other knowledge depends (6.51). Scientific knowledge (*epistēmē*), which is theory, and craft-knowledge (*technē*), which is designing and producing, are both teachable, both involve *logos* or rationality, and both are used so interchangeably by Aristotle as to sometimes make them appear indistinguishable (Dunne 253). The principal difference is that *technē* is concerned with production and things that change – this includes a broad range of professions such as carpenters, doctors, and engineers who use scientific knowledge to design and produce products or deliver services – while scientific knowledge is concerned with “what is necessary” and that which is “eternal” or unchanging (Aristotle, “Nichomachean Ethics” 6.21; Mitchum 120-121). Mitchum, in interpreting Book 1(A) of *Metaphysics*, describes the relationship between *technē* and *epistēmē* this way: “As a type of awareness of the world, [*technē*] lies between unconscious experience and knowledge of first principles; *technē* is part of the continuum that moves from sense impressions and memories through experience to systematic knowledge, *epistēmē”* (Mitcham 120).

Aristotle’s fifth virtue of thought is intelligence or *phronesis,* which is practical knowledge concerned with action. Its focus is on human concerns; in the words of Socrates, “The unconditionally good deliberator is the one whose aim expresses rational calculation in pursuit of the best good for a human being that is achievable in action” (“Nichomachean Ethics” 6.71) or what could be also be expressed as ethical deliberation and choice

about human affairs. Only *phronesis* is concerned with action – determining what is good or bad for people – and this distinguishes *phronesis* from all the other intellectual virtues or kinds of knowledge. Importantly, Aristotle distinguishes *phronēsis* from both *epistēmē* and *technē*. In other words, he distinguishes knowledge associated with deliberation about human affairs (such as ethical knowledge) from both scientific and craft (such as engineering) knowledge. He underscores the difference between *technē* and *phronesis* by stating "And since production and action are different, craft (engineering) must be concerned with production, not with action" (6.32, parenthetical added). He goes on to write that practical intelligence (*phronesis*) is something humans share with some animals and that "it would be absurd for someone to think that political science or intelligence is the most excellent science, when the best thing in the universe is not a human being [and the most excellent science must be of the best things]" (6.62).

In *Metaphysics,* Aristotle again sets up a taxonomy of knowledge with scientific and craft knowledge being superior to experience or *phronesis*: "the man of experience is thought to be wiser than the possessors of any sense-perception whatever, the artist wiser than the men of experience, the master-worker than the mechanic, and the theoretical kinds of knowledge to be more of the nature of Wisdom than the productive" (Aristotle, "Metaphysics Book I (A)" 1.25-30). Aristotle thereby seems to create a divide internal to his own philosophy that distinguishes and opposes the knowledge of science and technology against that of deliberation and choice about human affairs.

The Platonic/Aristotelian conception of differences in knowledge and who can access them has important implications for technology and engineering. The ideal state

described by Plato in *The Republic* and Aristotle's detailing of the differences in the intellectual virtues and their particular applications are prescriptions for occupational specialization. Along with specialization comes an alignment of ethical responsibility. Under this structure, deliberation and ethical choice in human affairs are granted to the statesman or philosopher-king who is now responsible for deciding what is good for the republic. Engineering's claim that the responsibility for ethical decision-making about the applied uses of engineering work resides with management and policy makers arguably derives from this argument.

A relevant question at this point is whether Aristotle really did set up *technē* as an ethically neutral kind of knowledge such that engineering and other professions can claim with philosophical justification that ethical decision making should be left to others. Or does Aristotle's conception of *phronesis* somehow attach to *technē* and thereby infuse *technē* with ethical accountability? Surprisingly, the concept of *phronesis* appears infrequently in Aristotle's work and is explained only briefly, in *Nichomachean Ethics VI.* In contrast to *technē,* which is "very deeply embedded in the core of [Aristotle's] metaphysics," *phronesis* "is what might almost be regarded as a 'deviant' concept' " (Dunne 245). Yet *phronesis* has been ascribed enormous importance as a standard for ethical knowledge and action. Whether it applies to *technē*, Aristotle does not say, leaving the answer to interpretation and conjecture. Dunne's central argument in *Back to the Rough Ground* is that Aristotle implicitly intends for *phronesis* to place some ethical boundaries on the operation of *technē.* He relies on two statements from *Nichomachean Ethics* in support of this proposition: first, "while there is such a thing as excellence in techne, there is no such thing as excellence in phronesis; and in techne he who errs

willingly is preferable, but in phronesis, as in the [ethical] excellences he is the reverse" and second, "[phronesis] rules the productive intellect, as well, since every one who makes for an end, and that which is made is not an end in the unqualified sense (but only an end in a particular relation, and the end of a particular operation) – only that which is done is that; for good action is an end, and desire aims at this" (Dunne, quoting Aristotle, "Nichomachean Ethics" 6.44 and 6.2). With respect to these passages, Dunne writes:

> . . . Aristotle might be taken to mean that while the execution of a work, strictly *qua* actualization of one's techne, is morally neutral, it may *also* be weighted with moral value (comparing, for example, a poorly constructed table made for a poor person to excellent flute playing for the S.S. in Auschwitz). . . . This sentence (6.2) very explicitly subordinates one's accomplishments as a *technitēs* to one's wider concerns as a human being; and one might then say that it is only within this subordination, and not within the narrow realm of techne itself, that aretē *accrues or does not accrue to one's techne* (265, parentheticals added).

Whitburn, on the other hand, vigorously argues that Aristotle divided human activity into the "practical sciences, theoretical sciences, and productive sciences" and that he located deliberation and decisions about human affairs within the practical sciences. At the same time, argues Whitburn, Aristotle wrongly but deliberately categorized rhetoric as a *technē* or productive science by which he effectively "reduced the stature and scope of rhetoric through definitional exclusion. He excluded the art of ethical choice, the selection of subject matter, and the multiplicity of human goals beyond persuasion" (25–26). By Aristotle's own definition, then, *technē* precludes ethical choice, according to Whitman.

MacIntyre also seems to say that *phronesis* does not attach to *technē*, at least not in a systematic way. In discussing virtues of character – that which makes a good person –

and the intellectual virtue of intelligence (practical judgment or *phronesis),* MacIntyre writes that “According to Aristotle then excellence of character and intelligence cannot be separated” (MacIntyre 154). Moreover, according to Aristotle – and a point that MacIntyre considers a weakness in Aristotle’s otherwise well-favored virtue theory – “one cannot possess any of the virtues of character in a developed form without possessing all the others” (155). Applying this maxim to a person engaged in the practice of *technē,* unless that person also possesses all the excellences of character identified by Aristotle, it simply isn’t possible for that person to have practical intelligence or *phronesis*. Moreover, any attempt to exercise what that person might think is practical intelligence is false and “degenerates into or remains from the outset merely a certain cunning capacity for linking means to any end rather than to those ends which are genuine goods for man” (154). That is to say, those false efforts amount to no more than dangerous rhetoric. So the answer to this question – does *phronesis* attach to *technē*? – is ambiguous and scholars disagree on what Aristotle intended.

The Sophists and Rhetoric

The epistemological divide over the nature of knowledge is nowhere manifested more cogently than in the differences over rhetoric, a central part of the philosophical battle between Plato and Aristotle, on the one hand, and the group of Greek educators called “sophists,” on the other hand. The trade pursued by the sophists and the educational skills in rhetoric they offered their students were roundly condemned by both Plato and Aristotle as something that scarcely deserved to be called knowledge. The principal case against the sophists was a twofold claim: first, they trained in and practiced *dissoi logoi* – in Greek, “different words” – the concept that there are two contrasting sides to every

argument and that both sides, however seemingly contradictory, could be argued by the same person even within the same argument (Dzialo 221,224; Kerferd 84). Second, because sophists were willing to take up any cause, irrespective of merit or plausibility, they were able to use their skills in persuasion to make a weaker argument appear to be the stronger. These two practices are symbiotic. The end result, critics such as Plato and Aristotle charged, was the privileging of relativism and probability over truth, the very opposite of what humans should be striving to achieve.

In *Gorgias*, Plato writes of a conversation between Socrates, Polus, Chaerepho, and Gorgias in which he mocks the sophistic practice of rhetoric:

> There are then these four arts which always minister to what is best, one pair for the body, the other for the soul. But flattery perceiving this – I do not say by knowledge but by conjecture – has divided herself also into four branches, and insinuating herself into the guise of each of these parts, pretends to be that which she impersonates: and having no thought for what is best, she regularly uses pleasure as a bait to catch folly and deceives it into believing that she is of supreme worth. This it is that cookery has impersonated medicine and pretends to know the best foods for the body, so that, if a cook and a doctor had to contend in the presence of children or of men as senseless as children, which of the two, doctor or cook, was an expert in wholesome and bad food, the doctor would starve to death. This then I call a form of flattery, and I claim that this kind of thing is bad – I am now addressing you, Polus – because it aims at what is pleasant, ignoring the good: and I insist that it is not an art but a routine, because it can produce no principle in virtue of which it offers what it does, nor explain the nature thereof, and consequently is unable to point to the cause of each thing it offers. And I refuse the name of art to anything irrational (Plato, "Gorgias"464C-E, 465A).

In *Phaedrus*, written after *Gorgias*, Plato distinguishes between false rhetoric and philosophical or scientific rhetoric (Kennedy 66–67). So, although he restores philosophical rhetoric to a respectable art, he continues to severely criticize the rhetoric of the sophists. "One essential duty of philosophy is to guard the enterprise against such

speculative sophistry, and the further distortions it brings with it, and to recall men to those basic dialectical truths which are within their reach" (Wild 281).

The sophists became and remained a metaphor for all things false and dangerous. The rhetoric they practiced was alleged to be devoid of art and was relegated to mere technique or knack (Mitcham 118). In fact, sophistry arguably did not even rise to the level of respectable technique because it was imbued with deception and irrationality. Moreover, the sophistic view of knowledge was grounded in human beings and irreverently shifted our focus from the soul, otherworldliness, and the life of contemplation to the mundane worldliness of human affairs (Whitburn 15). Nothing brought this point home to Plato more than the statement attributed to Protagoras: "Man is the measure of all things, of things that are as to how they are, and of things that are not as to how they are not" (*Theaetet.* 161c). So important is this statement about the sophists that Kerferd suggests this single writing "will take us directly to the heart of the whole of the fifth-century sophistic movement" (Kerferd 85–86) and to the central point of controversy between Plato/Aristotle and the sophists.

Many scholars argue that the reputation of the sophists is undeserved and offer several explanations for the harsh historic and contemporary judgment of the sophists. First, little written work of the sophists exists so we have few primary documents to study, and what little has been written about their actual work is unreliable (Kerferd 1). Second, what we know of the sophists and the sophistic movement is largely through the "profoundly hostile treatment of them" by Plato (Kerferd 1) and by Aristotle (Kerferd 5; Poulakos, "Toward a Sophistic Definition of Rhetoric" 35; Poulakos, "Rhetoric, the Sophists, and

the Possible" 10). Third, Plato and Aristotle were in academic and economic competition with the sophists and, therefore, had reasons to discredit them (Whitburn 25). Scenter-Zapico suggests a fourth reason that goes back to the impact of literacy itself. Today we are a dominantly literate society – enhanced exponentially by technology – where the written word has more value than the spoken. That, he argues, makes it even harder to appreciate the oral skills of the sophists and the conditions in which they had to practice their profession (Scenters-Zapico 364–365). Because of historic good fortune, the works of Plato and Aristotle survived the millennia and are esteemed while the works of the sophists carry pejorative implications. This, it has been observed, is something of an irony given that someone like Socrates arguably "outsophists the sophists" (Dzialo 224).

Whitburn, who is a strong proponent of the sophist Isocrates and the rhetoric he used to train leaders in ethics and statesmanship, argues that Plato's strong preference for the otherworldly pursuit of Truth over action in human affairs – and his corresponding disdain for sophistry and rhetoric – set the course for the rest of history in terms of the privileging of science over ethics:

> Humans have this dualism within them – a body associated with this world and something called a soul associated with the otherworldly. They are encouraged to turn away from experience associated with body – for instance, sensations resulting from hearing and sight or emotions such as love and fear – and turn toward experiences associated with soul – for instance, thinking, reasoning, and knowing. They are inclined to disparage the use of judgment to make decisions about what is particular, concrete, changing, and temporary and to praise the effort to acquire certainty about what is universal, abstract, unchanging, and permanent. They turn away from action in human affairs toward contemplation of divinity and the forms, which results in truth, knowledge, and science. They disparage politics and admire mathematics, geometry, and astronomy (p. 23).
>
> Methodologies associated with philosophy and science gained stature, while methodologies associated with the art of choice in human affairs

> remained undeveloped and underappreciated. Little effort was devoted to the development of an art of choice that could adequately support ethical deliberation in any area of endeavor and insure that all relevant issues could be brought to bear in the engagement of problems. Instead, methodologies developed to determine truths about unchanging phenomena gained such stature that they were inappropriately used to address problems in changing human affairs (23).

Nor is Whitburn any more kindly disposed toward Aristotle who, in his view, removed the art of ethical choice from rhetoric by “definitional exclusion” (25-26). Aristotle – motivated perhaps by the practical realization that the sophists were gaining widespread acceptance and that he needed to compete more effectively for students but in a way that would still validate his rejection of sophistic rhetoric – articulated a philosophical rhetoric that he presented as an art or *technē* (Aristotle, *The Art of Rhetoric*). Lawson-Tancred, one of the translators of *The Art of Rhetoric*, says about this work: “[Aristotle] is at pains to integrate the activity of rhetoric within his general hierarchy of intellectual activity. It must be assigned its place alongside those sciences and arts to which the Platonic tradition attached greater significance. This task is achieved by the recognition of rhetoric as a *technē*” (Aristotle, *The Art of Rhetoric* 15).

Mitchum makes a connection between Aristotle’s conception of rhetoric and the philosophical reasoning of the pre-Enlightenment and Enlightenment thinkers that would eventually render science and technology ethically neutral:

> [Under the influence of 17th century thinkers such as Galileo, Descartes, and Newton,] the material world began commonly to be regarded in much the same way as Aristotle looked upon words. Instead of a potentiality unknowable in itself yet ordered toward something higher, matter began to be conceived of as separated from any cosmic process. This trend is easily exemplified by the Cartesian theory of matter as pure, lifeless extension, in itself ordered toward nothing, something to do with as one pleases. More succinctly, matter ceased to be thought of as in any sense

> living – as having, as it were, any spiritual aspirations of its own. Consider the case of alchemy as illustrative of the ancient worldview; for the alchemist, matter is an aspect of God. It is not so much opposed or indifferent to spirit as it is a necessary complement. In modern scientific theory, however, matter does come to be conceived of as wholly inert, totally devoid of spirit. Finally, it was through the modern hiatus that human beings began to imagine the possibility of a *logos of techne.* Thus it began to make sense to use a term originally applied to the study of the manipulation of words, then to the organization of systems of words, to name the study of the manipulation of nature (p.133).
>
> *Technē* involves *logos*, but only in grasping form, not in directing the actual process of production, the activity qua activity. There is no *logos* of this activity. But is this not precisely what modern technology proposes to furnish – a *logos* of the activity, a rationalization of the process of production, independent of, if not actually divorced from, any particular conception of *eidos* or form? Is this not precisely why it can so vigorously claim to be neutral, to be dependent in use on whatever human beings want to do with it, on purely extrinsic ends? (p. 128).

Schmidt and Marratto underscore the ethical vacuum that was left by Enlightenment thinking in their book *The End of Ethics in a Technological Society*:

> We are arguing that the Enlightenment project in moral theory has failed precisely because it has been unable to offer any coherent ethical framework that might enable us to deal with the crises that have emerged as technological progressivism has reached greater and greater speeds. In other words, the Enlightenment has transformed our view of ourselves and our relation to nature in such a way as to facilitate our domination of that nature, and that very transformation, which had the effect of casting the moral self adrift from its moorings in the natural order, has, not surprisingly, failed to offer any compelling restraints on our collective will to domination (167).

Arendt describes the movement to an ethically-free science and *technē,* tracing it from the ancient Greek mathematician Archimedes through Descartes and on to modernity and the contemporary human condition:

> The perplexity inherent in the discovery of the Archimedean point was and still is that the point outside the earth was found by an earth-bound creature, who found that he himself lived not only in a different but in a topsy-turvy world the moment he tried to apply his universal world view to his actual surroundings. The Cartesian solution of this perplexity was to move the Archimedean point into man himself, to choose as ultimate

> point of reference and certainty within a framework of mathematical formulas which are its own products. Here the famous *reduction scientiae ad mathematicam* permits replacement of what is sensuously given by a system of mathematical equations where all real relationships are dissolved into logical relations between man-made symbols. It is this replacement which permits modern science to fulfil its "task of *producing"* the phenomena and objects it wishes to observe. And the assumption is that neither God nor an evil spirit can change the fact that two and two equal four (p. 284).

The consequence of all of this is that the sophistic conception of knowledge – that which is given sensuously, concerned first with human affairs, premised on contingency and uncertainty, geared toward action – took a back seat to the more powerfully alluring knowledge of *epistēmē* and *technē*, today's science and technology. And, whatever "spirit" that may have dwelled within *technē* has long been disregarded or discarded altogether. This is a key insight of Goldman and one which is a fundamental premise for my argument about the current state of engineering ethics pedagogy – that contemporary engineering ethics education is constructed to present engineering as a largely ethically neutral endeavor. Goldman contests this notion of engineering as ethically neutral and identifies two models of rationality – "contingency" versus "necessity" – that correspond to sophistic versus Aristotelian epistemologies. He argues that, although engineering claims its roots are in the necessity based model of rationality – that is, science – engineering is not, contrary to what engineering educators tell engineering students, "applied science." Rather, engineering is rooted in the sophistic contingency model of rationality:

> There is a profound difference between engineering design and scientific theorizing that further undermines the characterization of engineering as applied science. While at any point in time there may be rival scientific theories of some phenomenon, in principle there can be only one theory that is 'true', namely the uniquely correct account of the way things are 'out there'. Design, however, is an irreducibly pluralistic exercise of

> reason because of the role played in design by contingent value judgements, which from the perspective of working engineers often appear arbitrary. These contingent value judgements – embodied in performance specifications and specification of size, weight, production cost, reliability, materials, time to market, manufacturability, serviceability – determine the parameters in terms of which both engineering problems and what will be recognized by management as *acceptable* solutions to them are defined. Furthermore, designs are open ended: they evolve over time as problem and solution parameter weights vary " (166–167).

Goldman argues that the contingency based model of rationality is the actual "intellectual 'home' of engineering" (171) but that the "growing power of the cult of science" (171) clouds this fact. Engineering lost its soul, so to speak, so that today "engineers in the Anglo-American world have overwhelmingly insisted that they are only technical problem solvers, that accountability for actions based on their solutions and for consequences of those actions lies with others" (172).

All of which now returns me to my argument about the impact of this epistemological divide on engineering ethics pedagogy. My argument is that engineering programs remain firmly entrenched in the position that scientific and technological knowledge is privileged, particular to certain professions, and generally ethically neutral. Accordingly, engineering ethics should teach knowledge and application of the professional rules of ethics, which emphasize technical excellence and public safety as ethically paramount, while omitting and disregarding the study of engineering itself and social policy about the uses and consequences of technology (Winner). This attitude is manifested in the student learning outcomes established by undergraduate engineering programs and the parameters that are placed on how engineering ethics is taught.

Student Learning Outcomes for Engineering Ethics Education

In the late 1990s, ABET (then called the Accreditation Board for Engineering and Technology) rocked the engineering education world when it added an ethics outcome to the ABET Engineering Criteria 2000 for baccalaureate level engineering programs: E.C. 3(f)[7] states that engineering graduates must have “an understanding of professional and ethical responsibility” (ABET, “Engineering Criteria 2000”). This Criterion is often considered in connection with E.C. 3(h): “the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.” If an institution wants its engineering programs to be accredited, then it must adopt and satisfy all the ABET accreditation criteria. E.C. 3(f) was controversial when it was adopted and questions immediately arose about the willingness of engineering programs to take the new criterion seriously (Herkert, “ABET’s Engineering Criteria 2000 and Engineering Ethics”) and whether engineering faculty would be able to teach ethics (Schimmel). Fifteen years later, those issues are still relevant.

Engineering programs are expected to develop “performance indicators” to help programs know if they are meeting the ABET Engineering Criteria, including E.C. 3(f). Performance indicators are “specific, measurable statements identifying the performance(s) required to meet the outcome; confirmable through evidence” (Rogers 7). So, for E.C. 3(f), engineering programs must develop a set of performance indicators

[7] ABET establishes a number of Criteria that must be satisfied for engineering programs to receive ABET accreditation. One of the Criteria is Criterion 3 Student Outcomes a-k. “Student outcomes” are defined as what undergraduate engineering students are expected to know and able to do by the time of graduation. They relate to the knowledge, skills, and behaviors that students acquire as they progress through the program (Rogers).

that can be used to determine if undergraduate students have an understanding of professional and ethical responsibilities. ABET offers training on how to develop performance indicators but does not determine what they must be. As a result, these indicators vary widely from one engineering program to another in terms definition and measurement. The left column of Table 1.2 includes a sample of performance indicators for E.C. 3(f) that have been established by five engineering programs. These programs are representative in that they identify performance indicators for assessing students' understanding of professional and ethical responsibilities that are common to almost all engineering programs: (1) the ability to identify ethical issues, (2) knowledge of professional codes of ethics, and (3) the ability to analyze and resolve ethical problems by applying professional codes of ethics or other ethical principles to the problems. These performance indicators are almost universally applied in the form of a rubric that measures student performance on a quantitative scale.

The ABET criterion of "an understanding of professional and ethical responsibility" is sufficiently vague that engineering programs can meet the criterion by establishing a range of expectations of students in terms of their ethical development. Issue spotting and ethical reasoning skills, which are what these engineering programs tend to measure as evidence of student "understanding of professional and ethical responsibilities," are skills associated with lower levels of moral development (see Chapter Three). These skills are also perhaps the easiest to measure. Engineering programs generally do not try to measure affective engagement with ethics, an attitude of caring or concern that is associated with more sophisticated levels of moral development.

Table 1.1 - Ethics Education Performance Indicators
A Comparison of Engineering Programs to Ethics Educators/Scholars

A Sample of Engineering Program Performance Indicators to Assess ABET Engineering (Ethics) Criterion 3(f)	**Ethics Educators and Scholars' Ethics Learning Objectives for Engineering Undergraduates**
University of Kentucky (draft July 2012 www.bae.uky.edu/academics/**abet**/**Rubrics** Draft July 2012.docx • Ethical issue recognition • Application of ethical perspectives/concepts University of Puerto Rico, Mayaguez http://ece.uprm.edu/programs/performanceCri.html • Student recognizes ethical issue • Student evaluates ethical problem through harm, publicity, reversibility tests • Student anticipates possible ethical conflicts and includes counter-measures to reduce possible ethical dilemma Oregon Institute of Technology http://www.oit.edu/docs/default-source/provost-documents/program-student-learning-outcomes/mechanical-engineering-technology/2011-12-met-assessment-report.pdf?sfvrsn=2 • Using code of ethics, describe ethical issue(s) • Describe parties involved and discuss their points of view • Describe and analyze possible/alternative approaches • Chooses an approach and explains the benefits and risks University of Delaware (Civil & Environmental) http://www.ce.udel.edu/ABET/Current%20Documentation/Outcome_8.html • Understanding and adherence to professional code of ethics and UD students' code of conduce • Participation in class discussion and exercise of ethics and professionalism • Demonstration of ethical behavior among peers and faculty • Takes personal responsibility for his/her actions • Punctual, professional, collegial. Attends class regularly • Evaluates and judges a situation in practice or as case study using facts and professional code of ethics • Uses personal value system to support actions but understands role of professional ethical standards for corporate decisions. The Ohio State University (CSE) http://web.cse.ohio-state.edu/~neelam/abet/DIRASSMNT/thirdGroup.html • Establishes a rubric to assess students' understanding of ethical and professional issues in context of "p/p/e: product/practice/event	**Harris, et al.** (Harris et al.) • Ethical imagination • Recognize ethical issues • Analyze key ethical concepts • Deal with ambiguity • Take ethics seriously • Sensitivity to ethical issues • Knowledge of relevant standards • Improve ethical judgment • Increase ethical will-power **Huff & Frey** (Huff and Frey) • Master knowledge of basic facts and understand and apply basic and intermediate ethical concepts • Moral imagination • Moral sensitivity • Adopt professional standards into the professional self-concept • Build ethical community **Callahan/Hastings Center** (Callahan) • Ethical imagination • Recognize ethical issues • Analyze relevant ethical concepts • A sense of responsibility • Deal with ambiguity and disagreement **Pfatteicher** (Pfatteicher) • Understanding of the nature of engineering ethics (explore, define, and defend what it is to be an ethical engineer) • Understanding of the value of engineering ethics • Understanding of the resolution of problems in engineering ethics

By contrast, the right column of Table 1.1 identifies ethics learning outcomes recommended by various engineering ethics educators and scholars and offers an instructive comparison. These learning outcomes depart significantly from engineering program student outcomes and performance indicators in that they aim for higher levels of moral or ethical development, including a stronger commitment to ethics. For example, each of the four sets of outcomes calls for ethical or moral imagination and the ability to deal with ambiguity (Callahan; Huff and Frey; Harris et al.; Pfatteicher), which are more complex and sophisticated skills of moral development than knowledge of codes of ethics and the ability to identify ethical issues connected with engineering design issues. Harris wants students to take ethics seriously and improve their ethical will-power (Harris et al.). Huff and Frey aim for students to build ethical communities and to adopt professional standards into the professional self-concept (Huff and Frey). Pfatteicher places strong emphasis on teaching students, not what to think but *how* to think – what she calls "breeding inquiry vs. breeding apathy" (140).

An important point to take from this comparison between the assessment-driven performance indicators set by engineering programs and the learning outcomes recommended by ethics educators is to recognize that engineering ethics education remains largely under the control of engineering faculty. That, in turn, continues to dictate how ABET's E.C. 3(f) will be interpreted, what engineering ethics instruction will look like, and what will pass as an "understanding of professional and ethical responsibilities" for our engineering students.

Critique of Engineering Ethics Instruction

In a 2012 article entitled “Grave New World” written for *Prism*, the flagship publication of the American Society for Engineering Education’s (ASEE), Pine wrote:

> Over the past decade, the burst of new technologies has been breathtaking – and often revolutionary. . . . But with these breakthroughs have come disturbing new ethical questions that challenge traditional ways of training conscientious citizen-engineers. No longer is it enough for students to be taught how to respond if a boss ignores safety standards. The engineers of tomorrow must grapple with technology that not only empowers humans with spectacular new tools but also threatens to break free of human control (n.p.).

Pine’s article implicitly raises three questions relevant to engineering ethics education: (1) whether the emergence of ethical questions arising from modern technology that are relevant to engineers and engineering is really just a 21st century phenomenon, (2) whether engineering education should include the study of ethics, and, if so, (3) why current engineering ethics pedagogy fails to adequately prepare our engineers for their professional and citizen roles?

Ethics and Modern Technology: Not a 21st Century Phenomenon

To the extent that Pine expresses the perspective of the wider engineering education community – that technology has presented ethical issues worthy of engineering concern only in the past decade – he affirms and seems to justify engineering education’s failure to recognize until now the post-Enlightenment impacts of technology and technology’s ethical symbiosis with engineering. Philosophers have long been thinking and writing about the dangers posed by modern technology. Karl

Marx wrote in 1859, in *A Contribution to the Critique of Political Economy*, about the impact of the industrial revolution on humankind:

> In the social production of their life, men enter into definite relations that are indispensable and independent of their will; these relations of production correspond to a definite stage of development of their material forces of production. The sum total of these relations of production constitutes the economic structure of society – the real foundation, on which rises a legal and political superstructure and to which correspond definite forms of social consciousness. The mode of production of material life determines the social, political and intellectual life process in general. It is not the consciousness of men that determines their being, but, on the contrary, their social being that determines their consciousness (159–160; Preface).

Technology, argued Marx, allowed for an unlimited supply of labor (factories with repetitive mass production rather than individual craftsmen) and thus the expansion of capital; it altered the ownership of the means of production and diminished the working conditions for and power of labor (Harvey 119–125).

Technology as the subject of epistemological and ontological inquiry was a prominent focus of philosophy in the 20th century. In his 1949 lecture entitled *The Question Concerning Technology*, Heidegger distinguishes modern technology from pre-modern technology. He warns us of the "enframing" dangers of modern technology. Technology becomes our very way of engaging with the world and deludes us into believing that we are empowering ourselves when, in fact, it is this "enframing" essence of technology that threatens to turn everything, humans included, into nothing more than "standing reserve" or human inventory. Contrary to many interpretations that understand Heidegger's work as a condemnation of technology and despite all his warnings about the dangers of technology, Heidegger does not demand that we abandon technology. In the end, Heidegger says we must engage in "essential reflection upon technology and decisive

confrontation with it"; Heidegger suggests that we must never stop questioning technology and that art or *poeisis* offers a platform for questioning (Heidegger, *Basic Writings* 339–341).

Ellul defines technology (*technique*) as the "*totality of methods rationally arrived at and having absolute efficiency* (for a given stage of development) in *every* field of human activity ("On the Aims of a Philosophy of Technology" 182, emphasis in original). For Ellul, technology is not ethically neutral ("The 'Autonomy' of the Technological Phenomenon" 394–395). Its defining quality is that it is autonomous: "autonomy is the very condition of technological development" in that "technology endures no judgment from the outside nor any restraint. It presents itself as an intrinsic necessity. . . . The technological system, embodied, of course, in the technicians, admits no other law, no other rule, than the technological law and rule visualized in itself and in regard to itself" ("The 'Autonomy' of the Technological Phenomenon" 386). This condition of autonomy, he argues, makes technology the dominant force in the 20th century that controls economic, social, and political structures – upending the Marxist philosophy of materialism that says capital is the dominant force ("The 'Autonomy' of the Technological Phenomenon" 393). Like Heidegger, Ellul also finds that humans are trapped by their mistaken belief that they control technology. And, also like Heidegger, Ellul does not think we can get rid of technology but must "transcend" it ("On the Aims of a Philosophy of Technology" 186). One solution he proposes in a later writing is an ethics of nonpower where human beings exercise technological restraint and "agree not to do everything they are able to do" ("The Search for Ethics in a Technicist Society" 9). One of the most difficult questions that Ellul addresses in many of his writings is whose responsibility it is

to define and impose an ethics on technology. His answer is that it rests with all of us, educators, designers (engineers), and users of technology.

A common theme in the philosophy of technology is the warning that technology has become an end in itself and that it alone can deliver the tools for human salvation. Mumford writes that what makes us human is not our tool-making ability but rather “man’s capacity to combine a wide variety of animal propensities into an emergent cultural entity: a human personality.” Mumford states “Until man had made something of himself he could make little of the world around him” (Mumford 345, 347). Mumford distinguishes between two kinds of technology: polytechnics, which resembles his conception of *technē* in ancient Greece, a technics that was “broadly life-centered” and bound up with nature, versus monotechnics, which is “work-centered or power-centered” (347). He traces the origin of monotechnics, characterized by task specialization that is alienated from all other aspects of human life, back more than 5000 years and locates what he calls the “Megamachine.” The Megamachine is “the human model for all later specialized machines” (348) and is today “regarded by many as the main purpose of human existence” (350) even though it has given us technology with the capacity to annihilate all of humanity. As with Heidegger and Ellul, Mumford also sees a way out. His proposal is that technology become the means of liberation *for* work rather than *from* work – that we engage in “more educative, mind-forming, self-rewarding work, on a voluntary basis” as a “counterbalance to universal automation” (351).

Winner invokes a 2500 year old conversation from *Prometheus Bound* to show that the problems posed by modern technology are not new. Winner also warns that technology

has become autonomous, that it has evolved into a new “technological politics,” and that, contrary to what we may want to believe, we are no longer in control of technology. He critiques the work of others, such as Marcuse and Ellul, as “trivial” in terms of offering real solutions, and he addresses multiple barriers to any new paths toward technological reform. For his part, he proposes an “epistemological Luddism.” Unlike traditional Luddism which would physically dismantle technology to be rid of it, Winner would deconstruct technologies through a “method of inquiry” to reveal, in a way that derives its significance from the ancient Greek concept of *technē*, the “forgotten essence of technical activity.” And he suggests three criteria by which, at the individual or group levels, we can reconsider both existing and proposed technologies: (1) the technology must be understandable by non-experts, in particular, the people the technology will affect, (2) the technology must be flexible, in other words, changeable by people so that it doesn’t acquire autonomy, and (3) the technology should create as little human dependency as possible (Winner, *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought* 325–35). Winner, as with the other philosophers discussed here, acknowledges the permanency of modern technology and its autonomous nature but asserts that it is not too late to deconstruct technology and use the knowledge we gain to make informed decisions about existing and future technologies.

Bunge, who is both a theoretical physicist and a philosopher of science, distinguishes pure science from technology in a way that is similar to the distinction made by Aristotle between *epistēmē* and *technē:* “Whereas science elicits changes in order to know, technology knows in order to elicit changes” (173). Science, he argues, does not need much ethical control because it is self-governing (179) but technology, Bunge says, is

different. He argues that technology itself is not ethically neutral. To the contrary, he writes that "technology is involved with ethics and wavers between good and evil". Importantly for engineering ethics pedagogy, Bunge argues that we do a disservice to both the profession and to society when we train engineers and other technologists to be no more than "skillful barbarian[s] who must be kept in [their] modest place as the provider[s] of material comfort" and who are expected only "to carry on their task without being distracted by any ethical or aesthetic scruples" which are exclusively in the domain of management (180).

Hannah Arendt begins *The Human Condition* by recounting a modern technological feat, the successful launch in 1957 of the Russian satellite, Sputnik. For Arendt, who published *The Human Condition* in 1958, this event was "second in importance to no other" because of its political implications (1). She argues that technology has changed the labor process and, consequently, our human condition such that our lives are now consumed by making – production and consumption – rather than on action, that is, "to think what we are doing" (5). Despite all the threats posed by the modern predicament, Arendt, too, is optimistic that humanity, by virtue of its plurality, its capacity for forgiveness and promising, and the fact of our natality – that there will always be a new generation of us – can thrive.

These voices and others make it clear that ethical questions surrounding modern technology and its connections to engineering are not recent and, moreover, that these questions are not unique to the modern age or the 21st century. They affirm that neither technology nor engineering is ethically neutral and that the responsibility for ethical

decision-making about technology does not reside with philosophers or policy makers alone. Yet, these voices have been and are excluded from traditional engineering ethics education. Both technology and engineering as the objects of ethical inquiry remain off-limits for traditional engineering education. Why is this? The case of the Engineering Publicity Program introduced by MIT in the 1920s is instructive. Russell examines this program in the context of asking whether instructors of technical writing courses whose students are mostly undergraduate engineering majors have a responsibility – or even the prerogative – to teach ethics.

Should Engineering Students Study Ethics?

The story of MIT's Engineering Publicity Program, briefly, is that in 1916 MIT decided to place greater emphasis on literature and history in its required composition courses and hired a literary scholar to chair the department. The goal was to educate more well-rounded engineering students. The new chair, Frank Aydelotte, taught composition as "training in thought" which meant that he pursued a literary perspective emphasizing critique as opposed to a science, business or engineering perspective. The engineering students, as Russell describes them, "were not much interested in having their characters and aims of life humanized in Aydelotte's way, and they chafed at the literary instruction" (178). Aydelotte left after three years and was replaced by Archer T. Robinson who changed the curriculum again and replaced the literary courses with so-called "contact courses" because, in his view, most engineering students were not cut out for a literary education and the duty of MIT was to prepare its engineering students with the workplace skills needed to enter their chosen careers. He introduced three courses, The Engineering Field, The Human Factor in Business, and Engineering

Publicity. The courses were intended to bring students into contact with engineers, most of whom were management level, to discuss problems encountered in the professional working world and to absorb the “ethos” of the profession. But the “ethos” that the engineering students encountered was engineering design, writing for engineering publication, their duties to the employer, how to manage personnel and other workplace problems, and how to get promoted. These skills, Robinson argued, were the “ethos” that engineering students needed to enter their profession.

This vision of professional engineering “ethos” is little changed today. In 1985, Norman Bowie, a professor at the Carlson School of Management at the University of Minnesota, in arguing that there is no difference between business ethics and engineering ethics, wrote, in a way that could just as well have been penned for MIT’s contact courses:

> What is a good engineer? A good engineer is one who lives up to the obligations of her employment contract, who conforms to the etiquette of the job situation she finds herself in, and whose individual engineering practice at least equals the performance standards of the profession (44).

Researchers from Purdue University recently studied the perceptions of ethics of students who worked on multidisciplinary engineering design teams at four different universities. These institutions were selected because their engineering project teams are multidisciplinary and designed to give students a practical “real-world” type of engineering experience. The researchers conducted extensive interviews with the students and used discourse analysis to analyze student responses. Although each university had a unique “discourse” that influenced student perceptions of ethics and although there were individual differences among students at the same institutions, there were nevertheless some common themes raised by students during the interviews.

Students at all institutions expressed foremost concern for the technical excellence of their products. Students were also strongly focused on meeting their clients' expectations, following standards, avoiding adverse legal consequences (for example, violation of patent rights or confidentiality agreements), and being part of a team (Kenny Feister et al.). The point here is that, although each team had its own "discourse," the students viewed professional ethics within a rules-based framework. Students did not generally raise concerns about their ethical obligations toward technology *qua* technology, the ambiguities and uncertainties of engineering design practice, the political implications of engineering, the social responsibilities of engineers, and the impacts of globalization, for example. Today's engineering students have a perception of the "ethos" of the engineering profession that is almost indistinguishable from the one Robinson was aiming to impart with his contact courses at MIT in the 1920s.

Conventional thinking says that students become engineers because they are already disposed to this type of thinking but research suggests that majoring in engineering reinforces and perhaps even generates these attitudes among students. Colby and Sullivan discuss several research studies that evidence this is true:

> [Engineering majors] are also more likely than any other major to graduate believing that the chief benefit of college is to increase their earnings potential, that individuals cannot change society, and that it is not important to develop a meaningful philosophy of life. They are less likely than other students to be committed to promoting racial understanding and less likely to describe themselves as altruistic or socially concerned. Majoring in engineering is also negatively associated with writing, listening, and foreign language skills and with cultural awareness (335).

Moreover, citing the work of Sax, they state that the differences in social commitment between STEM (including engineering) and non-STEM undergraduate students can be

attributed, at least in part, to the impact of being an engineering major. In other words, the entrenched nature of the engineering curriculum and the views of engineering faculty toward social responsibility can reinforce and even generate these student attitudes that mirror the century-old MIT conception of the ethos of engineering (335).

Nearly 100 years later, the question of how much and what kind of ethics instruction we should require of engineering students remains as contentious as ever. Latour calls this a “two-culture debate” in which “[o]ne camp deems the sciences accurate only when they have been purged of any contamination by subjectivity, politics, or passion; the other camp, spread out much more widely, deems humanity, morality, subjectivity, or rights worthwhile only when they have been protected from any contact with science, technology, and objectivity” (134). Russell, a Professor of English, offers a compromise he calls the “*kairos* of critique” that respects the career choices made by engineering students and works to prepare them for that profession by selectively critiquing – at the right time – the “structures and values of the community that an individual student is struggling to enter” (182). Bizell also recognizes that it is painful for students to “deconstruct ideologies [they] hold as foundational,” especially when we give them nothing to use in their place. She argues that higher education should help make our students better people and better citizens. She calls for a non-prescriptive dialog between teachers and students to discover workable alternatives that can “collectively generate trustworthy knowledge and beliefs conducive to the common good” (671).

The adoption by ABET of Engineering Criterion 3(f) made some form of ethics preparation for undergraduate students essential if engineering programs were to

maintain accreditation. But years later, the ambiguity about engineering ethics and the continued resistance of engineering programs to embrace ethics instruction remains. It was expressed by an engineering professor quoted in the *Grave New World* article: “[M]any of the [ethical] questions they raise are issues for society as a whole to decide, not just engineers. ‘Engineers have a lot to contribute, but it’s only a small part of the whole’. . . Students already must master a jam packed engineering curriculum, with little time for additional electives; teaching ethics classes holds little prestige for either engineering professors or philosophy professors; and students resist ethics classes because they’re an elective” (Pine).

So if the answer to the question about whether engineering programs should require some sort of ethics instruction for engineering students is a reserved and begrudging “yes” – and that is what it seems to be – the next step is to examine and critique how that obligation is currently being met. ABET’s E.C. 3(f) sets the threshold – an “understanding of professional and ethical responsibility” – for ethics instruction, so engineering programs are now obligated to do <u>something</u>. But how much ethics should be taught and what it should look like are not prescribed by ABET and remain the prerogative of individual engineering programs. Pine talked with several engineering educators about ethics instruction in light of the ABET requirement and found many who were skeptical about the ability of engineering programs to satisfy the criterion. Among them was Miller, who spoke about ABET’s failure to prescribe standards for Criterion 3(f), “I worry a bit that these look better on paper than as they have actually been implemented” (n.p.).

A critique of the current traditional approach confirms that most engineering ethics instruction is designed to teach students about the professional rules of conduct and how to use decision analysis tools to resolve ethical questions that involve engineering design or workplace issues. The focus remains on imparting particular knowledge and ethical reasoning with little or no concern for developing emotional engagement with ethics and an understanding of what it is to be ethical engineers.

Ethics Education for Engineering Students: Critique of Traditional Approach

The literature on engineering ethics education is abundant and growing. It includes periodic general accounts of how undergraduate engineering ethics is taught in the United States. Studies that attempt to summarize the state of engineering education at varying points during the years since ABET adopted Criterion 3(f) in 2000 include, for example, “Engineering Ethics Education in the USA: Content, Pedagogy and Curriculum” (2000) (Herkert), “Is Engineering Ethics Optional?” (2001) (Stephan), “Ethics Teaching in Undergraduate Engineering Education” (2008) (Colby and Sullivan), and “Models of Teaching Professional and Research [Engineering] Ethics” (2013) (Burbules, Lang, and Ramsey).

Ethics instruction is delivered through (1) stand-alone courses usually taught by philosophy faculty, (2) embedding professional ethics knowledge in engineering coursework, thereby making engineering faculty primarily responsible for this instruction, (3) a set of ethics modules taught usually in a first year introduction to engineering course or senior capstone design course, and (4) other methods such as service learning and Science and Technology Studies (STS) coursework (Colby and Sullivan;

Stephan; Herkert, “Engineering Ethics Education in the USA”; Davis and Feinerman). Engineering ethics is rarely a required separate course for students. Stephan examined 242 domestic engineering programs and reported in 2001 that 78% of the programs had no across-the-board engineering ethics requirement (8). Shuman, et al. found that, of 120 students surveyed, only 17 of them had taken an ethics course and that none of them had taken a stand-alone ethics course. Colby and Sullivan studied a diverse selection of U.S. engineering programs by interviewing faculty, administrators and students and by observing classes. They reported in 2008 that a “broad, intentional, planned approach to ethics and professional responsibility was rare. . . . Overall, a picture emerged of rather spotty and unsystematic attention to students’ development of professional responsibility” (332).

The traditional engineering ethics curriculum – whether a stand-alone course, embedded in technical coursework, or a set of modules – centers on ethical theory. The three most taught theories of engineering ethics are deontological or rules-based ethics, consequentialist or utilitarian ethics, and Aristotelian virtue ethics.[8] Rule-based ethics forms the core of ethics education. Kant gave us the supreme paradigm of rules-based ethics, the Categorical Imperative: to act only according to that maxim by which you can at the same time will that it should become a universal law (Kant, “The foundations of the metaphysics of morals”). His notion of the rules that govern “right” behavior is that they are derived through reason, they are universal, they are inviolable, and they apply

[8]These are the three dominant and most taught theories of ethics. There are numerous others. Among those most often included in edited anthologies are “contractarianism” of John Rawls from his seminal work *The Theory of Justice* (Rawls) and a feminist “ethics of care” articulated by Carol Gilligan (Gilligan). This by no means – and is not intended to be – an exhaustive list or a dismissal of other theories.

without exception. The National Society of Professional Engineers has given us the rules for engineers - the NSPE Code of Ethics. Nearly all of the rules in the Code are written in prescriptive terms, telling engineers that they “shall” or “shall not” engage in certain conduct. At the beginning of the semester, I often ask my students to write a brief essay reflecting on what they think it takes to be an ethical engineer. Without exception, the students (nearly all of whom are in their final year of undergraduate studies) tell me that the most important thing for an ethical engineer is to adhere to Canon 1 of the NSPE Code of Ethics: “Engineers, in the fulfillment of their professional duties, shall hold paramount the health, safety, and welfare of the public” (NSPE). Canon 1 is the single most memorable lesson in engineering ethics that students recall from their prior four or five years of engineering education. In their view, almost every professional engineering ethics decision (and ethical questions, of course, almost always arise in terms of whether a design meets risk standards) can be decided by reference to this Canon. This, I suggest – and my conclusion is supported by research – is the depth of professional ethical awareness of most undergraduate engineering students (Colby and Sullivan 330).

Reliance on professional codes of ethics, although the most common point of reference in engineering ethics instruction, is criticized by Bucciarelli as being too “narrowly read, as the framework for defining what constitutes an ‘ethical problem’. “ He cites as an example Canon 1 which “is read as a demand for product safety – as a means to avoid liability – not as a call to social responsibility” (11, 10). Burbules, et al. find that the value of codes of ethics as instructional material depends on how they are used. Merely studying codes and applying them to particular cases may increase a student’s

knowledge about ethics but it does little to improve ethical decision-making skills (18–19). Codes of ethics can be effective, they write, when students recognize and understand the community values that are behind them (20). Similarly, Davis argues that codes of ethics can only be effective if they are used interpretively (150). Wike argues that codes and rules are a too simplistic approach to engineering ethics and mistakenly lead students to believe that laws and codes provide all the answers to ethical problems (n.p.). Harris warns of engineering ethics education as a system of "preventive ethics" that consists of negative rules and disaster case studies that inadequately prepares students for most aspects of professional engineering practice (154). Frey, who doesn't reject the use of codes of ethics, nevertheless sees that codes of ethics are too often presented in instruction as products rather than as processes and that, properly redeployed, can have instructional value (622). Haws, on the other hand, considers that instruction using codes of ethics for engineering students locks students into what he calls "*ethical primitives"* and will leave them "functioning at the level of dogma" (207, emphasis in original).

The second theory commonly taught in engineering ethics education is act utilitarian ethics – today more commonly known as consequentialism. Act utilitarianism requires that we act in ways that will result in the greatest good for the greatest number (Bentham; Mill). On its face, consequentialism appears to be a pragmatic and realistic theory for ethical decision-making – we weigh the consequences of our various options and we try to pick the action that will do the most good or, in some cases, the least harm. Consequentialism is, however, deceptively simple and is, in reality, a very complex and demanding way to live (Singer; Timmons; Baron, Pettit, and Slote). In

terms of engineering and engineering ethics, “utility” is an attractive approach to ethical decision-making because it relies on a variety of formulae and decision-models such as risk analysis, cost-benefit analysis, impact analysis, and so on, to help engineering students assign numerical values to quantifiable factors in order to calculate the best and “right” decision. Although multiple quantifiable factors may go into the calculation, students don’t see this process as a particularly challenging one – it requires that a formula be applied to a set of facts in order to yield the ethically correct answer. It is a part of the design process for which students are trained beginning in year one with Engineering Fundamentals, and it is the first tool that students turn to when confronted with an ethical engineering problem.

Heuristics are decision models that give students a framework and rational process for ethical decision-making. They are often used as a utilitarian calculation and critics typically consider heuristics and risk/cost-benefit analyses together. Such models are plentiful – one need only Google “ethical decision making model” to find thousands of results. A typical model systematically helps define the ethical problem, identify available alternatives, evaluate the alternatives (applicable rules, stakeholder consequences, costs and benefits, etc.), make the decision, implement the decision, evaluate the impact of the decision, and make adjustments if possible. This process bears a remarkable resemblance to the engineering design process and is what Newberry has called the “engineer-ization of ethics” which attempts to make ethical problems “simply another class of problem that can be tackled by our rational-scientific procedures” (350). Haws thinks that heuristics might help students resolve ethical dilemmas but, having said that,

he also considers the heuristic to be “just a multi-step rule, which can itself become dogma if relied on in an unexamined way” (208).

Deontology and utilitarianism are ubiquitous in engineering ethics instruction although they are often masked as a code of ethics and cost/benefit analysis. Virtue-based ethics, while not a standard component of ethics instruction, is receiving increased attention in engineering ethics education literature. Aristotelian virtue ethics holds that the right action is that which a virtuous person would do under the circumstances. For Aristotle, it is not enough that a person does the right thing because there is a rule that prescribes the behavior or because a reasoned calculation would bring us to that result. Rather, the action must be done for its own sake and it must come from the core virtuous character of the individual. The virtuous decision is a manifestation of the virtuous person. Hursthouse writes that virtue as a character trait is “a well-entrenched or settled state of a person – a certain sort of way they are, through and through, all the way down – which involves a disposition of a very complex sort” (63). In engineering ethics instruction, virtue ethics is typically implemented in the classroom by having students study cases of “moral exemplars” – engineers who exhibited exceptional judgment in ethically challenging situations – or by asking students to create a “professional virtue portrait” of a good engineer (Pritchard, “Professional Responsibility”; Stovall; Harris Jr; Gorman). Burbules, et al. think the study of moral exemplars can inspire students but they warn that it, too, can be taught in a way that becomes “dogmatic and hinders moral development” (23).

Whether ethics is taught from a deontological, consequentialist, or virtues theory approach, the method universally employed to teach students how to use ethical knowledge is the case study. Case studies – real or fictitious – are the applied side of engineering ethical knowledge and they are plentiful and well-known: the space shuttle Challenger and Columbia disasters, the Ford Pinto gas tank explosions, the Hyatt Regency skywalk collapse, the Bhopal chemical spill, and the made-for-the-classroom depictions of multiple ethical dilemmas in films such as *Henry's Daughter, Gilbane Gold,* and *Incident at Morales* ("National Institute for Engineering Ethics"). The case study method offers the greatest opening for variety in the classroom because there are nearly unlimited options. Instructors can show movies or documentaries, use real ethical cases from a growing number of online engineering ethics centers or from the NSPE, make up their own cases, or ask students to use actual project design problems from their own coursework. The case study method permits a wide range of applications in the classroom including class or team discussions, role play, arguing for or against a position, essay responses, and so on.

Notwithstanding its versatility, utility, and ubiquity, the case study instructional method garners both support and harsh criticism. It has strong defenders (Stephan 11; Harris et al. 94–95) and it has moderate defenders, those who warn against using only disaster cases and advises a balanced mix of good and bad (Haws), those who create a taxonomy of cases for students to study (Huff and Frey), and those who advise students to focus on "good news cases" rather than negative disaster cases (Pritchard, "Professional Responsibility"). Although the case study approach is rarely questioned in actual engineering ethics instruction, the method is severely criticized in ethics pedagogy

literature. Winner applauds the effort to teach ethics to engineers but argues that the use of case studies allows students and instructors to avoid the harder ethical issues that should be confronted by engineers:

> This can seem to be nothing more than a useful attempt to transcend mere abstractions and to provide contexts for issues by locating them in the "real world" of practice. Unfortunately, what such moves often do is to bracket the realities of daily work in favor of hypothetical situations that are comforting because they are so remote. . . . So-called ethics case studies usually point students toward specific troubling incidents within what are assumed to be otherwise harmonious patterns in ongoing institutions. The patterns themselves, however, are not identified as anything problematic. Indeed, it is a property of the case study approach to education in business, law, and engineering that the contexts that underlie particular cases are never themselves called into question. By failing to analyze and criticize these contexts, case studies tend to legitimate and reinforce the *status quo* ("Engineering Ethics and Political Imagination" 53–54, emphasis in original).

Colby and Sullivan express reservations about the heavy reliance on case studies in engineering ethics instruction. They point out that this approach "does not require students to struggle with the trade-offs involved in actual engineering decisions or with the fact that the consequences of those decisions become clear only in retrospect" (331). Lynch and Kline also criticize the standard use of "prepackaged ethical dilemmas" because these cases don't reflect the conditions in which engineers actually work on a day to day basis and, thus, do not adequately prepare them for ethical decision-making:

> [These] all-or-nothing dilemmas can be disabling for students: to take the extreme case, if the only choices one is given are to challenge superiors, potentially losing one's job, or accept the status quo, potentially leading to serious, negative outcomes, students may feel that ethics involves nothing more than a pure trade-off between sacrificial heroism and amoral self-interest. Such cases may not promote the initial recognition of ethical problems in ill-structured, real-world situations, nor are they likely to give students a sense of how different elements of their work setting and culture can impede or facilitate remedial action (208–209).

Conlon and Zandvoort, who are engineering and technology policy faculty at the Dublin Institute of Technology and Delft University of Technology respectively, critique the "individualist approach" to engineering ethics as giving too simplistic a view of the practice of engineering: (1) case studies focus on the individual actor who, alone, must make the ethical decision between "personal sacrifice" or doing nothing; (2) students use a code of ethics to analyze the case; this gives the false impression that rules or codes of ethics are clear and unambiguous; (3) if rules don't solve the problem, students look to "neighbor-ethics" or a narrow use of moral philosophy that fails to place the ethical question in a much broader context; and (4) case studies typically assume that "win-win solutions" are always possible and that they can be successfully adopted and implemented (220-221).

With their criticism of the "individualist approach" in engineering ethics instruction, Conlon and Zandvoort open a critique of traditional engineering ethics education. This returns us to the epistemological roots of engineering, that is, the millennia-old divide that opposes knowledge as universal, transcendent, discoverable by reason and ethically neutral against knowledge as contingent, constructed, emerging from competing and often conflicting values, and requiring ethical choice. If we accept that the practice of engineering is the latter, that it is imbued with ethics and based on contingency and uncertainty (see, for example, Bucciarelli, Herkert, Frey, Johnson, Goldman, and Winner), then the proper question for engineering ethics pedagogy is: What are the ethics of the *technē* of engineering? Traditional engineering ethics instruction avoids this question altogether. With its reliance on an instrumentalist

approach to ethical decision making, it never asks engineering students to consider the ethics of engineering itself and the essences of being an ethical engineer.

Bucciarelli says that what is needed most in engineering ethics education is attention to "the social responsibility of the profession as a whole" (11). He challenges the value system of the current engineering curriculum and argues that the entire engineering program – not just ethics instruction – must be reformed so that students understand "the social as well as instrumental challenges of contemporary professional practice and what this might entail as the profession's 'social responsibility' (and ethical behavior of the practicing engineer)" (14). Bucciarelli contrasts object-world work, which is the current engineering approach toward ethical decision-making – an approach that is not consonant with the reality of engineering practice – with that of social exchange and action:

> What engineers do, and are expected to do, includes much more than rational problem solving and constructing efficient means to reach desired, externally specified ends. My division of the work life of the engineer into two modes – i.e., object world work characterized as solitary, instrumental, mono-paradigmatic, materialistic, value-neutral, hard, certain and calculative (yet challenging in a puzzle-solving way and empowering) and all the rest characterized as social, i.e., collective, negotiable, ambiguous, soft, qualitative, compromising, political – is no lofty categorization of structure unfelt, but real and recognized by engineers themselves. It is the case, however, that object-world work is the kind of labor seen as primary by engineering faculty – and consequently seen as such by our students. It is what they (we) explicitly teach in our core curricula – the "hard" stuff – whereas the social is generally not seen, neglected, or worse yet, made a laughing matter (4).

Herkert builds on earlier concepts of microethics and macroethics and considers them in the context of engineering ethics. " '[M]icroethics' [which is] concerned with ethical decision making by individual engineers and the engineering profession's internal

relationships, and ‘macroethics’ referring to the profession’s collective social responsibility and to societal decisions about technology” (“Ways of Thinking about and Teaching Ethical Problem Solving: Microethics and Macroethics in Engineering” 374). Herkert observes that microethics is the approach used in most engineering ethics instruction. It focuses on questions of individual agency, the solitary engineer making ethical decisions about designing safe products, not fabricating or altering test results, and so forth. Herkert does not suggest that microethics is unimportant for students but says that it is only part of the ethical skills that engineers must develop. Macroethics, for Herkert, works at the collective level of the engineering profession and is concerned with social policy and policy making. He positions macroeconomics as squarely within ABET’s Criterion 3 that engineering graduates “understand the impact of engineering solutions in a global, economic, environmental and societal context.”

The microethics/individual agency – macroethics/social responsibility distinction is usually described as a continuum and is correlated with stages of moral development as well as the teaching methods that promote one stage or another. Haws says that students should move from lower levels of moral development to higher ones, that is, “to a deeper ethical conviction (and more consistent ethical actions) as well as an improved efficacy in expressing their convictions to others” (210) and this requires more complex skills than lower level ethical reasoning. Meta-ethics, which for Haws involves an immersion in the study of original texts of ethical theory, is the way to achieve higher levels of moral development (209). Burbules, et al. track the microethics/individual agency – macroethics/socially situated nature of choice and social good continuum with how people make moral decisions and with corresponding instructional methods geared

toward lower or higher levels of moral development (13–16). Kline also critiques the agent-centered focus of microethics (associated with case study method) because it narrowly analyzes what an individual engineer should do in a particular case without considering that engineering is a social experiment to be understood in a much broader context (16–17).

Deborah Johnson attempts to answer the question about the social responsibilities of engineers. Though she is addressing this question in the context of military research, she wants to come up with a broad set of principles that could be useful for all engineers when considering what work they should or should not do when it impacts the safety and welfare of the public. She considers three different positions – (1) a “guns for hire” view where the engineer is a morally neutral actor who is not entitled to impose a personal point of view on the work, (2) a purely personal view where each engineer needs to decide if a project conflicts with one’s own personal values, and (3) a social responsibility view where engineers consider risk to the public and can proceed only if there is public consent to the projects. Johnson generally favors the third view and wants only to offer a frame of reference to open the discussion because she recognizes that such decisions are complex and raise many more questions (107, 113-114).

For Goldman and Winner, engineering ethics is not satisfied by merely taking into account or working toward the social good. For them, engineers cannot separate themselves from the social, economic and political structure. Goldman writes:

> Engineering practice in the modern world is embedded in a very particular social context, one that has evolved out of mid twentieth century industrial capitalism. . . .The common denominator is the process within which engineers function. . . . one in which engineering serves managerial

> agendas. Engineers apply their expertise to the solution of problems that derive from these (commercial or political or military) agendas, and their solutions enable the realization of these agendas. Engineering is thus ineluctably a sociopolitical, as much as a technical knowledge, practice. As a matter of historical fact, engineers in the Anglo-American world have overwhelmingly insisted that they are only technical problem solvers, that accountability for actions based on their solutions and for consequences of those actions lies with others. This insistence rings hollow, however, with deeper insight into the nature of engineering. . . .If engineering reasoning is by its very nature embedded in action contexts, then engineers cannot escape sharing responsibility for that action (172).

Winner also situates engineering ethics in the political. Though supportive of the movement toward increased engineering ethics instruction, he is critical for what it does not do. First, by promoting the idea that technology is ethically neutral and by failing to examine the phenomenon of power, traditional ethics instruction tacitly allows engineering students to embrace without question "the power relationships the profession contains" ("Engineering Ethics and Political Imagination" 56). Second, engineering ethics courses fail to explore "the question of vocation, one's calling in a moral sense":

> It is reasonable to expect that as a person contemplates committing several decades to a profession, some basic issues ought to be addressed. What are the fundamental ends of a life invested in this line of work? What is the purpose of developing my knowledge and skill in this direction in the first place? Who ought to control the most basic definitions of what my vocation entails? Our educational institutions now shortchange students by avoiding such issues, neglecting focused study of the moral and political groundwork of the professional life.
>
> Courses on engineering ethics tend to focus upon issues of right and wrong in personal conduct – extremely important matters indeed. But beginning with Aristotle, philosophers have noticed that there is a logical juncture where ethics finds its limits and politics begins. That turning point comes when we move beyond questions of individual conduct to consider the nature of human collectivities and our membership in them. This calls upon us to ponder the nature of political society and what membership in it means for us, not merely as individual actors but as participants in a community neglecting focused study of the moral and political groundwork of the profession life (57).

To this end, Winner says that engineering students must learn to engage in political reflection. This means asking, not only the “how” questions that are so natural to engineers, but also the “why” questions, especially important in today’s world of rapidly emerging technologies. He urges deliberations to discover “deeply grounded reasons to guide our choices” (60). Finally, Winner argues that engineers should recognize the public political and policy roles of engineers:

> Engineers and technical professionals are the unacknowledged legislators of our technological age. Choices that affirm the public good or trample it often rest in their hands. If they overlook this critical role and responsibility, they will also acquiesce in yielding power to agents whose ends are increasingly distant from humanity’s best (59).
>
> Ethical responsibility now involves more than leading a decent, honest, truthful life, as important as such lives certainly remain. And it involves something much more than making wise choices when such choices suddenly, unexpectedly present themselves. Our moral obligations must now include a willingness to engage others in the difficult work of defining what the crucial choices are that confront technological society and how intelligently to confront them.
>
> The first requirement, therefore, might be called the responsibility of dialogue; the second, the responsibility of citizenship. . . . Our task is that of bringing these practices to life for the era of high technology (62-63).

Arendt effectively brings this critique together to make practical sense about the ethics of the *technē* of engineering, the role of engineers in ethical debate and decision making, and the skills they need to do this. Arendt argues that what is “sensuously given” for people has been replaced by a “system of mathematical equations,” an argument that assumes science is an adopted rather than a natural way to live and that the modern dominance of science has changed the human condition by replacing concern for action with a compulsion for production. In the following, Arendt appears to argue that scientists (including engineers) and politicians are not the people that should be consulted about

the very questions that Winner, Goldman, Bucciarelli, and others claim are integral to their ethical responsibility as engineers. But a careful reading reveals that Arendt is arguing that the language of science and technology simply cannot give us ethical answers and that, instead, scientists and technologists must acquire the language skills that enable them to speak meaningfully about these questions. It is not that they should not be heard or have nothing to contribute; rather, scientists and engineers are not today given the skills to speak about what they know or experience:

> The question is only whether we wish to use our new scientific and technical knowledge in this [destructive] direction, and this question cannot be decided by scientific means; it is a political question of the first order and therefore can hardly be left to the decision of professional scientists or professional politicians (3).
>
> For the sciences today have been forced to adopt a “language” of mathematical symbols which, though it was originally meant only as an abbreviation for spoken statements, now contains statements that in no way can be translated back into speech. The reason why it may be wise to distrust the political judgment of scientists *qua* scientists is not primarily their lack of “character” – that they did not refuse to develop atomic weapons – or their naïveté – that they did not understand that once these weapons were developed they would be the last to be consulted about their use – but precisely the fact that they move in a world where speech has lost its power. And whatever men do or know or experience can make sense only to the extent that it can be spoken about (4).

Arendt delivers a compelling argument that engineers should participate in the ethical debates posed by modern technology but that, to do so, they must acquire the language or rhetorical skills – and rhetoric is taken in the way that the sophists understood rhetoric as the skill to work with knowledge that is contingent, uncertain, and permeated with values and ethical choice – so they can responsibly fulfill their duties both as citizens and as engineers.

Assessment of Student Outcomes

It is necessary to include, along with a critique of traditional engineering ethics pedagogy, data on the results it achieves. Is ethics instruction accomplishing, at a minimum, what ABET Engineering Criterion 3(f) requires? Two problems arise with respect to assessment of student learning outcomes for engineering ethics. First, there is little data on which conclusions about student learning outcomes can be based. Ethics is considered difficult to measure and less important to assess and report than technical knowledge for engineers. Second, from the data that is available, the conclusions seem to be that student learning outcomes for engineering ethics are not meeting expectations.

In their 2008 report, Colby and Sullivan found that assessment for ethics learning of undergraduate engineering students was weak; ethics coursework was often ungraded; and faculty saw ethics as “subjective and personal” and not assessable (333). They reviewed 100 ABET self-studies that tracked ethical learning and concluded that the reports from these programs were “vague and sometimes even seemed to be inaccurate” – in other words, the very assessment data that are supposed to prove engineering program success in meeting ABET’s ethical learning outcome criterion are flawed and unreliable (336). Davis and Feinerman attempted to conduct an NSF-funded study to assess ethical learning outcomes of graduate engineering students and encountered several impediments to effective assessment, including the time it takes for assessment testing which detracts from time spent on other aspects of the course, the objections of faculty to the seeming irrelevance of such assessment, and challenges of finding testing methods that offer comparability of results (5-7). Harding, et al. undertook

a broad nationwide assessment of the state of undergraduate engineering students' ethical knowledge, reasoning, and behavior. They reported in 2013 that ethics assessment is usually done on a class by class basis with no generalizable results (n.p.). So the challenges of sound assessment of ethical learning outcomes for engineering students continue to be used as a justification for inadequate assessment and as an argument against the requirement of ethics instruction in the first place.

Colby and Sullivan undertook a comprehensive review and analysis of several quantitative studies on student learning outcomes for engineering ethics. Their overall conclusion is that these studies confirm that engineering ethics instruction does not adequately prepare students for the ethical work they will face in actual engineering practice. They site studies of practicing engineers who report that their undergraduate education left them unprepared for addressing ethical issues and who now express stronger support for an ethics curriculum (334, citing McGinn) and that the ethical reasoning skills of engineering students do not significantly improve between their freshmen and senior years (334, citing Shuman et al.). This confirms my own experience that the ethical reasoning skills of engineering students entering their fourth and fifth years of undergraduate education are not significantly different from the ethical reasoning skills for first year engineering students, as measured against the national norms established for undergraduate students by the DIT-2 (Troesch n.p.; Bebeau and Thoma 35). There are other studies that seek to quantitatively measure the student learning outcomes and impacts of ethics instruction on engineering students and to develop and test new assessment tools; and these will be discussed further in Chapter Three, the research methods portion of this dissertation.

Rhetoric Revisited: Its Ontological and Epistemological Importance

Previously in this chapter, I examined sophistic rhetoric as the epistemological opposition to the certainty and truth of both idealism and science. The context was a historiographic study of the “necessity-contingency” dualism that originated in recorded Western history with the ancient Greeks and that continues today and is manifested in the tensions between science/engineering and the humanities. So powerful is the positivist position that it continues to try to set the standards for what counts as knowledge outside of science, to the exclusion of rhetoric. For example, Perelman refers to failed efforts to develop a “logic of value judgments” in that scientists have not been able to successfully reduce the exercise of judgment based on values to a logical science (512). The power of science is present and strong in education as well, requiring teachers to institute rational “behavioral objectives” models so that learning can be assessed by quantitative, standardized measures (Dunne 1–8), defining what counts as an acceptable course of undergraduate study ((Miller, “A Humanistic Rationale for Technical Writing”), and, especially for my purposes in this dissertation, whether and what engineering students should and will study about engineering ethics (Russell).

Rhetoric is not *per se* the topic of this dissertation and may not be out front in the ensuing discussions, but it is also not hidden away in the deep shadows and blocked from our consideration altogether. Rather, rhetoric is always already there within the penumbra of all that is written here. It has both ontological and epistemological significance for engineering practice and for philosophy and ethics education. My purpose here is to give a due accounting of these significances.

We have been and continue to be mistakenly led to accept that the “self-evident” – demonstrably certain scientific truth – is the sole mark of reason. We are asked to believe that knowledge based on “necessity and self-evidence” (Perelman and Olbrechts-Tyteca) is not only the paramount but also the most useful and productive kind of knowledge. If we think about it, however, we will find that there is very little “certain” knowledge at all (Booth 61). To the contrary, our lives are lived mostly in uncertainty and as rhetorical beings who dwell in the “domain of argumentation” which is that “of the credible, the plausible, the probable, to the degree that the latter eludes the certainty of calculations” (Perelman and Olbrechts-Tyteca 1). We must live as deliberating and deciding beings precisely because most things are not self-evident. Moreover, most of our decisions have ethical implications to one degree or another.

Rhetoric then is part and parcel of our being. Gross, who argues that rhetoric was central to Heidegger’s fundamental ontology, writes, “We are human insofar as we can generate shared contexts, articulate our fears and desires, deliberate and judge in the appropriate terms of our day, and act meaningfully in a world of common concern” (4). As Goldman points out, this holds as much for the practice of engineering as it does for our living and being in general. To practice engineering is to deal in contingency; to be an engineer, then, is essentially to be rhetorical, deliberative, and choice-making.

Scholars debate the epistemological foundations of rhetoric. Plato depicts rhetoric as among the lowest forms of *technē,* that is, mere flattery or “cookery” (*Gorgias,* 464C-E, 465A). George Kennedy argues that, although Aristotle was inconsistent and referred to

rhetoric at varying times as theoretical, productive, and practical, it was Aristotle's intent that rhetoric was not a productive kind of knowledge but rather an *epistēmē* (Kennedy 77-79). A growing consensus among postmodernists is that rhetoric is praxis, the action side of *phronesis* or practical knowledge (Zhao; Miller, "What's Practical about Technical Writing?"). Rhetoric as praxis makes the most sense, certainly from a sophistic point of view, when we consider what rhetoric is and does. I'll offer four interconnected epistemological significances of rhetoric and, in particular, how they relate to science and engineering practice.

First, rhetoric is what keeps us from operating in utter chaos:

> The assertion that whatever is not objectively and indisputably valid belongs to the realm of the arbitrary and subjective creates an unbridgeable gulf between theoretical knowledge, which alone is rational, and action, for which motivations would be wholly irrational. Practice ceases to be reasonable in such a perspective, for critical argumentation becomes entirely incomprehensible, and it is no longer even possible to take seriously philosophical reflection itself. For it is only those fields from which all controversy has been eliminated that can thenceforth lay claim to a certain rationality. As soon as a controversy arises, and the agreement of minds cannot be reestablished by "logico-experimental" methods, one would be in the sphere of the irrational – which would be the sphere of deliberation, discussion, and argumentation (Perelman and Olbrechts-Tyteca 512).

Second, when science cannot provide an answer, rhetoric is the necessary alternative. I have said that, if we think about it, we will find that there is very little "certain" knowledge and that, to the contrary, we live our lives mostly in uncertainty. Rhetoric is what helps us deliberate through the mass and tangle of information about problems and find possibilities where science ceases to be useful. Walzer and Gross provide an illustrative example of the limited utility of science in their discussion of the decision to launch the

space shuttle Challenger. They point out that it was the uncertainty of science and the subsequent failure to engage in rhetorical deliberation that ultimately led to the decision to launch the space shuttle. The engineers from Thiokol, the manufacturer of the booster rockets used on the shuttle, could not say with certainty how the O-rings would perform under the low temperatures that were expected at time of launch. This was not a *failure* of science but rather an example of the *uncertainty* of science knowledge and, accordingly, where its usefulness ends. Science could not give an answer when it was needed. Walzer and Gross go on to uniquely argue that rhetorical deliberation – "an art that helps find the best reasons for assent or dissent and the best reasons for decision and action, especially in the absence of consensus among experts" – could have yielded a no-launch decision had those in charge not reversed NASA's safety priorities by shifting the burden of persuasion from those who advocated for a launch to those who advised against a launch (Walzer and Gross 427). There was no known scientific answer, so rhetorical deliberation was the only means left to decide the fate of the shuttle. This deliberation required an ethical decision. And that kind of deliberation did not take place. When Goldman describes the contingency model of knowledge within the realm of engineering practice, this is what he means. Rhetoric allows us to deliberate and, from ambiguity and uncertainty, create new knowledge and possibilities. Its capacity for revealing possibilities is perhaps rhetoric's greatest value. Poulakos compares the "possible" of sophistic rhetoric to the "ideal or actual" – a dualism that aligns with "contingency" and "necessity" and gives an assessment of the greater potentials offered by a sophistic rhetoric:

> Unlike *the possible, which is the outcome of man's subjective experience and imagination*, the ideal is an instance of "divine madness" entirely separate from the structure of the lived world. Further, the ideal is beyond actualization. . . .By contrast, *the possible can be actualized*; and its

> actualization constitutes not the end but an origin or source of yet another set of possibilities. . . . In distinction to the actual, which is bound to the requirements of presence and necessity, the possible is absent and not necessary. The actual stands for what the world is and can be discerned by the cooperation of the senses under the purview of reason. *While the actual is tied to the reality of facts and their proof, the possible has no special regard for facts and cannot be proved; at best it is concerned with their extra-factual dimension we know as interpretation* (Poulakos, "Rhetoric, the Sophists, and the Possible" 221–222).

This is to say, rhetoric frees us from the rigid constraints of science and objectivity to create and deliberate possible ideas and solutions that take into account more than science, including ethical perspectives and the views of others. In the case of the Challenger, for example, the astronauts on board had no idea of their fate and were not consulted about risks and options. Aside from the ethical implications of failing to consult or inform them, we will never know if other possibilities might have been actualized.

Third, science itself is rhetorical. Miller explains that science – what we think is absolute and true knowledge – in fact changes, making "human knowledge thoroughly relative and science fundamentally rhetorical" such that "[s]cientific observation relies on tacit conceptual theories, which may be said to 'argue for' a way of seeing the world. Scientific verification requires the persuasion of an audience that what has been 'observed' is replicable and relevant" (Miller, "A Humanistic Rationale for Technical Writing" 615-616). Similarly, Perelman and Olbrechts-Tyteca explain that "judgments of reality (science)" can have no need of rhetoric only if "the terms they contain must be free of all ambiguity, either because it is possible to know their true meaning, or because a unanimously accepted convention does away with all controversy on this subject. These two possibilities, which are respectively the approaches of realism and nominalism in the linguistic field, are both untenable" (513). Booth, in making his case

for what he calls “listening rhetoric,” in *The Rhetoric of Rhetoric,* devotes a full chapter to the intrinsic necessity of rhetoric to science. He writes:

> [E]very corner of life invites not just the *use of* but *thought about* how the language in that corner both changes realities and depends on indemonstrable beliefs about what is real. The pursuit of knowledge cannot be divorced from rhetorical issues. That is why in most fields most genuine thinkers address the rhetorical questions openly, though usually in non-rhetorical terms. They probe questions about the reliability of the assumptions and methods on which all of them depend – often with no “scientific” proof (Booth 59, emphasis in original).
>
> How were they to face the unquestionable *fact* that most of our efforts at communication, most of our debates, are about judgments that entail values? How were they to demonstrate that feelings (*pathos),* and reliance of character (*ethos),* and non-empirical forms of demonstration *(logos)* are not totally separable from *rational* persuasion? (61, emphasis in original).

Fourth, and perhaps most significant for philosophy in general and engineering ethics in particular, rhetoric makes choice and action possible. If we can deliberate, we can also choose. “Only the existence of an argumentation that is neither compelling nor arbitrary can give meaning to human freedom, a state in which a reasonable choice can be exercised. If freedom was no more than necessary adherence to a previously given natural order, it would exclude all possibility of choice; and if the exercise of freedom were not based on reasons, every choice would be irrational and would be reduced to an arbitrary decision operating in an intellectual void” (Perelman and Olbrechts-Tyteca 514).

Our capacity for choice and action is a central tenet of Arendt’s *The Human Condition.* It was the substitution of making for action and our human turning from the *vita activa* to that of *homo faber* as an attempt to avoid the uncertainty and irreversibility of action that most worried Arendt. While she holds open the possibility for a return to action made

possible by our human capacities for forgiveness and promise-making, she ends *The Human Condition* with a critique of the role of scientists in policy making:

> It certainly is not without irony that those whom public opinion has persistently held to be the least practical and the least political members of society should have turned out to be the only ones left who still know how to act and how to act in concert. . . . But the action of the scientists, since it acts into nature from the standpoint of the universe and not into the web of human relationships, lacks the revelatory character of action as well as the ability to produce stories and become historical, which together form the very source from which meaningfulness springs into and illuminates human experience" (Arendt 324).

I would argue that the "ability to produce stories and become historical" are skills that scientists can learn and use, given the opportunity, and that rhetoric is the means and the opportunity. Goldman would say that engineers cannot escape this responsibility: "Engineers apply their expertise to the solution of problems that derive from these (commercial or political or military) agendas, and their solutions enable the realization of these agendas. Engineering is thus ineluctably a sociopolitical, as much as a technical knowledge, practice" (172). Thus, when engineers try to claim that they are "only technical problem solvers" with no accountability for outcomes, Goldman, responds: "This insistence rings hollow, however, with deeper insight into the nature of engineering and the cumulation of negative consequences of technological action. If engineering reasoning is by its very nature embedded in action contexts, then engineers cannot escape sharing responsibility for that action" (172).

Rhetoric, then, with its ontological and epistemological significances, is indispensable to both engineering practice and philosophy. We are rhetorical beings, a capacity that is not severed from our being when a person becomes or works as an engineer,

irrespective of what engineers and engineering students might be told or might believe to the contrary.

It may be that Arendt has unwittingly revealed the work of engineering ethics education: to give undergraduate engineering students a setting and opportunity to explore stories of themselves and others; to examine their traditions, histories, and values; and to investigate and illuminate human experience as it relates to being ethical engineers and to their professional and ethical responsibilities. This is a rhetorical endeavor. Phenomenology, the study of experience, can inform such a pedagogy. That is what I take up in Chapter Two.

Chapter Two
A Phenomenology-Informed Engineering Ethics Curriculum

If there is a principal conclusion to be drawn from the foregoing, it is that the engineering ethics instruction available to most undergraduate engineering students isn't producing the outcomes we want for those students. Students do not demonstrate adequate ethical reasoning skills, (Colby and Sullivan), they express little interest in engineering ethics and consider it trivial and unimportant (Newberry), and they are unprepared for the ethical challenges posed by modern technology (Pine). In short, there is widespread acknowledgement that engineering students who graduate from ABET accredited engineering programs are ill-prepared for the real ethical work they will face as practicing citizen engineers (McGinn; Pine). Yet, knowing this, the teaching of engineering ethics does not change.

I propose that phenomenology – the study of human meaning from the standpoint of experience – can inform the design of an engineering ethics pedagogy. My instinct is that there is a connection between studying the meaning within the human experience of being ethical and understanding ethics itself. Reynolds concludes that "any decent moral theory must include a sophisticated phenomenology of moral experience" that "ought to take seriously core phenomenological methodological strictures" (Reynolds 113). I proposed that by studying the experience of being an ethical engineer – by investigating the question, "what is it to be an ethical engineer?" – students would not only improve their ethical reasoning and sensitivity skills but also develop an affective engagement with ethics and an understanding of professional and ethical responsibilities that can

prepare them for ethical practice. In this chapter, I review the underlying principles of phenomenology, explain why phenomenology has the potential to improve and perhaps transform undergraduate engineering ethics instruction, and present a phenomenology-informed curriculum design.

Phenomenology

Phenomenology is “the study of essences” (Merleau-Ponty, p. vii). It seeks to discover and describe human meaning from the standpoint of experience. For Husserl, who was the first to bring phenomenology to the forefront of philosophical thinking, phenomenology centered on the study of human consciousness, the understanding that being human is to have consciousness of something and that our actions are those of intentionality. Heidegger makes this focus on human experience explicit in the opening line of *Being and Time:* “We are ourselves the entities to be analysed” (Heidegger, p. 67) and defines this essence of our Being – of Dasein – as:

> *The ‘essence’ of Dasein lies in its existence.* Accordingly those characteristics which can be exhibited in this entity are not ‘properties’ present-at-hand of some entity which ‘looks’ so and so and is itself present-at-hand; they are in each case possible ways for it to be, and no more than that. All the Being-as-it-is which this entity possesses is primarily Being. So when we designate this entity with the term ‘Dasein’, we are expressing not its “what” (as if it were a table, house or tree) but its Being (67, emphasis in original).

Van Manen describes “essence” in the context of phenomenological research:

> [T]he word “essence” should not be mystified. By essence we do not mean some kind of mysterious entity or discovery, nor some ultimate core or residue of meaning. Rather, the term “essence” may be understood as a linguistic construction, a description of a phenomenon. A good description that constitutes the essence of something is construed so that the structure of a lived experience is revealed to us in such a fashion that we are now able to grasp the nature and significance of this experience in a hitherto unseen way (van Manen, *Researching Lived Experience: Human Science for an Action Sensitive Pegagogy* 39).

Phenomenology is grounded in the real, lived world of everyday human experience, an *a priori* condition Heidegger calls "being-in-the-world." Being-in-the-world is an *existentiale*, a state of our Being, as opposed to a mere corporeal presence (Heidegger, 79). Ilsley and Krasemann state that "the task of phenomenology is to reflectively disclose the criteria already implicit in those intentional acts that individuals perform in everyday life through which we come to know this world" (5). Phenomenology "is to look on lived experience as a spectacle in order to get the overall sense of it and to understand it for its own sake" (Burch, "On Phenomenology and Its Practices" 202). Phenomenology "approaches a phenomenon – that is, whatever manifests itself to consciousness – in its lived aspect, with the intention first and foremost of understanding not its causes, but the meaning the phenomenon takes on in human experience" (Guimond-Plourde 4).

The focus of phenomenology is on the everyday lived experiences of people, what Husserl called the "natural attitude." It is "that province of reality which the wide-awake and normal adult simply takes for granted in the attitude of common sense. By this taken-for-grantedness, we designate everything which we experience as unquestionable; every state of affairs is for us unproblematic until further notice" (Schultz and Luckmann 3–4). "[W]hat we have primarily in mind in the expression *everydayness* is a definite *how* of existence by which Dasein is dominated through and through 'for life' [*zeitlebens*] (Heidegger, *Being and Time* 422). "Everydayness refers to the absorption of the individual into the world, it is the rhythm of life or surface existence. 'Everydayness'

stands for that way of existing in which the human being maintains itself everyday. It is the practical, pre-critical way of being in the world" (Ilsley and Krasemann 11).

Importantly, "being-in-the-world" cannot be the subject of scientific, theoretical, or causal explanations of phenomena. Rather, phenomenology *describes* a phenomenon and interprets it in order to express an understanding about the essence of that phenomenon – what is that phenomenon about, what does it mean? Unlike science and positivism which hold that scientifically certain knowledge about causation or explanation is the highest and perhaps only true form of knowledge, phenomenology admits the existence and value of scientific knowledge but holds that the world encompasses more than science, is already there, and precedes knowledge (Merleau-Ponty viii). In fact, Husserl, Heidegger and Merleau-Ponty all "placed phenomenological theorizing squarely in the tradition of 'first philosophy,' and thereby affirmed its radical, ontological significance" (Burch, "On Phenomenology and Its Practices" 191). Merleau-Ponty says that phenomenology "rests on itself, or rather provides its own foundation" (xx-xxi). As to the relationship between science and phenomenology, he writes:

> Scientific points of view, according to which my existence is a moment of the world's, are always both naïve and at the same time dishonest, because they take for granted, without explicitly mentioning it, the other point of view, namely that of consciousness, through which from the outset a world forms itself round me and begins to exist for me. To return to things themselves is to return to that world which precedes knowledge, of which knowledge always *speaks,* and in relation to which every scientific schematization is an abstract and derivative sign-language, as is geography in relation to the country-side in which we have learnt beforehand what a forest, a prairie or a river is (ix, emphasis in original).

Heidegger also points out the inadequacy of science to account for the ontological facticity of our being:

> In suggesting that anthropology, psychology, and biology all fail to give an unequivocal and ontologically adequate answer to the question about the *kind of Being* which belongs to those entities which we ourselves are, we are not passing judgment on the positive work of these disciplines. We must always bear in mind, however, that these ontological foundations can never be disclosed by subsequent hypotheses derived from empirical material, but that they are always 'there' already, even when that empirical material simply gets *collected.* If positive research fails to see these foundations and holds them to be self-evident, this by no means proves that they are not basic or that they are not problematic in a more radical sense than any thesis of positive science can ever be (Heidegger 75, emphasis in original).

Phenomenology broke sharply from dualism and positivism precisely because it did not promise certainty and universality. Descartes, in his aim for certainty, had to separate the mind from the body in order to locate reality and certainty (Heidegger 122-134). Kant, Hegel, and even Husserl held on to distinctions between two separate realities (Kafle 183–184). Western thought was not unique in understanding "truth" in terms of dualisms; Kafle describes similar distinctions present in Hinduism, Buddhism, and other eastern thought (184-185). Phenomenology, however, renounced these dualisms and brought the mind and body into unity. "The world is not what I think, but what I live through" (Merleau-Ponty xvi). Phenomenology recognizes that the mind as a separate entity from the body with separate functions (mental processes versus bodily processes) is an impossibility because "it is precisely the relationship of the mind and the body that is definitive of our experience and that needs to be explained" (Russon 23–24) "The subject and the object are not indifferent beings that might or might not come into relation: they are already involved, each having a grip on the other" (Russon 20).

Phenomenology seeks to disclose the essences of human experiences so that we can get a better understanding of what these experiences are like, to capture how it is to do

or experience something and what that experience means. It is an understanding that science cannot provide. In our everyday lives, we have experiences with both things and with other people. While they are both part of our lifeworld, we experience things and other people differently (Heidegger 157). Heidegger describes our “ready-to-hand” experiences with things such as a hammer (101). Once we know how to use a hammer, we do not have to “think” the process of hammering a nail. Similarly, a practiced chef no longer must “think” cooking and a musician does not “think” playing the guitar (Ruspoli). Merleau-Ponty describes the body in relation to experience and objective thought:

> I move external objects with the aid of my body, which takes hold of them in one place and shifts them to another. But my body itself I move directly, I do not find it at one point of objective space and transfer it to another, I have no need to look for it, it is already with me – I do not need to lead it towards the movement’s completion, it is in contact with it from the start and propels itself towards that end. The relationships between my decision and my body are, in movement, magic ones (94).

The unity of the mind and body is like the unity of a work of art: “The body is to be compared, not to a physical object, but rather to a work of art. In a picture or a piece of music the idea is incommunicable by means other than the display of colours and sounds. . . . [Our body] is a nexus of living meanings, not the law for a number of covariant terms (Merleau-Ponty 150–151).

Human experience is also that of being with others:

> “Being with Others belongs to the Being of Dasein, which is an issue for Dasein in its very being. Thus as Being-with, Dasein ‘is’ essentially for the sake of Others. . . . [B]ecause Dasein’s Being is Being-with, its understanding of Being already implies the understanding of Others. This understanding, like any understanding, is not an acquaintance derived from knowledge about them, but a primordially existential kind of Being, which, more than anything else, makes such knowledge and acquaintance possible” (Heidegger, *Being and Time* 160–161).

Heidegger tells us that Dasein's Being-with Others is primarily a "phenomenon of *care*" and that this is an essential part of Dasein's Being (157, emphasis in original). So, even though humans can behave in inhumane and unethical ways toward others, even though humans can live in states of inauthenticity for perhaps their entire lifetimes, and even if some humans can exist without being around other people, our core essential Being is one of "care" and "solicitude" toward Others. Importantly, this attitude of care, I think, is an intuitive opening for a phenomenological inquiry into understanding ethical behavior and what it is to be an ethical professional.[9]

No quality is more central to phenomenology than interpretation. Ontologically, to live is to interpret. It is how we are and it is what makes experience meaningful for us. We are always taking something *as* something, interpreting, and it is the "primordial givenness of our world orientation" (Schwandt, "A.(2000), Three Epistemological Stances for Qualitative Enquiry" 194). Gadamer, considered the founder of philosophical hermeneutics, wrote extensively about language, understanding, interpretation, and the conditions in which meaning takes place: *"[L]anguage is the universal medium in which understanding occurs. Understanding occurs in interpreting*" (390, emphasis in original); "Understanding and interpretation are indissolubly bound together" (Gadamer, *Truth and Method* 399–400; Schwandt, "A.(2000), Three Epistemological Stances for Qualitative

[9] While *Being and Time* treats human experiences with things and with people as separate and dissimilar experiences – and so Heidegger doesn't speak about the possibility that these experiences may overlap and intersect in some ways such that humans could and perhaps should have an attitude of "caring" toward things as well as other people – this does become a central theme in his later lecture, *The Question Concerning Technology*. Heidegger not only warns that humans can become enframed by technology such that they are essentially and see Others as the "things" of "standing reserve," he also implies that we have duties of care toward things like the environment.

Enquiry" 194–196). Interpretation and understanding take place within what Gadamer calls a "fusion of horizons" (390) whereby we bring to bear all our prior experiences, prejudices, traditions, and so forth into our interpretation or understanding of a text (even when the "text" is not linguistic in nature and would include, for example, actions). This is what makes understanding our own (Burch, "On Phenomenology and Its Practices" 208). Russon describes the significance of a "fusion of horizons" in practical terms:

> Probably the single most important aspect of the critique of this familiar view [the Cartesian separation of subject and object] is found in the recognition that our experience is always interpretive: whatever perception we have of the world is shaped by our efforts to organize and integrate all of the dimensions of our experience into a coherent whole. How we go about this will be dictated by the level of our education, by our expectations, and by our desires, and so the vision we have will always be as much a reflection of ourselves and our prejudices as it is a discovery of "how things really are." In other words, the very way that we see things reveals secrets about us: what we see reveals what we are looking for, what we are interested in. This is as true of our vision of things that we take to be outside us as it is of our vision of ourselves (10).

This sense of how interpretation of the "texts" of our lives occurs is integral to the uncertain nature of understanding and what we call knowledge. Our "horizon" is not fixed and unchanging but fluid and dialectic. "By relating with the world's objects, beings and things, a person is a being who perceives the world *from different standpoints depending on the situation in time and space,* who perceives particular perspectives that vary accordingly to the perceptual field – which is a *horizon,* that is, the place of perceptual experiences" (Sadala and Adorno 287). Merleau-Ponty describes this as a "transition-synthesis" (30) where immediate experience is ephemeral but not without some transformational imprint. This forever changing horizon helps account for the uncertain nature of knowledge because "we never understand exhaustively or with absolute

certainty" (Burch, "On Phenomenology and Its Practices" 211). Moreover, the horizons of no two persons are the same so there will always be different interpretations.

The impermanence and variability of our horizons does not, however, make interpretation or understanding relative, arbitrary, or inaccurate. For one thing, our changing horizons allow for subsequent reflection on experience against new backdrops; although an experience occurs and we perceive it immediately, we also reflect on the experience and allow its meaning to take on a new perspective (Russon 15; Burch, "Phenomenology, Lived Experience: Taking a Measure of the Topic" 134). In other words, we can change our minds about things. For another, interpretation itself, given that it takes place within our horizons or hermeneutic situations, implies a freedom to reflect and to choose. "Our engagement in that world (i.e., in the "disclosure of beings as such") is the freedom that we *are.* In this sense, then, for human being 'to be' is 'to interpret.' Its essential freedom is the original projection of possibilities of meaning, a fundamental process of interpretive understanding that takes place on the basis of a world always already in play" (Burch, "On Phenomenology and Its Practices" 208, emphasis in original).

Introduction to Phenomenological Research

I have been describing the ontological essentiality of phenomenology and interpretation, that to live is to interpret. But we also use phenomenological interpretation as a research method in order to study phenomena and gain an understanding of what they are about. In phenomenological research, the aim is still that of discovering human meaning from the standpoint of experience. "[L]ived experience is itself essentially an interpretive

process that calls for a correspondingly interpretive appropriation" (Burch, "On Phenomenology and Its Practices" 207). But the degree of interpretation appropriate for phenomenology research is debatable, depending on the particular approach that is adopted. Though there are several distinctions made among approaches to phenomenology research (Butler-Kisber; Creswell; Denzin and Lincoln, *The Sage Handbook of Qualitative Research*; Kafle; Finlay, "Debating Phenomenological Research Methods"; Prasad; "The Interpretive Perspective: An Alternative to Functionalism"; Schwandt, "A.(2000), Three Epistemological Stances for Qualitative Enquiry"; "The Interpretive Perspective: An Alternative to Functionalism"), the two that are often contrasted are transcendental (descriptive) phenomenology associated with Husserl and hermeneutic (interpretive) phenomenology associated with Heidegger and Gadamer . The most practical – and contentious – distinctions between the two are how much "distance" there needs to be between the researcher and the experience and people being researched and what degree of interpretation is permissible or acceptable in describing a phenomenon.

Husserl's idea was that the phenomenological "reduction" would allow us to gain enough distance from a phenomenon in order to understand it without the distraction and distortion of our own prejudices. He thought that we needed to transcend experience in order to better grasp its true meaning and that we could do this by "bracketing out" our "natural attitude," something that encompasses not only personal prejudices and ways of thinking about things but also the scientific attitude or positivism. In so doing, it would be possible to arrive at a single essential description of the phenomenon. This view came to be described as an impossible "God's view" or what Nagel termed the "View from

Nowhere” because, even though transcendental phenomenology differentiated itself from the positivism of science, it still relied on the possibility of securing an objective description of human experience (Matthews 14). Merleau-Ponty didn’t deny the need for some sort of reduction , though he did recognize that the “most important lesson which the reduction teaches us is the impossibility of a complete reduction” (xiii-xiv). Burch quotes a rather cynical Adorno on the impossibility of detachment: “ ‘The detached observer remains as much entangled as the active participant; the only advantage of the former is insight into his entanglement, and the tiny freedom that lies in knowledge as such’ “ ("On Phenomenology and its Practices" 203, citing Adorno 26).

The reduction – understood as the adoption of a “phenomenological attitude” that “refrains from importing external frameworks and sets aside judgements about the realness of the phenomenon” – has certainly not been abandoned as an element in phenomenology research (Finlay, “Debating Phenomenological Research Methods” 19). Transcendental phenomenology, understood as pure description, is more often encountered today in the human or social sciences and business schools, where an objective description is the established standard, than in humanities, where there is a strong preference for hermeneutic phenomenology (Putnam; Schwandt). There are exceptions to this generalization. Van Manen, for example, is widely regarded as an authoritative voice on hermeneutic phenomenology for the human sciences.

To say that one engages in hermeneutic phenomenology does not position oneself squarely anywhere, however. Hermeneutic phenomenology covers a broad spectrum of interpretivism, and there is no consensus on where to draw the line on the interpretation continuum. Burch describes this stepping back as one that requires “distance and

withdrawal" but not so much as to "resuscitate in a hackneyed form the old metaphysical dualism – that philosophers withdrew to a 'higher' region to grasp a truth always invisible and inaccessible to ordinary folk" ("On Phenomenology and Its Practices" 202). A relationship of inter-subjectivity develops between the researcher and research participants such that "phenomenological research is a lived experience for researchers as they attune themselves towards the ontological nature of phenomenon" and the researcher becomes the "signpost pointing towards essential understanding of the research approach as well as essential understandings of the particular phenomenon of interest" (Kafle 188-189). Hermeneutic phenomenology "move[s] beyond description to interpretation where the researcher actively takes a role in explaining participant meanings" (Butler-Kisber 51). Guimond-Plourde explains hermeneutic phenomenology as an "orientation in which the descriptive (phenomenological) and interpretive (hermeneutic) aspects of every reflection are distinct but inseparable elements in a process of clarification" (Guimond-Plourde 4).

Garrick questions whether interpretation is possible at all and uses postmodern theories such as power/knowledge formations and deconstruction to argue that the authenticity and individual agency of research participants should be subjected to greater scrutiny and doubt. He examines experience as it is relayed by those who actually experience a phenomenon and questions the reliability of the participants themselves who are the source of phenomenological research (151–153). In the end, Garrick makes it clear that he doesn't want to set up a binary – either interpretation is possible or it is not – but he does argue for becoming reflexive to enhance validity and reliability of interpretive research work (154).

Schwandt distinguishes between interpretive understanding – which (1) views human action as meaningful, (2) has fidelity to the life world, and (3) thinks it is possible to understand subjective meaning in an objective manner – and philosophical hermeneutics as exemplified by the works of Gadamer. Schwandt argues that, according to Gadamer, it is not only impossible but indeed undesirable to try to eliminate or transcend our prejudices and traditions. Rather, to understand, we must engage these prejudices and traditions by putting them "at risk" (Gadamer, *Truth and Method* 390) in the "dialogical encounter with what is not understood" in order to challenge and test these preconceptions. From this, understanding emerges and this is as much for the benefit of the interpreter as it is for representing the experience under study:

> [U]nderstanding is something that is *produced* in that dialogue, not something *reproduced* by an interpreter through an analysis of that which he or she seeks to understand. The meaning one seeks in "making sense" of a social action or text is temporal and processive and always coming into being in the specific occasion of understanding (195).
>
> In this sense, philosophical hermeneutics opposes a naïve realism or objectivism with respect to meaning and can be said to endorse the conclusion that there is never a finally correct interpretation. This is a view held by some constructivists as well, yet philosophical hermeneutics sees meaning not necessarily as constructed (i.e., created, assembled) but as negotiated (i.e., a matter of coming to terms (195).
>
> A focus on understanding as a kind of moral-political knowledge that is at once embodied, engaged (and hence "interested"), and concerned with practical choice is a central element in the hermeneutic philosophies that draw, at least in part, on Gadamer and Heidegger. . . (196).

Putnam argues for a critical approach to interpretation. Far from being objective, the work of interpretivism is to actively use interpretation to understand and make apparent the forces of power and oppression in society and to realize a more humane and just

world. Putnam contrasts two interpretive approaches to the study of organizations: naturalistic research which aims “to describe and to understand organizational reality as it is without questioning what it could or should become” and critical research which “strives for emancipation through a critique of social order” and that by exposing “inconsistencies in the deep structures of organizational life, free[ing] people from a sense of alienation and oppression” (53) Freire, a Brazilian educator and philosopher, maintained that the goal of education should be the revealing of oppression and the politicizing of the learner and that this is achieved, in large part, by the kind of approach used in the interpretation of texts (57–58).

Most hermeneutic phenomenology research practice seeks a balance between the extremes of objective description and critical interpretation. Denzin (who is himself a postmodern social constructivist) and Lincoln contend that all qualitative research falls within an interpretive paradigm and recognize the influence of poststructuralism and postmodernism on qualitative research. But, rather than arguing for a single standard for what constitutes knowledge and the role of interpretation, they acknowledge that researcher and research participant are always socially situated and that a range of interpretive methods is needed to study and understand experience (Denzin and Lincoln, *The Sage Handbook of Qualitative Research* 11–12; Denzin 152–153). Orbe and van Manen represent this balanced approach toward hermeneutic phenomenological research. Both locate their work within hermeneutic phenomenology. Although their approaches are not identical, they both stress the need for what Orbe calls “radical reflection,” an iterative process of “simultaneously thematizing, bracketing, interepreting and then beginning the process again” (616). Van Manen takes a lead from Merleau-

Ponty and makes “wonder” the pivotal element in his phenomenological methodology; he says that “phenomenology not only finds its starting point in wonder, it must also induce wonder” (van Manen, *Researching Lived Experience: Human Science for an Action Sensitive Pegagogy* 44–45). Merleau-Ponty describes “wonder” as part of phenomenological reduction:

> Reflection does not withdraw from the world towards the unity of consciousness as the world’s basis; it steps back to watch the forms of transcendence fly up like sparks from a fire; it slackens the intentional threads which attach us to the world and thus brings them to our notice; it alone is consciousness of the world because it reveals that world as strange and paradoxical. Husserl’s transcendental is not Kant’s and Husserl accuses Kant’s philosophy of being ‘wordly’, because it *makes use* of our relation to the world, which is the motive force of the transcendental deduction, and makes the world immanent in the subject, instead of *being filled with wonder* at it and conceiving the subject as a process of transcendence towards the world (xiv, emphasis in original).

Reflexivity is not only central to the process of interpretation, it is also essential to the scholarly rigor of phenomenology as a research method. The positivist/science research community has been and continues to be highly skeptical of qualitative research precisely because of its reliance on interpretation rather than objectively determined and scientifically proven fact (van Manen, “Phenomenology of Practice” 19–20; Denzin). Notwithstanding current lip service given to equal consideration of “mixed methods” and qualitative research, those who use qualitative research remain on the defensive, continually justifying the method. For that reason, considerable attention is given to the conduct of qualitative research so that it meets rigorous standards of validity and reliability (Orbe; Daly; Finlay, *Introducing Phenomenological Research*; Garrick; Seidman; Mischler; Guillemin and Gillam). Guillemin and Gillam describe the process and role of reflexivity as ensuring rigor in one’s research:

> Reflexivity involves critical reflection of how the researcher constructs knowledge from the research process – what sorts of factors influence the researcher's construction of knowledge and how these influences are revealed in the planning, conduct, and writing up of the research. A reflexive researcher is one who is aware of all these potential influences and is able to step back and take a critical look at his or her own role in the research process. The goal of being reflexive in this sense has to do with improving the quality and validity of the research and recognizing the limitations of the knowledge that is produced, thus leading to more rigorous research (Guillemin and Gillam 275).

Phenomenology is both a theory and a research methodology. With its fundamental ontological purpose being the investigation and understanding of lived experience, it goes to the very core of what it is to be. As a research method, its objective is also to investigate and understand lived experiences. My purpose here has not been to write an exhaustive description of phenomenology but rather to explain enough of its characteristics so that its usefulness for pedagogical practice may become apparent.

Phenomenology and Pedagogy

My argument and proposal is that phenomenology – the revealing and understanding of lived experience – can inform a pedagogical method that helps students discover, interpret, and understand what it is to be an ethical engineer. By investigating experience, students can become more emotionally engaged with ethics and acquire an understanding of professional and ethical responsibilities. Phenomenology is particularly useful to study professional experience because it investigates the phenomenon "starting from the origin of all knowledge – experience of the world" (Sadala and Adorno 288). Sadala and Adorno, who used phenomenology to help nursing students understand the world of nursing on an isolation ward, found that this method is the most effective way for students to investigate the lived professional world because they will acquire "experience in a situation where *they relate to an already given world, which is*

out there, into which they are launched and which they will have necessarily to face" (287-288, emphasis added). In the context of engineering ethics education, phenomenology can be a powerful way for undergraduate engineering students to understand the experience of what it is to be ethical engineers and to help prepare them for a professional world into which they will soon "be launched" and "will have necessarily to face."

Phenomenology can do this because of the intersubjective relationship that necessarily develops between the researcher (student) and the experience and experiencers being studied. The orientation of the students (as those who study ethical experience) is their involvement "in the world of the research participants and their stories" (Kafle 188, 196). This contrasts sharply from traditional ethics education which follows a positivist linear paradigm in which students learn rules and principles of ethics along with problem-solving heuristics and then apply them to ethical problems presented in case studies. With the traditional approach, engineering students are taught to position themselves as objective, external observers as they confront and solve ethical problems just as they would do in solving technical design problems. They are encouraged – indeed trained – to be detached from the subject matter and the process. As a result, they are affectively disengaged from ethics.

When students study ethical engineering experience from a phenomenological perspective, however, they must necessarily become engaged with the experience itself and the people who are experiencing it. Phenomenology allows students to examine the phenomenon of being an ethical engineer from the inside – subjectively and

empathetically and not as an outside unbiased observer. Students move from "knowing" to "understanding" ethics. Solloway and Brooks, who use hermeneutic phenomenology for classroom assessment, describe this process of hermeneutic phenomenology elegantly:

> While the act of knowing reduces learning to the mastering of facts, understanding implies something more. . . .From this perspective student learning is not couched in terms of domination of a body of knowledge, but in terms of an engagement with that body as an Other to be understood. The learning process is not seen as one of mastery of new facts and/or skills, but as one of dialogue characterized by a kind of play, a back and forth or to and fro movement. Through this to and fro, self-sustaining momentum of questioning and answering, the possibility of transformation – rather than domination – occurs in the transcendence of previous understandings and the apprehension of new insights. The possibility of evolving wisdom and compassion is widened (45).

Phenomenology is a "powerful way for 'understanding subjective experience, gaining insights into people's motivations and actions, and cutting through the clutter of taken-for-granted assumptions and conventional wisdom' " (Butler-Kisber 51 citing Lester 1). "[Phenomenology's] chief practical benefit lies instead in the reform of understanding, in what its serious pursuit 'does with us.'. . . The understanding that theorizing initiates and carries forward enables one to situate what she does in a more encompassing context of meaning and thus opens her to the possibility of acting more thoughtfully, that is, with a view to her whole person and the wise conduct of her life" (Burch, "On Phenomenology and Its Practices" 204). "Phenomenological research tries to describe an experience from the point of view of the experiencer, and in the process it hopes to achieve awareness of different ways of thinking and acting in its search for new possibilities" (Hultgren 16). Gadamer explained the changes that come with understanding:

> Understanding, like action, always remains a risk and never leaves room for the simple application of a general knowledge of rules to the

> statements or texts to be understood. Furthermore where it is successful, understanding means a growth in inner awareness, which as a new experience enters into the texture of our own mental experiences. Understanding is an adventure and, like any other adventure is dangerous. . . But. . . [i]t is capable of contributing in a special way to the broadening of our human experiences, our self-knowledge, and our horizon, for everything understanding mediates is mediated along with ourselves (Schwandt 196 quoting Gadamer, *Reason in the Age of Science* 109–110).

When students move from knowing to understanding, important changes take place for them. “From an educational point of view, phenomenology should be seen as a way to educate our perspective on reality, to reflect on our relationship with the world, to change and refine our point of view, to build and define our mental posture, and to broaden the way we look at the world” (Gallagher and Francesconi 3). Similarly, engineering students who use phenomenological methods to investigate the experience of what it is to be an ethical engineer should be able to move from knowing to understanding professional and ethical responsibility; this experience should change them and prepare them to be ethical engineers and perhaps to see the world differently than they might otherwise have done.

The core of undergraduate engineering education is teaching and developing technical skills of engineering students. Ethics is a taken-for-granted backdrop, something that is assumed to be understood by students to the extent it is considered relevant at all to engineering work. “What is taken for granted is the familiar. People immersed in their day-to-day concerns and activities normally do not give them much conscious attention” (Hultgren 14). Heidegger recognized the importance of illuminating features of our everydayness: “And because this average everydayness makes up what is ontically

proximal for this entity, it has again and again been *passed over* in explicating Dasein. That which is ontically closest and well known, is ontologically the farthest and not known at all; and its ontological signification is constantly overlooked" (Heidegger 69, emphasis in original). This is exactly what a phenomenological approach to engineering ethics pedagogy changes. It shifts the focus from ethics as part of the unimportant taken-for-granted background of the everydayness of engineering practice and brings this very aspect of engineering practice to the forefront where students can investigate and discover what is significant about ethics and about being an ethical engineer.

The principal concern of my research is to develop an ethics pedagogy that improves, not only the ethical reasoning skills and ethical sensitivities of undergraduate engineering students, but more importantly their emotional engagement with ethics – that they will care about ethics and being ethical – and their understanding of professional and ethical responsibilities. The practice of hermeneutic phenomenology can help achieve this. Van Manen writes about phenomenology as practice, which he describes as "an ethical corrective of the technological and calculative modalities of contemporary life." He speaks of the benefits that inure to such a practice, one of the most important being that we come to "grasp the world pathically" (van Manen, "Phenomenology of Practice" 20). Pathic understanding "is not primarily gnostic, cognitive, intellectual, technical – but rather that it is, indeed, pathic: relational, situational, corporeal, temporal, actional" (20). "[A] phenomenology of practice aims to open up possibilities for creating formative relations between being and acting, between who we are and how we act, between thoughtfulness and tact" (13). "[A] pathically tuned body recognizes itself in its responsiveness to the things of its world and to the others

who share our world or break into our world. The pathic sense perceives the world in a feeling or emotive modality of knowing and being" (21). "[W]e may say that a phenomenology of practice operates in the space of the formative relations between who we are and who we may become, between how we think or feel and how we act" (26). Van Manen does acknowledge the difficulty and challenges of teaching toward pathic understanding, especially in educational settings that lean toward the technological and calculative (20–21). Nevertheless, the potential outcome for engineering students – moving from knowledge to pathic understanding of professional and ethical responsibilities, ABET's expressly stated student learning outcome – seems to be so intrinsically rewarding that it's somewhat surprising that hermeneutic phenomenological inquiry is not a more commonly used as a pedagogical method.

Hermeneutic phenomenology is not entirely new to education and pedagogy. It is an important method for education research and as a way for teachers to improve their own teaching in the classroom (see, for example, *Hermeneutic Phenomenology in Education: Method and Practice*; van Manen, *Researching Lived Experience*). Phenomenology as a research method is being introduced to engineering education research (Borrego, Douglas, and Amelink; Koro-Ljungberg and Douglas; Gallagher and Francesconi) and is being tried in some engineering classrooms (see, for example, Borges, Silva Goncalves, and Cunha, who use phenomenological and hermeneutic concepts to teach calculus).

Phenomenology as a pedagogical method for engineering ethics education is also not untried or unreported. Porra, a professor at the Helsinki University of Technology in Finland, described a phenomenological approach to ethics in design engineering at the

2004 International Conference on Engineering Education and Research. He introduced phenomenological methods in an existing course to help reveal to students the "values, forces, interests, and mechanisms in society" that pose ethical questions for design engineers (Porra n.p.). Broome described an impromptu activity he tried in an ethics workshop to prepare students for the FEE professional engineering licensing exam. He asked students to take the exam before he delivered his lecture. Then, also before the students received any instruction, Broome asked them to take the exam again but, this time, to imagine themselves as an "aged, highly mature person: a family member or some legendary character; someone who exhibited great wisdom and caring for others." The results were stunning: students either failed or performed marginally on the first exam but "maximized the examination" when they imagined themselves to be wise and caring (Broome Jr n.p.).

Wike, who adopts a values-based approach to teaching engineering ethics, describes values in decidedly phenomenological terms: "If, as I am claiming, the best way to talk about ethics is in terms of values, then ethics is everywhere*. Ethics isn't 'outside' a technical practice; it is already there. We just have to make it explicit"* (Wike n.p., emphasis added). Lynch and Kline describe what amounts to a phenomenological approach to engineering ethics when they suggest that students focus on the everyday mundane ordinariness – the essences – of engineering ethical decision-making (Lynch and Kline). These are all attempts to get students to understand – to experience, describe, empathize with, and internalize – the real world phenomenon of being an ethical engineer.

Using hermeneutic phenomenology as a pedagogical approach to teaching engineering ethics seems, then, to have the potential to help undergraduate engineering students acquire and improve their "understanding of professional and ethical responsibility." The next question is what such an ethics curriculum would include and how it would be delivered.

Engineering Ethics Pedagogy Grounded in Hermeneutic Phenomenology

The pedagogy I propose is drawn from my experience of teaching engineering ethics for three semesters using an approach informed by hermeneutic phenomenology. The curriculum was not static during each of those semesters but, rather, evolved each term based on prior student outcomes and suggestions, my experiences in the classroom, and what I learned from my own "phenomenology of practice." As I write this, I already know that the next time I teach ethics, the curriculum will have changed again. I will describe here the principles that should govern a hermeneutic phenomenology-informed pedagogy, the curriculum I used in my classroom and research, and comments about a model curriculum. The curriculum I propose is one that is accessible to and useable by both engineering and non-engineering faculty. This is important because the teaching of engineering ethics remains primarily in the domain of engineering faculty.

The course I teach is Ethics in Engineering Design, ENT3958, a one-credit elective course offered through the Enterprise Program at Michigan Technological University. The Enterprise Program is an alternative to engineering senior capstone design. Students work in multidisciplinary teams to solve real-world problems supplied by industry. Students can earn a minor or a Certificate in Enterprise from Michigan Tech by

completing requisite coursework. ENT3958 is an elective offered by the Enterprise Program to fulfill the minor or certificate requirements, but it is open to all students at Michigan Tech.

Phenomenology – the revealing of essences or the meaning of phenomena – can inform a pedagogical method that helps students discover and understand the experience of what it is to be an ethical engineer. In my ethics class, I give students a platform where they use hermeneutic phenomenology research methods to investigate the question that is the singular focus of inquiry for the course: what is it to be an ethical engineer? By using this approach, students can come to understand professional and ethical responsibility in a different way than traditional ethics coursework allows. They can also achieve greater ethical reasoning skills, ethical sensitivity, and engagement with ethics.

Some time ago, I was discussing my ethics class with a colleague who is an engineering educator. She asked me, “how can students be expected to understand what it is to be an ethical engineer when they haven’t ever been engineers?” This is a reasonable question, and the answer is that this is exactly what phenomenological research intends – to make it possible for a researcher to gain an understanding of the meaning of being an ethical engineer through studying lived experiences of others without personally having the actual experience. It is what makes phenomenology such a powerful way for students to study professional experience because “it tries to place a researcher in the perspective of the research participants in order to understand their experience and feelings, thus unveiling what it means, from their point of view, *to be in the situation within the experience*” (Sadala and Adorno 288, emphasis in original).

The course curriculum is designed to provide students with requisite background knowledge of ethics (theory) and basic phenomenology research methods so they can undertake and complete their coursework. When I say that students use hermeneutic phenomenology methods to investigate the question of what it is to be an ethical engineer, I mean that students step into the role of researcher. Assignments include readings, reflections, writing, discussions, and interviews, all of which are part of the research the students conduct. At the end of the semester, students write a paper that uses their research data to express their understandings of what it is to be an ethical engineer.

The course is about ethics, not phenomenology, and the purpose of the course is not to train students to be phenomenologists or phenomenology researchers. But because the phenomenological approach grounds the course curriculum and is critical to achieving intended student learning outcomes, the students need to be able to use some fundamental principles and methods of hermeneutic phenomenology research in order to do their work.

I previously addressed the principal differences between transcendental and hermeneutic phenomenological research:[10] the degree of description versus interpretation allowed the researcher and the role of the reduction or distance between

---

[10] These are not the only two phenomenological research methodologies. Finlay explains the differences among multiple – more than a dozen – approaches and contrasts how the actual practice of phenomenological research is influenced by the methodology that is chosen (Finlay, *Introducing Phenomenological Research*).

the researcher and the research participants. Irrespective of these differences, there are some key assumptions and principles of phenomenological research that all methods share. Finlay writes that the "central concern [of phenomenological researchers] is to return to embodied, experiential meanings" (Finlay, *Introducing Phenomenological Research* 17). Creswell observes that all phenomenological methodologies rely on three common foundations: "the study of the lived experiences of persons, the view that these experiences are conscious ones . . . and the development of descriptions of the essences of these experiences, not explanations or analyses" (58). Orbe identifies six key assumptions that make phenomenology a practical option for research into lived experience:

- Phenomenology seeks to gain a deeper understanding of the nature and meaning of our everyday experiences.
- Phenomenology rejects the notion of an 'objective researcher' and the claims of positivist epistemology.
- Phenomenological method differs from traditional research in that traditional research specifies beforehand what it hopes to discover from its research. . . . Phenomenological questions are 'meaning questions' – questions that ask for the possible meaning and significance of a certain phenomenon.
- Phenomenology seeks to study phenomena in an open, unconstricting way. Ambiguity is viewed as productive, necessary, and valuable.
- Phenomenology is interested in the study of 'persons,' as opposed to 'individuals.'
- Phenomenology focuses on researching conscious experience (capta) rather than hypothetical situations (data) (Orbe 606–608).

These various assumptions inform the design of my ethics curriculum. At its core, phenomenology seeks to gain a deeper understanding of the nature and meaning – the essences – of our everyday experiences. In my class, the focus is on real engineers, real-world ethical engineering practice, the everyday impact and meaning of personal and professional values, and the "everydayness" of engineering work and ethical practice. Most of my students are perplexed when I tell them they will be researching experience, specifically the experience of being an ethical engineer. So helping them understand what "lived experience" means is one of the first challenges in preparing them to do their coursework research. There are two aspects to this challenge. The first is simply getting the students to understand that everyone – engineering students included – has "lived experience" and that this is our normal way of being in the world. Engineering students are so inculcated into the scientific explanation for how things – including their own selves – work technically and biologically that they rarely if ever are given the opportunity to simply think about what it is for them to be and how "lived experience" can be something that we actually want to and can study.

The second aspect of this challenge is helping the students understand what counts as "lived experience" for research and how it is studied. Phenomenology rejects the notion of an 'objective researcher' and the claims of positivist epistemology. The "natural attitude" of engineering students – one that is so well cultivated by their engineering education – is that there has to be a problem to solve and that it must be solved using an objective, instrumental, problem-solving approach. The students want to approach their research in this class as subjects studying objects, whether those objects are written

texts or other people, and then they want to write a report from an objective, detached "view from nowhere" position about what they've read or learned. The phenomenological investigation of "lived experience" doesn't fit into this paradigm. There is no problem statement, no hypothesis, nothing to be solved. The engineers that students interview are not objects or "individuals" whose statements are recorded and reported as data. Each one is a person who experiences the phenomenon of "being an ethical engineer." For most of my students, the activity of "interpreting" written or human "texts" to express their own understanding or meaning of lived experience is counterintuitive. It is not the case, however, that students are incapable of doing any of this. It's more a matter of giving them permission to do something that, to this point in their engineering studies, they've not been asked to do.

The question: "what is it to be an ethical engineer?" does not have a pre-known answer and no theory is put forth for students to test. Instead, inquiry is a subjective rather than objective experience in which each student explores this phenomenon and, through interpretation, discovers his or her own answer to the question. Because there are no fixed answers, ambiguity is expected and necessary. Becoming comfortable with ambiguity in a profession that rejects that notion is important for many reasons. "Being able to deal with ambiguity" is not only part of the phenomenological process and an often-cited student learning outcome in general and for ethics, it is also a condition of our being. Merleau-Ponty proposes a "*dialectics without synthesis*" that is essentially the nature of ambiguity. Nothing ever stops for us and is complete. We constantly take in new input, new information, new perceptions, and we somehow fit them in with everything else that is already there. Sadala and Adorno describe this in terms of the

phenomenological research process: “The question and the investigation remain open, always in transformation. As in the research reported in this paper, whenever a new horizon of knowledge was reached, when our questions could be answered, we could see ahead new horizons of new questions and we set out a new search for more answers. People, from this standpoint, are eternally coming-into-being, always in the move, and, therefore, in a dialectic without synthesis” (286).

Interviewing is the chief method used by phenomenology researchers to study experience – they interview the experiencers. So one of the course requirements and part of the research process is that students must interview a practicing engineer. The central topic of the interview is the everyday experience of being an ethical engineer. Their inquiry is not about being an engineer but, pointedly, about being an ethical engineer. Interviewing is also not a subject-object experience but an intersubjective one where the “emphasis is on the person who experiences a phenomenon, and not on just the phenomenon as an object in itself” (Guimond-Plourde 4). Gallagher and Francesconi write about teaching phenomenology to researchers. They emphasize the necessity that students understand what does and does not constitutes “lived experience” in order to write interview questions that will help them access the lived experiences they are investigating:

> Students will often devise questions that ask the subjects about how they think of specific things in their life. These students equate the subjects' opinions or thoughts about their life with their lived experience. . . . What a subject thinks about something is not the same as his or her experience of that phenomenon. In the phenomenological court, so to speak, only certain things count as evidence, and theory, opinion, or hearsay are not accepted” (2).

These interviews with practicing engineers have proven to be an extremely edifying activity for the students, one that comes as a surprise to the students themselves who initially resist this assignment. The interview facilitates the movement from knowledge to understanding that is part of the phenomenological research process and, while students are investigating the details of the everyday lived experience of being an ethical engineer, they are at the same time thinking about and developing an idea of their own professional ethical identity. Research confirms that undergraduate engineers develop a sense of their own ethical professional identity far more from contact with other engineers than from formal study of engineering ethics (Loui, "Ethics and the Development of Professional Identities of Engineering Students" 385). Students consistently report that the interview was the most significant aspect of their research.

There are many approaches to the procedural practice of phenomenological research. Orbe, drawing on his own and others' work, describes a three part process: (1) collection of descriptions of lived experiences, (b) reduction of capta into essential themes, and (c) hermeneutic interpretation of themes (Orbe 610–618). Van Manen defines four activities for hermeneutic phenomenological research: (1) pick a human phenomenon to investigate that engages the researcher, (2) study the phenomenon as a lived experience and not a conceptualized or theoretical one, (3) identify the "essences" or themes that depict the experience in an effort to discover the meaning of the experience and to answer "what is it that constitutes the nature of this lived experience?" and (4) the researcher's interpretation must account for the whole of the experience on the basis of its parts and the role or impact of each of the parts on the whole (*Researching Lived Experience: Human Science for an Action Sensitive Pegagogy*).

Reflexivity and interpretation are necessary and integrally related practices in this research process. Reflexivity and self-reflection about the researcher's own biases and pre-conceptions – the "reduction" or "bracketing" that to some extent requires the researcher to step back from the research – is essential to the rigor of phenomenological research. That is a given. The issue among phenomenologists is what a researcher does with this reduction, and this becomes a practical question for phenomenological research. Everyone recognizes today that a complete reduction is impossible – we are simply not capable of extracting and ignoring our prejudices, biases, and pre-conceived assumptions from any investigation or interpretation that we undertake. Philosophical hermeneutics not only recognizes the impracticality of trying to do otherwise but also holds that these prejudices, biases, and preconceptions constitute part of who any researcher is and must be embraced as part of the interpretive process, as part of the act of finding meaning (Schwandt, "A.(2000), Three Epistemological Stances for Qualitative Enquiry" 194–195). The essence of hermeneutic phenomenological research is to "formulate an intersubjective reflection through interpretation" (Guimond-Plourde 4). This does not mean, however, that such biases and preconceptions must not be accounted for in the research, and there is no disagreement about this.

Reflexivity is in itself a complex process which I discuss in greater detail in Chapter Three, Research Methods. For purposes of student-conducted research in my class, it is important for students to think about and acknowledge their biases and preconceptions as they go through the research process. Gallagher and Francesconi call this an "awareness of one's own mind" and go on to say that "It is of fundamental importance

that *teachers and students* become aware of, and take responsibility for, their perspectives on the world" (3–4, emphasis added). My experience has been that students are able to account for their biases and preconceptions, at least at a level that is meaningful for their work in the class.

In addition to these commonly-held assumptions about phenomenology, I have three other tenets that guide the class curriculum. First, I do not assume that my students have any knowledge of ethics as an academic course of study. And that is usually a valid assumption. Other than an ethics module that is part of first year Engineering Fundamentals coursework, ethics is not a required course for undergraduate engineering students at Michigan Technological University. Almost all of the students in my course are in the final semester or two of undergraduate studies, which distances them by several years from that limited first year ethics instruction. That students at Michigan Tech receive almost no formal ethics instruction and remember very little of it was confirmed by the SEED study which, based on student and faculty focus groups, reported that "Students agree that ethics is sparse throughout the curriculum. Several students feel as though they do not receive much training on ethics within the curriculum. . . . Students also state that ethics is often taught in relationship to academic integrity. . . ." (Carpenter, Harding, and Finelli 11). So I do think it is essential to give the students some instruction in ethical theory at the beginning of the semester. It provides them with a theoretical grounding and it also gives them a point of departure when they undertake the research assignments.

Second, I am mindful of Arendt's critique in *The Human Condition* of the language of science, which is mathematical symbols that "in no way can be translated back into speech." As a consequence, scientists "move in a world where speech has lost its power" (5). She writes that "whatever men do or know or experience can make sense only to the extent that it can be spoken about" (Id.). "Language is not just one of man's possessions in the world; rather, on it depends the fact that man has a *world* at all. . . . Thus, that language is originarily human means at the same time that man's being-in-the-world is primordially linguistic" (Gadamer, *Truth and Method* 440). The point of my class is not singularly for engineering students to engage in a research activity that investigates the lived experience of being an ethical engineer. In doing this, it is just as important that my students be able to write and speak a language not exclusively of science but one that expresses meaning derived from experience. This is what will enable them to contribute to – to make sense of – the ethical debates they will face as citizens and engineers. Gadamer also wrote:

> Language and thinking about things are so bound together that it is an abstraction to conceive of the system of truths as a pregiven system of possibilities of being for which the signifying subject selects corresponding signs. A word is not a sign that one selects, nor is it a sign that one makes or gives to another; it is not an existent thing that one picks up and gives an ideality of meaning in order to make another being visible through it. . . . Rather the ideality of the meaning lies in the word itself. It is meaningful already. But this does not imply, on the other hand, that the word precedes all experience and simply advenes to an experience in an external way, by subjecting itself to it. Experience is not wordless to begin with, subsequently becoming an object of reflection by being named, by being subsumed under the universality of the word. Rather, experience of itself seeks and finds words that express it. We seek the right word – i.e., the word that really belongs to the thing – so that in it the thing comes into language (*Truth and Method* 416–417).

We live in language and, probably for that reason, it is taken for granted and not always given its due. This is all the more so in a world that privileges positivism and reason over emotion, experience, and Truth.

Third, and this is a corollary of my own "phenomenology of practice" and reflexivity, my role in this ethics classroom is teacher, advisor, and mentor. One of the often-expressed concerns of engineering faculty about humanities faculty and the subject matter we teach is that we intend to perform mind melds on our engineering students that will somehow change them into beings no longer suited for science. Indeed knowing where to draw the line between "teaching" and "preaching" in humanities classes is a long-debated, and unresolved problem. I refer back, for example, to the debate about technical writing education and the outcry at MIT when a humanities-based approach was introduced to its Engineering Publicity Program, discussed *supra* in Chapter One. Russell, on the one hand, doesn't think it is his place to ask engineering students to question at a fundamental ethical level the profession they've chosen to enter; rather, it is his job to give them the tools so that they are well-prepared and empowered to enter their chosen professions (Russell 183–184). Winner, on the other hand, argues that questioning both one's profession and its policies is one of the core functions of engineering ethics education (Winner *Engineering Ethics and Political Imagination*).

My thinking is that I am obliged to create a climate where my students can recognize and consider such questions on their own initiative. Using a phenomenological approach and structuring the class as inquiry into being an ethical engineer can help create a climate for exploration, discovery, questioning, and reflection. Students need guidance

and advising in this process, of course. Ethics as academic study is not familiar subject matter to most or all of the students, a new research method is being introduced, and there is much ground to cover in this one-credit course, all of which requires direction. I've found that, with a broad range of readings, their face-to-face interviews with engineers, and the opportunity for reflection, class discussion, and personal meetings between me and my students, they are for the most part quite capable of raising and addressing issues that they hadn't previously thought much about, including the question of whether or not being an engineer is the right thing for them.

The Place of Values in Engineering Ethics Education

Pfatteicher addresses "teaching versus preaching" in engineering ethics education and probably echoes the prevailing attitude toward how instructors should approach the job of teaching engineering ethics. She acknowledges that it's impossible to extract ideology from the classroom but she certainly argues that it should be minimized as much as possible, at least on the part of the instructor. She argues that, if teaching inculcates any beliefs at all, it should be that instructors "inculcate belief about the value of critical thinking" (Pfatteicher 139). I think that Pfatteicher is preaching to the masses of college instructors, none of whom is likely to disagree with her statement. I agree with much of what she writes. For example, she proposes that one objective for undergraduate engineering ethics instruction ought to be that students have an "understanding of the *nature* of engineering ethics" and she includes in this inquiry not only engineering ethics design dilemmas but whether professional ethics should or does extend to the social and economic consequences of technology and to an engineer's personal life (137-138). She

argues that students need to learn to question the world around them and that they must learn to be comfortable with ambiguity (140).

But I disagree with Pfatteicher's argument that another objective for engineering ethics instruction is that students should understand "the *value* of engineering ethics, as opposed to the values of an ethical engineer" (138). We should give them reasons for why they should be ethical but we should not get into the values that engineers have. There are at least two problems with this. First, in terms of students understanding why they should act ethically, Pfatteicher tells us that that students should be told the risks of unethical behavior and the rewards of ethical behavior. This, on its own, is an instrumental approach to engineering ethics and is nothing more than a variant of cost-benefit analysis – a calculation of how much I stand to gain or lose in making any ethical decision.

What Pfatteicher says about the values of engineers is more concerning to me. Pfatteicher clearly considers the study of the values of engineers to be off-limits for engineering ethics education. I speculate that her reasoning is that a discussion of values too closely approaches that line of "preaching." I disagree. I am not arguing that we as ethics instructors should or must prescribe a set of values to our students. In fact, we should not, but that doesn't mean we should not ask students to think about values and their impact on ethical decision-making. To take the examination of and reflection on values completely off the table is, not only unjustified in the sense that values are central to ethics and ethical experience, but counterproductive if we want our students to

understand – in the pathic sense of caring about – engineering ethics and being ethical engineers.

Traditional ethics instruction assumes that deontology, utilitarianism, and virtue are complete in themselves – that we can derive what we need to know about ethics from these theories and then use them in ethical decision-making. What this assumption ignores is the role of values that operate in the background of all ethical theory. Values cross all theoretical boundaries. Both deontological and consequentialist ethics are premised on complex sets of values, even though the values are not always obvious or explicit. The virtuous engineer is virtuous because he or she holds fundamental values that inform and define virtuous behavior. Blackburn tells us that, in the end, ethical progress is “given from the values we deploy” (Blackburn 134). To rely on rules, cost-benefit analyses, or just being a good person as the basis for ethical decision-making without examining underlying values is the equivalent of an ethical house built on sand.

If our purpose in engineering ethics instruction is to prepare engineering students to enter the world of engineering practice, then we cannot possibly accomplish that outcome if we exclude examination of values from the ethics curriculum. “As engineering exemplifies a practice that successfully couples values and knowledge to ‘the world’, pursuing a philosophy of rational action by studying engineering practice seems a particularly promising vehicle *for exploring experience as itself a source of values*” (Goldman 175, emphasis added). Bucciarelli divides the work life of an engineer into an object world where engineers perform their technical and instrumental problem-solving work – and this, he says, constitutes only a part of the actual work world of engineering – and the

social. The former, he says, is the one we associate with engineering and it is the one that gets the most attention, to the neglect of the latter, in engineering education. “Once one acknowledges that the challenges participants face are not wholly amendable to instrumental resolution and that social exchange and action is part and parcel of an engineer’s work, engineering practice appears as a much richer experience, one in which values and value judgments, often not made explicit – about the user, about robustness, about innovation, quality, about responsibilities, safety, social benefit, risks and cost – are made” (Bucciarelli 4). Wike, who uses a values-based approach in engineering ethics instruction, reminds us that “(1) values are fundamental; (2) values are familiar; and (3) values are inclusive and pluralistic. . . . If, as I am claiming, the best way to talk about ethics is in terms of values, then ethics is everywhere. Ethics isn’t ‘outside’ a technical practice; it is already there. We just have to make it explicit” (Wike n.p.). Stephan addresses the question of whether engineering ethics is optional and, quoting John Staudenmaier, offers the most practical reason of all for students to think about values (their own and those of engineers), how values are prioritized, and how values influence ethical decision-making: “. . . professionals need to think through their own ethical standards before situations arise in which they will have to apply those standards by making choices. The moment of choice is no time to begin figuring out what you stand for. . . “ (Stephan 12 quoting Staudenmaier 94).

Values are not to be considered the same thing as virtue ethics. These terms are often used interchangeably, although I intend and understand a clear distinction between them. This will also help explain why virtue ethics is not, by itself, a “good enough” theory to ground a course in engineering ethics. As I’ve stated, a values-centered

approach to engineering ethics does not supplant virtue ethics or any other theory of ethics for that matter. But reflection on values, as a place to start in studying what it is to be an ethical engineer, offers something that other ethical theories, including virtue ethics, cannot give us, and that is a deeper awareness of ourselves, what is important to us, how we prioritize things in life, and how we make ethical decisions. I consider values as an accessible way to think about ethics for those of us who are mere ordinary people who cannot expect or hope to live the perfectly ethical life of Aristotle's virtuous person.

Virtue ethics arises from the Aristotelian notion of the virtuous person and the multiple virtues of character and intelligence such a person would possess as laid out by Aristotle in his writings, principally in *Nichomachean Ethics*. Aristotle is unwavering in his conviction that the virtuous person is virtuous through and through (Hursthouse 63). This is not someone who merely does the right thing; the virtuous person acts virtuously because that is who the person is. To be a virtuous person requires "a capability to judge and to do the right thing in the right place at the right time in the right way" (MacIntyre 150). The virtuous person must possess, in addition to practical intelligence, all the virtues of character fully developed – a so-called "unity of virtues" (MacIntyre 155), all of which makes the virtuous person exceedingly rare. Ethics scholars and educators who advocate for a virtues-based approach to engineering ethics usually begin with Aristotle and then offer prescriptive, though rarely identical, lists of the virtues that a virtuous engineer would possess (see, for example, Harris Jr; Stovall; Pritchard).

One problem with virtue ethics as given to us by Aristotle is that a virtuous person is infallible because to be a virtuous person by definition means that the person always

does the right thing. Moreover, Aristotle contends that any given ethical problem has a single answer only (Nussbaum 635). MacIntyre cites another problem with virtue ethics which arises from Aristotle's pursuit of idealization and his conviction that conflict must be "avoided or managed." In our actual life experiences, "it is through conflict and sometimes only through conflict that we learn what our ends and purposes are" (MacIntyre 164), suggesting again that experience can be as good a teacher about ethics as formal education in the virtues.

Proponents of a values-based approach to engineering ethics emphasize human values, things that are important to and that motivate people (Wike; Cummings). In this respect, values-based ethics resembles virtue ethics. But values cross all theoretical boundaries in ethics. As the in-class activities on values demonstrates, both deontological and consequentialist ethics are premised on complex sets of values, although the theories themselves seek to give universal guidance on right behavior without the need to explicitly acknowledge or identify the values underlying them. As with virtue ethics theorists, values-based ethics proponents can fall into the same trap of prescribing the fixed values that are needed to make ethical decisions (Cummings, for example, prescribes twelve human values that must be considered in engineering design and she uses these to analyze and ultimately justify as ethical the decision to design the Tactical Tomahawk cruise missile. Wike, on the other hand, identifies only six values to which professional engineers should be committed. Who is right?). In the end, both virtues and values-based approaches, as well as deontological and consequentialist approaches, have the potential to end up as prescriptive "formulas" by which to make ethical decisions, and that is what I seek to avoid. As part of a phenomenological inquiry into

what it is to be an ethical engineer, students discover and reflect on the values they think are important, rather than have these values delivered to them as pre-packaged, already-known content.

Proposed Engineering Ethics Curriculum

How do these assumptions and principles inform an engineering ethics curriculum? I now provide an overview of the course I teach and some of the core assignments I use. They are not prescriptive or rigid. The phenomenological inquiry approach allows an instructor to try a variety of assignments and to use student performance and feedback to gauge outcomes and make revisions. It is also intended to be used by engineering faculty who may not be versed in engineering ethics. The curriculum content has evolved over the three semesters though the phenomenological interpretive approach has been the same throughout. The students undertake a variety of assignments that are informed by hermeneutic phenomenology and designed to help them discover, interpret, and describe the real, every day, lived experiences of an ethical engineer. Assignments include selected readings about engineering practice, personal interviews of engineers, activities in which students explore and reflect on personal and professional values in a variety of contexts, and a final research essay in which students express their understanding of what it is to be an ethical engineer. The best way to introduce and describe my course is to walk through the syllabus. This is the syllabus I used in ENT3958 during the fall semester of 2014. Excerpts are incorporated into this narrative and the full syllabus is included in Appendix A.

Course Objectives: I begin the course by introducing the three course objectives: (1) to develop a working knowledge of the principles of ethical theory and how these theories connect to actual personal and professional ethical decision making, (2) to explore and articulate their own understanding of what it is to be an ethical engineer, a question that will be their central inquiry during the semester, and (3) to demonstrate proficient communication skills. These objectives also help students meet three of Michigan Technological University's Student Learning Goals: Critical and Creative Thinking, Communication, and Social Responsibility and Ethical Reasoning.

Course Overview: The "Course Overview" explains what the class is all about and my expectations of the students. Some pertinent excerpts follow:

> Your work in this class will be a research project, but not the kind of research you are accustomed to doing as engineering students. The research you will do is qualitative rather than quantitative. It is also interpretive and will find no "right" or "wrong" answers. Everyone's work will be personal and unique. Your research will address the question: What is it to be an ethical engineer? You will use multiple resources to help you discover some answers and insights into this question. At the end of the semester, you will submit a research paper that reports what you have discovered and understand about being an ethical engineer.
>
> This class is premised on multiple assumptions. First, most engineering students don't care about learning ethics philosophy – that's a general observation made by most instructors who teach engineering ethics. Second, most engineering students don't actually engage with the study of ethics even though this is one of the learning outcomes that we expect. Third, engineering students prefer to investigate a question rather than study about it in books – you want hands on projects. Fourth, engineering ethics will be more meaningful if you study it in the context of everyday real engineering work. This is especially true because most of you in the class are preparing to graduate very soon and enter the engineering profession. This course takes all of these things into consideration.
>
> The goal is for you to investigate this question about what it is to be an ethical engineer – the lived everyday experience, not just when big issues arise. Ethics isn't something engineers choose to do; ethics and ethical decision-making are part of being an engineer. What you are seeking to

> understand is: what is the experience of being an ethical engineer in the routine day to day work I will do? You will explore this question by examining your own values, by talking with other engineers, by reading about being an ethical engineer, and by observing and listening. Your final essay will draw on your research as you begin to answer this question.

Review of Ethics Theory: I emphasize again that the approach of this class is intended to supplement and not supplant ethical theory. I do not assume that my students have any theoretical ethics knowledge so I allow two class periods for lectures and activities to give them some grounding in ethical theory. This is adequate time to cover the principles of deontology, consequentialism/utilitarianism, and virtue theory. I provide an overview of these three dominant ethical theories and how they relate to engineering ethics. I then pose two ethics problems to the students. These problems are well-known to ethicists but not necessarily to engineering students: the case of the inquiring murderer (a problem of deontology) and “Ivan’s Challenge” taken from *The Karamazov Brothers* and/or the trolley problem. For each of these problems, I ask the students to take time to think about and write down their thoughts. I have learned from classroom experience that, when students have something in writing to refer to, it’s much easier for them to volunteer and be part of a class discussion.

Kant gave us the paradigm of rules-based ethics, the Categorical Imperative: to act only according to that maxim by which you can at the same time will that it should become a universal law [5]. The rules that govern “right” behavior are derived through reason, they are universal, they are inviolable, and they apply without exception. Benjamin Constant posed the case of the “inquiring murderer” to Immanuel Kant to challenge Kant’s Categorical Imperative. Constant’s challenge to Kant is this: should a person lie to a

murderer who asks the location of his intended victim, even though that would violate the maxim against lying? We discuss possible ways to answer the question. Most students believe that breaking the rule against lying is justified by the circumstances, and they are surprised to learn that Kant's stunning reply to Constant was that lying about the would-be victim's location would violate the maxim of truth-telling and would be wrong (Kant, "On a Supposed Right to Lie from Altruistic Motives" 346–349). The larger lesson, of course, is that there will almost always be circumstances in which an exception to a rule seems to be justified, so that rules cannot be relied on to make ethical decisions in all cases.

Most students are familiar with the trolley problem: there is a runaway trolley and you can operate the switch that will avoid the trolley killing five people on the track but, by switching tracks, the trolley will kill one person on the other track. "Ivan's Challenge," however, is not as familiar and poses a more dramatic and emotional case:

> Tell me honestly, I challenge you – answer me: imagine that you are charged with building the edifice of human destiny, the ultimate aim of which is to bring people happiness, to give them peace and contentment at last, but that in order to achieve this it is essential and unavoidable fo torture just one little speck of creation, that same little child beating her chest with her fists, and imagine that this edifice, has to be erected from her unexpiated tears. Would you agree to be the architect under those conditions? Tell me honestly! (Dostoevsky i, part 2, bk. 5, ch. 4).

These problems illustrate one of the problems of consequentialism – weighing the costs and values when human life is at stake. They are excellent problems for class discussion.

Student Assignments: Everyone has values though they are usually not explicitly considered in our everyday lives. Students come into my class versed (to varying

degrees) in the NSPE Code of Ethics and ethical decision making based on cost-benefit analyses. Many students recognize that they rely on their “values” to make ethical decisions, but they have not usually considered just how those values actually operate in engineering ethics and all ethical decision-making. Two assignments are designed to bring to the foreground and make students mindful of the tangible, identifiable impact of values on decision-making. The first assignment is an in-class activity that we do on the first day of class. This activity follows a basic introduction to ethics theory (rules, consequentialism, and virtue).

Identifying and thinking about values (in-class): I ask students to think about how ethical decisions are actually made. If codes and rules and utilitarian calculations of consequences have limited practical usefulness in ethical decision-making, then how do engineers make ethical decisions? A set of three activities helps them think about values. Again, for each of these activities, I ask the students to take time to think about and write down their thoughts before we have the class discussion.

> First, I ask the students to think about what they ate (or didn’t eat) for breakfast and then to think about why they made those choices. What students discover is that even the simple choices they make about breakfast are based on their personal values and often carry ethical implications. The second activity asks student to work in small teams to consider the Canons of the NSPE Code of Ethics and to identify the values that are behind these rules. If they cannot rely on the NSPE Code of Ethics to definitively answer professional ethical questions, then why does it exist? If the NSPE Code of Ethics was not created out of whim, then where did these rules come from and what values inspire the rules? The third activity is also a team activity. Each student is asked to reflect on the values that made him or her choose engineering as a profession and the particular field of engineering. These three activities are inclusive ways to have students begin to talk about values, to realize how influential a role values have in all decision-making, and to understand how ethical consequences follow from values. Finally, I ask the students to consider a real-world case such as the Space Shuttle Challenger disaster. Students now understand the issues in the case from

> a values perspective rather than from a rules or consequentialist perspective, resulting in new questions, alternative possibilities, and perhaps otherwise unconsidered ethical options and obligations.

These seem like simple activities but they are convincingly effective in making the point to students about the ubiquity and power of values. Values are familiar and this is a good activity to introduce values and have the students begin to think reflectively about them.

Autobiographical Reflection on Values (Essay): The second assignment is a written autobiographical reflection on values. The students now have a good idea of what "values" are about and how they might identify and think about them. This is a written assignment and is due early in the semester:

> This is an introspective assignment. It is part of the process of answering the question that is the focus of this course: what does it mean to be an ethical engineer? This assignment requires you to reflect on your life experiences (including any internship or co-op work), to examine your own values, and to explain how you see yourself as an emerging engineer. In this paper, please address the following (your paper should be about 500-800 words in length):
>
> - Why do you want to be an engineer? What motivates you to choose this over other careers?
> - What field of engineering did you choose? Why? What does this choice say about you and your values (talk about explicit values that contributed to your decision)?
> - I will assume you want to be an ethical engineer. What values do you think you will need to be an ethical engineer? Identify some of these values and describe what you mean by them.
> - Think about relevant experiences (without betraying confidences!) that helped you learn more about yourself as an ethical engineer such as co-op, internship, or other work experiences. Think about how values were involved in the everyday work you were involved in or that you observed. Give a couple of examples. Think about what values motivated actions you took or that others took and how these values impacted ethical judgment.

It's important to include the opportunity for students to reflect about prior co-op or internship experiences. There are limited means for engineering students to get

to this “everydayness” of being an ethical engineer. The intent of the co-op or internship experience is almost always to provide both the student and the employer with a way to check out one another for possible post-graduation employment. In fact, these experiences reinforce the foregrounding of engineering technical work and the “taken-for-grantedness” of ethics and ethical practice. Students are seldom, if ever, asked to reflect about their perceptions of how engineers experience being ethical during or after a co-op or internship, and this is an opportunity to think about those experiences in new, reflective ways.

Introduction to Phenomenology: Phenomenology is concerned with what Heidegger called “being-in-the-world” – a way of understanding what it means to live our everyday lives – how we work with things and how we encounter other humans. Phenomenology is not concerned with scientific explanation or causation, though it certainly does not deny the importance of scientific and technical knowledge. There are two fundamental aspects of phenomenology that I want my students to understand. The first concerns “knowing” in a phenomenological sense. I give a brief introduction to and explanation of what the students should look for in the film, “Being-in-the-World” (Ruspoli). This film requires an introduction and advance positioning so that the students view it in some context relevant to the course. Engineering students are so immersed in the assumption that scientific knowledge can explain everything. This film makes explicit that we all have a kind of “knowing” that is pre-reflective such that we can do things expertly without thinking about it. Our minds are not “thinking” our bodies to act; rather these craftspeople and artists are being and doing what they are, with no separation between mind and body. Examples include craftsmanship carpentry, Flamenco guitar playing, and culinary

arts. I ask the students to think about where this kind of knowledge is situated with respect to scientific knowledge. I also ask them to think about this kind of knowledge in terms of engineering practice and, more importantly, how it might relate to ethical decision-making.

The second aspect of phenomenology is concerned with research methodology. The learned inclination of my students is to treat their research in this class either as a problem they must test and prove or as a report that summarizes what they have read and learned. I use the term "hermeneutic phenomenological research" when I explain the rudimentary but essential approaches they must take toward their research work in the class. I am not a purist on methods, however, because I don't think every step of academic phenomenology research is required to serve the purposes for this class. I explain about "bracketing" and acknowledging their biases and pre-conceptions that they bring to the research. I encourage them to be open about these biases and pre-conceptions because they will be able to recognize and understand them as they do the coursework readings and activities. I suggest how they can approach the reading selections – not as texts they have to learn in order to pass a test but as ways of looking at and understanding ethical problems and the role of engineers. I expect them to take notes about the parts of the texts that speak to them and have meaning about what it is to be an ethical engineer. I introduce the engineer interview assignment. Lastly, I discuss the final paper in which they will take all the activities that they have experienced during the semester and draw from them themes which help them understand what it is to be an ethical engineer. As I mention below, I meet with each student individually twice

during the semester. Those meetings, I've found, are necessary to help clarify and affirm this process for students.

Readings: I selected and assigned 14 readings for the fall semester 2014 class. I've used several of these readings before and some were new in 2014. I try to select readings that are accessible (written so they can understand it without having to refer to something else for interpretation) to the students. I also aim for readings that will provoke thought and reflection. I try to avoid strident articles that "preach" unless I have something that will provide a counter point of view. I do make it clear to my students that, while I have a point of view, I don't expect them to echo it. I ask them to ask what the meaning of a reading is and how it applies to their inquiry into what it is to be an ethical engineer. I encourage the students to take notes about the readings and I found that each student, in fact, did this. The required readings for 2014 were:

- Mario Bunge. *Philosophical Inputs and Outputs of Technology.* 2003 (Bunge).
- Michael Davis. *Does "public" mean an engineer's nation?* 2014 (Michael Davis, "Does 'Public' Mean an Engineer's Nation?").
- Gary Lee Downey, Juan C. Lucena, and Carl Mitcham. *Engineering Ethics and Identity: Emerging Initiatives in Comparative Perspective.* 2007 (Downey, Lucena, and Mitcham 463–487).
- Lav R. Varshney. *Engineering for Problems of Excess.* 2014 (Varshney).
- Pete Hylton. *Ethics and Competitive Advantage in a Fast-Paced Industry.* 2014 (Hylton).
- Gerard van Oortmerssen. *Ethics and ICT: Beyond Design.* 2014 (van Oortmerssen).

- Wade L. Robison. *Ethics in Engineering.* 2014 (Robison).
- Saif alZahir and Laura Kombo. *Towards a Global Code of Ethics for Engineers.* 2014 (alZahir and Kombo).
- *Human Head Transplants Now Possible, Italian Neuroscientist Says.* 2013 (“Human Head Transplants Now Possible, Italian Neuroscientist Says”).
- John Markoff. *Making Robots More Like Us.* 2013. (Markoff).
- Carl MItchum. *Martin Heidegger: The Question concerning Technology.* 1994 (Mitcham 49–55).
- Kristin Shrader-Frechette. *Technology and Ethics.* 1992. (Shrader-Frechette).
- Jason Millar. *Technology as Moral Proxy: Autonomy and Paternalism by Design.* (Millar).
- Jianping Zeng. *A Brief Introduction to Chinese Ethics* (transcript of video). 2013 (Zeng).

Individual Student Meetings: I schedule two individual meetings with each of my students. Fall semester 2014 was the first time I did this. Because I gave my students less structure and more autonomy to pursue the research activities (readings, interview) in this class, I was concerned that I needed to periodically meet with them to monitor their course progress. This concern turned out to be justified for some of the students and forced them to stay on track because they needed to account to me for their progress. As I met with students, I recognized two additional and equally important reasons for these meetings. It was a chance for students to ask questions about the readings, to get clarification on phenomenology research and interpretation (versus reporting), to bounce their ideas, to discuss activities they could do that would help their

research, and to help them think through what some of the meanings were that they encountered. Students must bring an outline of their research findings and interpretations – there are no specific requirements on what it must look like but they have to be able to discuss it – to the second individual meeting. Perhaps the most important outcome of these meetings is their contribution to development of emotional engagement of the students with ethics. This didn't become apparent until I read the course evaluations written by the students at the end of the semester. Several students wrote that these meetings were appreciated and helpful, particularly for clarifying expectations and discussing their ideas and getting feedback. It gave students a sense of individual importance.

Interview with Practicing Engineer: I'm reluctant to declare that any assignment is more impactful than others (I'd prefer to think that they all have equal importance), but it's hard to ignore the evidence. Year after year, this interview is the assignment that students report they dread the most (the time commitment, the effort to find someone to interview, and the fear of talking with someone from what they see as a subordinate student position) but that, after they have done it, they report gaining the most. The assignment requires them to interview an engineer who has experience working in industry:

> This is a required part of the research for this class. You can interview an engineer currently in academia as long as the engineer has significant (more than 5 years) experience working in industry. The focus of your interview is to help you answer the question: what is it to be an ethical engineer? Note that the interview is not about learning what it is to work as an engineer, but the focus is on the <u>everyday practice of being an ethical engineer – discovering what that means</u>. I will post a list of possible questions used by earlier classes for the interview but you can add any of your own. Keep notes about the interview that (1) summarize answers to the interview questions and (2) reflect on your interview experience and what it contributed to your own knowledge of what it is to

be an ethical engineer: what was helpful, surprising, new, not helpful, etc.?

This assignment often ends up being easier for the students than it is for the engineers they interview. These engineers in most cases have never been asked to talk about their experience of being an ethical engineer.[11] In that respect, the students must prepare the engineers by explaining – and affirming – the reason for the interview. Engineers often comment that they've not been asked to talk about this and they express interest and appreciation for the opportunity. I've yet to have a student report that the engineer he or she interviewed responded negatively to the question or the interview.

In-class Discussion: One class discussion is devoted to what students have discovered about what it is to be an ethical engineer. I ask each students to write down at least three points they want to share with the class. I make it clear to the class that these are not "presentations" but discussions. I go through the class to make certain each student has the opportunity to speak and, after each student makes his or her point, I allow some time for additional discussion. As long as they stay on the topic of ethical engineering, I don't interfere. Prior to 2014, I asked students to study a technology of choice and give a brief presentation on the ethical issues posed by that technology with a time for questions at the end of each presentation. The class discussion format I used for the 2014 class was a superior experience for me and for the students. I discovered

[11] Anecdotally, I am working with instructors in Engineering Fundamentals to revise the ethics module used in ENG1101. Interviews with engineers are an important assignment but it isn't practical to have 1000+ first year engineering students find engineers to interview. The alternative we came up with is to have a special symposium and to invite a panel of engineers to talk about and to answer student questions about what it is to be an ethical engineer. I attended the symposium held during fall semester 2014. Every engineer on the panel wanted to talk about being an engineer and had to be reminded by the instructor facilitators that the topic was "what is it to be an ethical engineer?" This is not a topic engineers routinely think about.

that, because nearly all of them will soon graduate, the everydayness of being an ethical engineer took on new importance for them. In their course evaluations, several students suggested that they would like at least one additional class for discussion, and I agree with that.

Final Research Essay: The capstone assignment is a final research paper. All of the students generally need to have the “interpretive” nature of this paper reinforced during the semester, and that is addressed during my individual meetings with students:

> This research paper draws on all the research work you have done this semester to answer the following question: What is it to be an ethical engineer? Your paper should be 1800-2000 words long (again, I’m not counting words but quality will be the paramount consideration). This is an interpretive form of research. In other words, I do not expect you to merely report or repeat what you have read, watched, discussed, or observed. What I expect you to do is take all of this input and use it to describe how you interpret and understand the essences of what it is to be an ethical engineer. You should refer to readings, interviews, etc. to support your ideas.

In prior years, the class met bi-weekly for two hours over the 14-week semester. I decided that, for the fall semester 2014 class, I wanted to create more of a research environment and give the students increased time for their research and more autonomy to do it. Table 2.1 includes the course schedule with some comments about its structure.

The significant changes to the class structure were (1) fewer class meetings; three classes of 90 minutes each were held at the beginning of the semester and used to deliver the knowledge students would need to proceed with their research (ethics theory and phenomenology); we met as a class only once more, at the end of the semester, for class discussion; (2) no assigned order for readings, and (3) addition of my individual

meetings with students with specified “deliverables” for each meeting. This was a risky approach, but it is one that paid off. There are modifications that can be made but, overall, the students appreciated the autonomy, were able to maintain progress over the semester to complete their work on time, and demonstrated significantly improved ethical reasoning, ethical sensitivity, and emotional engagement, as will be reported in later chapters.

Table 2.1 - Course Schedule ENT3958 Fall Semester 2014

Date	Topic	Assignment Due
September 4 Class meets 90 minutes	Introduction and Course Overview: What is it to be an ethical engineer? Review of principal ethical theories	Complete the DIT-2 (Defining Issues Test) and the TESSE (Test of Ethical Sensitivity in Science and Engineering). Links to these tests are below (page 4). They must be completed **by September 11** to count toward class participation grade.
September 11 Class meets 90 minutes	A phenomenological approach to understanding what it is to be an ethical engineer	Film: “Being in the World” Reading: Bunge: *Philosophical Inputs and Outputs of Technology* (Canvas – Pages: Course Readings) Completion of DIT-2 and TESSE.
September 18 90 minutes	Ethical Theories, continued	Writing Assignment due: Autobiographical Reflection on Values. See below (page 4).
October 7 and 9 (Tuesday and Thursday evenings 6:00-8:30)	Individual meetings with students – sign up on Canvas.	Bring a list of the readings you have completed and your interview plan. Also any additional sources you want to include as part of your research.
November 4 and 6 (Tuesday and Thursday evenings 6:00-8:30)	Second set of individual meetings with students – sign up on Canvas	Bring a draft or detailed outline of your research paper and interview notes. Be prepared to discuss some of your findings, observations, discoveries, etc.
November 20 Class meets	Presentations and discussion of research papers	Students will give brief presentations on highlights of their research. Class discussion as time permits.
December 4		Final Research Papers are due. See page 4.
December 11		Complete the DIT-2 and TESSE as post-assessments. They must be completed between December 4 and December 11 to count toward class participation grade.

For three years, the impacts of a phenomenological approach to engineering ethics have been a matter of supposition on my part supported by minimal testing using the DIT-2 to measure ethical reasoning skills. Chapter Three explains the research methods I undertook to at last quantitatively and qualitatively test and assess the outcomes of a phenomenology-informed engineering ethics pedagogy.

Chapter Three
Research Design: Quantitative and Qualitative Methods to Measure Ethical Sensitivity, Ethical Reasoning, Emotional Engagement, and Understanding of Professional and Ethical Responsibilities

My dissertation research examines whether a phenomenological approach to engineering ethics pedagogy can improve not only students' ethical reasoning and sensitivity but also their emotional engagement with and understanding of professional and ethical responsibilities. I contend that ABET's Engineering Criterion 3(f), which requires that graduates of engineering programs have "an understanding of their professional and ethical responsibility," is a far more demanding standard than most engineering programs recognize and that ethical reasoning, ethical sensitivity, and emotional engagement are all required in order for students to fulfill this criterion.

The meaning we give to "understanding" is really the crux of the problem for establishing what we want students to get out of engineering ethics, how we design and deliver engineering ethics instruction, and how we assess student learning outcomes. As I have argued, on the whole, current engineering ethics instruction follows a traditional model that emphasizes rational problem-solving, delivers an ethics curriculum with materials designed to teach rational problem-solving, and assesses student outcomes according to their ability to rationally solve ethical dilemmas. This is to be expected, given that deontological, utilitarian, and virtue ethics all hold that moral decision-making is a rational, cognitive process. It follows, unsurprisingly, that most research into the effectiveness of engineering ethics instruction adheres to this same premise and uses tests of cognitive skills – ethical reasoning – as the measure of student learning.

My research challenges this paradigm and proposes, instead, that the ABET Ethics Criterion does and should intend “understanding” in the way that Gadamer elucidates understanding as a set of conditions under which we open our existing or foregrounded horizons – including all our biases, prejudices, and values – and place them at risk in a dialog with a foreign “text” and, through interpretation and hermeneutic experience, we emerge with a “fusion of horizons” and a new understanding – different from where we were and unique to each person, a never-ending process that constitutes how we live. With understanding, there is a shift – momentous in that it happens – and our new horizons are forever changed, only to be put at risk and changed again. Gadamer’s explanation of understanding certainly includes a cognitive element, but there are also practical and linguistic elements that precede or exceed cognition (Grondin). So, although I don’t reject the utility of measuring cognitive skills – those skills are important and the measures offer a way to compare outcomes of my research to the work of others – I proceed from the premise that these measures are inadequate for the task of assessing whether our engineering students have attained an “understanding of their professional and ethical responsibilities.” This will be explicit as I describe the quantitative and qualitative measures used in my project to assess ethical reasoning skills, ethical sensitivity, and emotional engagement.

Research Setting and Participants

My research was conducted in ENT3958, Ethics in Engineering Design, a one-credit, 3000-level elective course offered by the Enterprise Program at Michigan Technological University. The Enterprise Program was initially funded as an NSF Action Agenda pilot program in 2000 as an alternative to engineering senior capstone design. Enterprise

offers teams of students from varied disciplines the opportunity to work for several years in a business-like setting to solve real-world problems supplied by industry. It is an extensive multi-year, multidisciplinary design experience. All Enterprise participants complete an Enterprise curriculum which includes a minimum of 20 credits for an Enterprise Minor and 12 credits for an Enterprise Concentration. Some of the courses are mandated and others are elective. Most Enterprise electives, like ENT3958, are offered for one-credit. Although Ethics in Engineering Design is an elective offered by the Enterprise Program, it is open to all students at Michigan Tech, irrespective of discipline or major. Course enrollment is restricted to juniors or seniors (lower grade levels with the permission of the instructor) who have completed first-year Engineering Fundamentals 1101 Engineering Analysis and Problem Solving (or equivalent) as a prerequisite. ENT3958 is offered each Fall Semester and has an enrollment cap of 25 students, though this cap is seldom reached.

The thirteen students enrolled in the Fall 2014 semester participated in this study. This was a quasi-experimental study because all students enrolled in the course were required to participate in the study as part of their assigned work, and no random selection occurred. The students were representative of all engineering majors at Michigan Tech, they were all white, and English was their first language. Of the 13 students, there was only one female, though this is not unusual at Michigan Tech where women continue to be underrepresented in engineering.

Students were required to complete all assessment components of the project: pre and post Defining Issues Test-2 (DIT-2) surveys, pre and post Ethical Sensitivity Scale

Questionnaire (ESSQ), and a final research essay. The DIT-2 and ESSQ tests were required and students received course points for taking them, although results were anonymous and actual responses were not graded. Students evidenced their participation in the DIT-2 by submitting a screen shot of the “thank you” page generated at the end of the survey, and they submitted the ESSQ during class so I could account for the fact that each of the 13 students completed the questionnaire. Students completed the DIT-2 and the ESSQ as a pre-test during the first week of the semester and as a post-test following submission of their final research essays at the end of the 14-week semester. Final research essays were graded. However, for the qualitative coding and explication of the essays, each essay was numbered with student names removed. During the semester, I met individually twice with each student, and these meetings were also required for point-value purposes but not graded. These interviews were not recorded because they were intended for the benefit of the students (to discuss readings, ask questions, and get feedback); however, I did make some field notes following these meetings, though no student names are included. No students withdrew from the course during the semester, and all 13 students completed each component of the project with the exception of the post-test DIT-2, which was completed by 12 students.

A Human Subject Use Request for Exemption Review to administer these tests and to conduct individual meetings with the students was submitted to Michigan Technological University’s Institutional Review Board, and the project was granted exempt status on July 25, 2014. The IRB exemption letter is included in Appendix B.

Research Methods

I am using both qualitative and quantitative methods to test and assess the impact of a phenomenological approach to engineering ethics instruction on the moral development, emotional engagement, and understanding of ethics of undergraduate engineering students. This statement brings to the fore a preliminary question of whether my work here is properly considered assessment or research. I've used the terms interchangeably and I want to acknowledge that there may be some objection to that. Assessment and research are distinguished (Upcraft and Schuh) but they are also not incompatible in the manner that I am using them in my work. Educational research frequently consists of testing an educational approach to determine if it is effective in producing a desired outcome. Qualitative or quantitative methods are appropriate depending the research question. Assessment is generally understood as a process for determining if an educational outcome has been achieved either in the classroom or institution-wide and, as with research, both qualitative and quantitative approaches can be used depending on what works best to measure the intended outcome.

My work entails both research and assessment. First, I want to know if a phenomenological approach to engineering ethics pedagogy is effective to improve ethical reasoning, ethical sensitivity, emotional engagement, and understanding of professional and ethical responsibility for undergraduate engineering students. If it is, I also propose that outcomes may be generalizable and that this pedagogical method may be transferable to engineering ethics classrooms beyond Michigan Tech. To this extent, my work tests an educational approach and is research. But I am also proposing a qualitative method to measure "engagement" and "understanding," that is, to assess

whether undergraduate student outcomes for ethics, such as ABET's Engineering Criterion 3(f), have been attained. To that extent, my work converges with assessment. Arguably I am testing an assessment method with the expectation that it could be generalizable and transferable, so this would be considered research as well. Although there may be objections to my failure to consistently distinguish between the two approaches (see, for example, Upcraft and Schuh), I also note that the terms "research" and "assessment" are used interchangeably by others who write about engineering education. Leydens et al., for example, entitle their comparison of qualitative and quantitative methods in engineering education research, "Qualitative Methods Used in the *Assessment* of Engineering Education" (Leydens, Moskal, and Pavelich, emphasis added) even though the entire article is devoted to a discussion of educational research and data collection methods without distinguishing between assessment and research terminology or processes. Similarly, Borrego et al., refer interchangeably to research and to assessment in their comparisons of "Quantitative, Qualitative, and Mixed *Research* Methods in Engineering Education" (Borrego, Douglas, and Amelink, emphasis added). So, having acknowledged this issue and explained its implications for my work, I will continue to use both these terms somewhat interchangeably and don't intend to problematize them further. To the extent that methodologies differ, I will apply the appropriate standards for research or assessment.

Qualitative Research in Engineering Education:

The question arises: why is it necessary to use qualitative methods to assess student outcomes in the first place? Aren't quantitative methods more reliable and more scientific? Denzin calls quantitative evidence the "elephant in the room" because the

standards for quantitative research have been transferred to qualitative research on the assumption that evidence and data from qualitative research are not acceptable otherwise. This has critical and far-reaching consequences for qualitative researchers. It affects, for example, where and whether one's work can be accepted for publication and eligibility for research funding (Denzin).

Strauss and Corbin define qualitative research as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss and Corbin). Although there are multiple paradigms or theories, along with associated methodologies, of qualitative research (see, for example, the works of Lindlof and Taylor; Prasad and Prasad; Denzin and Lincoln), all qualitative research classifications share a fundamental common assumption. They are critical of the position that all research should or can be conducted by an objective researcher who collects and then describes data about some fixed reality. Interpretive qualitative research assumes that human action is meaningful and seeks to understand how people make meaning in their lives, how they understand experience, and how they perceive the constantly changing world in which they live. It accepts that knowledge is not always fixed and unchanging but is "constructed" and permeated with values. Denzin and Lincoln describe qualitative research as follows:

> *Qualitative research* is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations. . . . At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them (Denzin and Lincoln, "Introduction: The Discipline and Practice of Qualitative Research" 3).

These definitions of qualitative research are hard to digest if one is looking for ways to compare it to quantitative research. The manifest and persistent bias against qualitative research in engineering education research continues notwithstanding the stated policies of research funding agencies such as the National Science Foundation (NSF), which routinely solicits proposals that use qualitative or mixed methods research and seeks to learn more about how qualitative methods can be used in engineering education research and assessment. Borrego, et al., received funding from NSF to study the use of quantitative, qualitative, and mixed methods research in engineering education. Their results, reported in 2009, conclude that there is a gap between the expressed desire for more qualitative research and the actual fact of funded qualitative research. Although researchers say they are disappointed with the low representation of qualitative research in engineering education, these same researchers nevertheless admit to far greater comfort with quantitative methods. Their responses demonstrate that they are unfamiliar with qualitative methodologies and that they judge qualitative methods by the same standards that apply to scientific or positivist research in terms of purpose, method, and validity. Specifically, researchers who were queried about qualitative methods stated that they are concerned about the absence of control groups as critical to experimental design, the inability to assess statistical significance of results, and the insistence on triangulation that correlates research results with student performance (grades) (61–62). Persons who conduct qualitative research expressed their perception of a bias against qualitative research by those who review their work, and that they feel pressured to include methods that will produce quantitative results that

can be statistically analyzed in order to have their work funded or accepted for publication (62).

Leydens, et al. compared quantitative and qualitative methods that are used to assess engineering education outcomes. The authors suggest that criticisms of qualitative research may be due to the fact that engineering educators misunderstand that the purposes of qualitative research differ from quantitative research. Quantitative researchers seek results that are generalizable and transferable across populations, and that is not an objective or outcome of most qualitative research (65) which tends to focus on the particular and the local. Leydens, et al. also acknowledge the misinformed perception among quantitative researchers that qualitative methods are “unsystematic or lacking in rigor” (65).

Koro-Ljungberg and Douglas conducted a meta-analysis of articles published in the *Journal of Engineering Education*, one of the premier places for publishing research on engineering education in the United States. They looked at articles that were published in the JEE over a two year period in which the articles’ authors claimed to use qualitative research methods. They analyzed these articles on one aspect of research rigor, the consistency between the authors’ theoretical perspectives and the actual research design. They found that, of the 26 articles that claimed to use qualitative methods, only four of them met their established criteria for rigorous qualitative research (168). They concluded that rigorous qualitative research is difficult to do properly and cautioned qualitative researchers to adhere to established standards for qualitative research (172).

All of these writers offer good reasons for qualitative research and why it serves a difference purpose and provides different information than does quantitative research. Leydens, et al. explain that “the broad purpose of qualitative research is to understand more about human perspectives and provide a detailed description of a given event or phenomenon” and that qualitative research is “not meant to provide fodder for cross-case generalization” (65). Borrego, et al. write that qualitative research is designed to use textual data in order to answer questions that require “rich, contextual descriptions of the data, what is often called ‘thick’ description” (Borrego, Douglas, and Amelink 56). Koro-Ljungberg and Douglas observe that qualitative research designs are increasingly being used in engineering education research because they “offer alternative ways of knowing and viewing the empirical world” and because they “have the capability to capture the complexity of human behaviors in ways that are not possible when studies are based on prediction and randomized controls” (163).

Educational assessment often claims to use qualitative methods. But, in fact, most qualitative assessment work that uses interpretive methods is ultimately converted to quantitative data so that it can be statistically analyzed and reported. The most evident form of “quantitizing” qualitative data is the scoring rubric (Leydens, Moskal, and Pavelich; Borrego, Douglas, and Amelink). Evaluators are asked to read student textual work or observe behavioral projects and then score it using a rubric that rates the work according to one or more measures on some numerical scale. Whether this can properly be called “qualitative” assessment is questioned (Borrego, Douglas, and Amelink 59).

Despite these problems with and resistance to qualitative methods, assessment of engineering education using authentic qualitative methods is being done. Loui used student essays written at the beginning of the semester and reflection papers written at the end of the semester to assess the impact of a course on engineering ethics on the development of undergraduate students' perceptions of their professional identities as well as to identify the potential for "deep learning" in the course. He used a coding scheme to sort responses into categories and themes and was able to identify important differences between the earlier and later essays. For example, students came into the class seemingly "hard-wired" for following a code of ethics whereas their final essays reflected recognition of the need for moral courage, understanding that ethical responsibilities extend beyond the workplace, and that there may be an obligation to consider the effects of technologies on the public (Loui, "Ethics and the Development of Professional Identities of Engineering Students" 388). Hashemian and Loui continued this qualitative approach in a study of whether engineering ethics instruction can affect students' feelings about professional responsibility. In this study, they interviewed three groups of undergraduate engineering students: six students who had completed an ethics course, six who had registered for the course but had not yet taken it, and six who had no formal ethics instruction. In the interviews, students were asked uniform sets of questions about their experiences and expectations of a career in engineering and two case studies that were variations of case studies used in the ethics course. Because of the small numbers of students in the pilot study and because of the possibility that students who had taken the ethics course were already familiar with similar case studies, the researchers were unable to draw conclusions about the effects of an ethics course on students' feelings of responsibility about ethical decisions (Hashemian and Loui). But

the study does show the availability of qualitative methods to inform assessment of engineering ethics instruction outcomes. In both of these studies, the researchers were using qualitative methods to investigate the influences of engineering ethics instruction in ways that quantitative methods could not address or capture.

Throughout this dissertation, I have argued for ethics instruction that emotionally engages students in the study of professional and ethical responsibilities, and I have argued that we can use qualitative methods to determine if this outcome is being achieved. Perhaps the most significant shift in my research occurred when I examined this outcome – emotional engagement – more thoroughly. What I found – and this jumps ahead a bit – is that I moved from an emphasis on emotional engagement as a learning outcome to the very thing that we as ethics instructors are charged with achieving: an understanding by students of their professional and ethical responsibilities, as mandated by ABET's Engineering Criterion 3(f). One of the implications of this change is that qualitative methods for assessment of "understanding" not only made more sense but, indeed, seemed indispensable.

Ethical Reasoning and its Measurement:

Moral development has historically been theorized and studied from a cognitive perspective. Aristotle, Kant, Bentham, and Mill all approached their ethical theories as matters of rational, cognitive thought. Piaget and Kohlberg followed in this tradition and, though critique of and alternatives to their thinking on moral development are offered, they are still influential in contemporary theory. Piaget engaged children in game playing and observed how they developed their moral understanding of rules. He ultimately determined that there are two principle stages of moral development: "moral

heteronomy” where children understand rules to be absolute and “moral autonomy” when children begin to mature and understand that rules are not fixed and absolute but that they are changeable and can be adapted to varying situations as the need may arise (Fleming 7–4).

Kohlberg applied Piaget’s theory of cognitive development to moral understanding. Unlike Piaget, he was less concerned with how children developed and applied rules about right and wrong than the reasoning they used to explain their moral decisions. He also studied children by giving them various situations presenting moral dilemmas and discussing with them how they came to their decisions about what was right or wrong. One of the most well-known dilemmas that he posed to the children is “Heinz Steals the Drug” where a man is unable to raise enough money to pay for an expensive drug needed to treat his wife’s cancer. When the druggist refuses to sell it to him for a cheaper price, he later breaks into the store and steals the drug. Children are asked to decide if the man’s action in stealing the drug was right or wrong and to explain the reasons for their decision. Based on his findings, Kohlberg expanded Piaget’s two stages of moral understanding to six stages that consist of three main stages with two sub-stages within each major stage, as follows:

I. Level I: Decisions about behavior are made on the basis of consequences – rewards and punishments.
    a. Stage 1: “Punishment and Obedience” – obey and order to avoid being punished. Child’s perspective is completely self-centered.

b. Stage 2: “Instrumentalism” – the child makes decisions based on the child’s own self-interest – there is a sense of “tit-for-tat” in that the child can understand behavior can be for mutual benefit.\

II. Level II: Conventional Morality: child begins to grasp the notion of social rules

a. Stage 3: “Interpersonal relationships” – the child understands about social approval and this becomes the child’s major motivation

b. Stage 4: “Maintaining social conventions” – the child places high priority on following rules and doing one’s duty. Law and order are important.

III. Level III: Postconventional Morality: At this stage of development, there is increasing recognition and development of one’s own idealized principles and less reliance on society’s standards of moral behavior

a. Stage 5: An understanding of the “social contract” – that rules exist for the mutual benefit of everyone in society

b. Stage 6: “Universal ethical principles” – the individual reflects on what is just and understands that right and wrong behavior cannot be prescribed only by rules. Personal ethical values are developed.

There have been many criticisms of Piaget’s and Kohlberg’s theories that other theorists have tried to address. One of the most important objections was the fact that Piaget and Kohlberg worked almost entirely with boys. Piaget, who did conduct limited separate studies of girls, observed that the rules girls developed for their games were less complex than the rules developed by boys and, from this, concluded that the moral development of girls might be less advanced than that of boys (Fleming 7–6).

Psychologist Carol Gilligan challenged Piaget's conclusions about girls as sexist and criticized his method of studying boys and then trying to generalize their behavior to both sexes. In her book *In a Different Voice: Psychological Theory and Women's Development,* Gilligan confronts the methods and theories of both Piaget and Kohlberg (as well as Freud). She begins with this:

> At a time when efforts are being made to eradicate discrimination between the sexes in the search for social equality and justice, the differences between the sexes are being rediscovered in the social sciences. This discovery occurs when theories formerly considered to be sexually neutral in the scientific objectivity are found instead to reflect a consistent observational and evaluative bias. Then the presumed neutrality of science, like that of language itself, gives way to the recognition that the categories of knowledge are human constructions. The fascination with point of view that has informed the fiction of the twentieth century and the corresponding recognition of the relativity of judgment infuse our scientific understanding as well when we begin to notice how accustomed we have become to seeing life through men's eyes (6).

She observes, in response to those who find the level of moral development of women to be inferior to that of men:

> Yet herein lies a paradox, for the very traits that traditionally have defined the 'goodness' of women, their care for and sensitivity to the needs of others, are those that mark them as deficient in moral development (12).

Gilligan posits that women are more likely to approach moral questions from an ethics of care perspective whereas men tend to decide these questions from an objectively principled and rational perspective: "Thus while Kohlberg's subject worries about people interfering with each other's rights, this woman worries about 'the possibility of omission, of your not helping others when you could help them.' "(21). Drawing on the work of Jane Loevinger, Gilligan argues:

> The autonomous stage in Loevinger's account witnesses a relinquishing of moral dichotomies and their replacement with a 'feeling for the complexity and multifaceted character of real people and real situations.'

> Whereas the rights conception of morality that informs Kohlberg's principled level (stages five and six) is geared to arriving at an objectively fair or just resolution to moral dilemmas upon which all rational persons could agree, the responsibility conception focuses instead on the limitations of any particular resolution and describes the conflicts that remain.
>
> Women's moral judgments thus elucidate the pattern observed in the description of the developmental differences between the sexes, but they also provide an alternative conception of maturity by which these differences can be assessed and their implications traced. The psychology of women that has consistently been described as distinctive in its greater orientation toward relationships and interdependence implies a more contextual mode of judgment and a different moral understanding. Give the differences in women's conceptions of self and morality, women bring to the life cycle a different point of view and order human experience in terms of different priorities (21-22).

Gilligan is recognized as an important and influential voice to counter the theories of Piaget, Kohlberg, and others. In addition to psychology theory and research, Gilligan's ethics of care has come to resonate as well in the field of ethics theory. Gilligan is routinely included in discussions of ethics, in particular virtue ethics and the virtue of care (see, for example, Timmons; *Ethical Theory: An Anthology; Ethics*). Gilligan's work eventually influenced changes in the way moral development was theorized and measured by people like Kohlberg and his successors. Consider, for example, the evolution of the Defining Issues Test, discussed infra, this Chapter.

Other criticisms of Kohlberg are that his theory focuses on cognitive development and ignores the influence of emotions in moral judgment. This, of course, was the central contribution of Hume to moral theory, who argued that passion was as much a motivator in ethical decision-making as was the rationality of Kant's theory (Fleming; Dunbar; Greene et al.; Haidt). Kohlberg's theory also fails to account for the fact that moral understanding does not always lead to moral action; ethical decision making is

situational and other factors, including emotions, can and do impact actions. Similarly, Kohlberg assumed that his stages of moral development were universal among all populations even though critics point out that, for example, his Level III Postconventional Morality reflects Western Enlightenment values that are not necessarily globally held or given the same priority among all cultures (Fleming).

Rest, who adheres to most of the foundational principles of Piaget and Kohlberg, nevertheless acknowledged these weaknesses in their theories (Rest et al. 644–645) and tried to account for them in his Four Component Model of moral behavior (Rest, *Moral Development: Advances in Research and Theory*). This model posits that ethical behavior and decision-making is comprised of four distinct and independent elements: (1) ethical sensitivity – how the person interprets the situation to recognize that there is an ethical problem, (2) ethical judgment or reasoning – how the person figures out what the morally ideal course of action is, (3) ethical motivation and commitment – how does the person decide what to do, and (4) ethical character or moral courage – whether the person actually does what he or she intends to do (Rest and Barnett; Rest, “A Psychologist Looks at the Teaching of Ethics”). Rest recognized that what people think they should do is not always the same as what they decide to do (or what they actually do) and that differing values and priorities of values play an important role and, at the same time, contribute to the problem of designing decision-making models (Rest, “A Psychologist Looks at the Teaching of Ethics” 33). Rest adopts what he describes as a “Neo-Kohlbergian” approach toward both the theory of moral development and, importantly for my purposes in this dissertation, the measurement of moral judgment or ethical reasoning (Rest et al. 644–645; Thoma). He was a principal in the development

of the Defining Issues Test and the successor Defining Issues Test-2, tests designed to measure ethical judgment.

Huff and Frey are critical of Kohlbergian and Neo-Kohlbergian theories. They give Neo-Kohlbergians – and this refers primarily to Rest – credit for recognizing the complexity of moving from perception of a moral issue to moral action but they also critique the Neo-Kohlbergian approach for its shortage of data on any aspect of the Four Component Model other than ethical judgment or reasoning (390). Huff and Frey consider that we are now in a “Post-Kohlberg” era where new theories of moral development are being proposed based on new data. They cite Haidt who proposes a “two-process” theory that involves both conscious (rational) and non-conscious (emotional or intuitive) processing in ethical decision-making (393, citing Haidt). Haidt’s work is significant because it brings emotion back into prominence in ethical decision-making theory. As Huff and Frey point out, this has important implications for how we teach professional ethics. Reason-based approaches (deontology, utilitarianism, virtue) appeal to and influence the conscious or rational part of decision-making. But if we want to target the intuitive process and aim for persuasion, the more effective instructional approaches would be methods that employ analogy, metaphor, and narrative (393) - rhetoric. It’s important to add that, although Huff and Frey critique Kohlbergian and Neo-Kohlbergian theories as somewhat outdated, they do not reject them outright. For example, they cite approvingly a study that uses the DIT (developed in part by Rest) to show that an ethics course can improve moral reasoning, thereby arguing that moral pedagogy is worth the effort (394).

As Huff and Frey note, there is little data on measuring aspects of moral development other than the second component of Rest's Four Component Model of moral behavior, that is, moral judgment or ethical reasoning. This data centers on the development and use of the Defining Issues Test (DIT) and the newer Defining Issues Test-2 (DIT-2), which were designed for the purpose of quantitatively measuring ethical reasoning skills. The DIT was first published in 1974 by researchers at the Center for the Study of Ethical Development, then located at the University of Minnesota. The DIT was used for 25 years before it was revised and replaced by the Defining Issues Test-2 (DIT-2). The DIT-2 was developed in response to several issues identified by the developers themselves. They cite three reasons for revising the DIT: (1) outdated dilemmas and language (referencing, for example, the Vietnam War and referring to Asian Americans as "Orientals"), (2) discovery of a more accurate calculation of a developmental score – the N2 score – that would replace or supplement the DIT "P" score, and (3) development of better ways to check for participant reliability and get rid of bogus data (Rest et al. 647).

The DIT-2 is a multiple choice test that consists of a set of five non-engineering-specific scenarios presenting various ethical dilemmas without obviously right answers. These dilemmas concern (1) famine where a father considers stealing food from a rich man's warehouse in order to feed his starving family, (2) a reporter must decide whether or not to report a controversial story about a political candidate that could impact the politician's career, (3) a school board has to decide if it will hold a public meeting over a controversial issue that could end up hostile and dangerous, (4) a doctor has to decide whether to give an overdose of a painkiller that could kill the terminal patient, and (5) an issue involving students demonstrating on campus against U.S. foreign policy (Rest et

al. 649). The DIT-2 is included in its entirety in Appendix C. In addition, participants are asked to agree or disagree with several controversial public policy issues (abortion, euthanasia, homosexual rights, due process, women's roles, and religion in public schools issues), and they answer questions about their religious ideology, political identity, demographics – age, religious affiliation, whether U.S. citizenship, and whether English is the participant's first language; gender is asked but is collapsed for analysis because the data has shown that gender does not make a significant difference in terms of participants' responses (Rest et al. 649–650).

The DIT-2 analysis gives two principal scores, the P (which aligns with Kohlberg's "Post Conventional" or "principles reasoning") score and the N2 score, both of which quantitatively measure the participant's ethical or moral reasoning skills (Thoma 2006; Rest, et.al 1999). The N2 is designed to provide a better measure of ethical reasoning than does the P score; however the DIT-2 continues to report both P and N2 scores for comparison. As Rest, et al. describe it, the "N2 index takes into account preference for postconventional schemas and rejection of less sophisticated schemas, using both ranking and rating data" (649). A detailed explanation of the N2 score is beyond the scope of this dissertation (but see Rest et al.; Thoma for a description of the design and interpretation of the N2 and other DIT-2 scores). In addition to the P and N2 scores, the DIT-2 provides a Personal Interest score and a Maintain Norms score. These two scores align, respectively, with Kohlberg's Stages 2/3 and Stage 4 levels of moral development. It is expected that, as P and N2 scores rise, indicating a person has achieved higher levels of moral development, Personal Interest and Maintain Norms scores will go down.

The DIT and DIT-2 have been validated and are used extensively by researchers and educators for the purpose of measuring ethical reasoning skills, including the ethical reasoning skills of engineering students (Thoma; Self and Ellison; Drake et al.; Finelli et al., "An Assessment of Engineering Students' Curricular and Co-Curricular Experiences and Their Ethical Development"). Its chief advantages are that it is a self-administered test that is objectively scored and that the Center for the Study of Ethical Development has compiled tens of thousands of participant data across all age ranges and educational levels so that scores can be compared to this national database (Rest and Narvaez; Shawver and Sennetti). It has also proven its validity and reliability for use in assessing the effects of educational interventions such as ethics education (Drake et al. 6).

But the DIT and DIT-2 are not without their critics (Rizzo & Swisher 2004). Most of the criticism is directed toward the original DIT and less so toward the DIT-2 because the DIT-2 was revised in response to many of the criticisms of the DIT. For example, Drake et al. credit the DIT-2 with recognizing that moral development is more integrative and doesn't go through distinct "self-contained stages." At the same time, the DIT-2 allows a researcher to see which of the four scheme (personal interest, maintain norms, postconventional, N2) is dominant in a participant's moral reasoning. Additionally, the DIT-2 goes beyond Kohlberg's principled reasoning about justice as the highest level of moral development. The DIT-2 responds to the criticism of people such as Gilligan and is designed to take into account the fact that moral thinking is driven by more than just rational, principle-based reasoning. Accordingly, the DIT-2 claims to no longer privilege any particular moral theory (Drake et al. 6–7).

But the revised DIT-2 did not quell all criticism. Shawver and Sennetti identify seven limitations of the DIT-2: (1) the dilemmas used in the test are “fixed and limited”, (2) the test is non-discipline specific, (3) it creates a “one dimensional score” that cannot validly be used as (4) a “valid pretest/post test measurement of the same respondent,” (5) it measures only the first two of Rest’s Four Component Model, that is, ethical sensitivity and ethical judgment, (6) it is subject to “gender, geographic, religious, and discipline-related biases,” and (7) it may not be reliable to measure cognitive moral development in persons under age 20 because they would not likely show sufficient variation in scores at this young age (664; see also Rizzo and Swisher). Nucci argues that the DIT-2 may be useful for research and practice in ethics pedagogy, but it is unsuited for basic research in the field of moral development – he argues that research methods in one paradigm are not suited to another paradigm. Moreover, because the DIT-2 follows Kohlbergian theory on moral development, he is concerned that there is a risk of reification of that method and that researchers will fail to explore new directions and alternatives (Nucci 317–318, 323).

The concern that the DIT-2 is non-discipline specific is expressed within engineering. Anecdotally, I work with faculty teaching a first year Engineering Fundamentals course. We are implementing and testing a revised ethics module used in a course taken during the first semester by entering undergraduate engineering students. The course is taught by several faculty who use the same curriculum. Among the measures we want to use for testing student outcomes among pilot and control groups of students is the DIT-2 However, several faculty refused to have their students use their time taking the DIT-2

because the dilemmas were not engineering related. Their rationale was that the students would not learn anything about engineering from taking the DIT-2.[12]

In response to these criticisms, alternative measures of ethical reasoning are being designed, tested, and introduced. Borenstein, et al. developed the Engineering and Science Issues Test (ESIT) that uses job-related ethical dilemmas from science and engineering, rather than the non-engineering-specific problems of the DIT-2, to measure moral judgment (Borenstein et.al 2010). Purdue University has developed an Engineering Ethics Reasoning Instrument (EERI) that also uses engineering job-related scenarios to quantitatively measure the ethical reasoning skills of undergraduate engineering students. The EERI is still being tested for validity and reliability (Michigan Tech is a partner institution helping with the testing and validation of the EERI). Neither the ESIT nor the EERI is available for general use at this time. New instruments continue to be developed and tested. Funding from agencies such as NSF provides important support for this work.

Notwithstanding its inadequacies and detractors, the DIT-2 remains the dominant available quantitative test of ethical reasoning. It continues to be used by researchers to measure ethical reasoning. For example, the SEED study, which tested the ethical reasoning skills and professional ethics knowledge of approximately 4000 undergraduate engineering students across 18 engineering programs in the U.S., used

[12] I note, however, that when we replaced the DIT-2 with the Engineering Ethics Reasoning Instrument (EERI) being developed by Purdue University (Michigan Technological University is participating in the study as one of the research sites) – the EERI also uses narrative ethical dilemmas but they are all related to issues that an engineer may encounter on the job – the same faculty still chose not to ask their students to take the test. So that begs the question about the importance of the test being engineering-related versus the time commitment required for students to take the test – about an hour for either the DIT-2 or the EERI. I also note that the purpose of either test is not to teach engineering ethics but to measure ethical reasoning skills.

the DIT-2 as the measure of ethical reasoning skills. When I began my research into the potential of phenomenology to inform engineering ethics pedagogy in 2011, the DIT-2 was the only instrument widely-available nationally. As mentioned, it has the advantage of a national database of tens of thousands of participant results. At the time, it was the best choice for my work. I continue to use it because it is probably as good as any other measure of ethical reasoning and because I can maintain consistency in my data from one year to the next. While objections may be raised that it is non-discipline specific, I don't consider this a serious problem. Students are as able to apply ethical reasoning to a famine problem as they are to an engineering design problem. I understand and accept that the DIT-2 has limitations in what it can measure (ethical sensitivity and reasoning), and my use of the instrument is confined to those measurements. I am willing to use other instruments such as the EERI in the future but, for my research here, I chose to use the DIT-2.

The DIT-2 is proprietary. It is owned and administered by the Center for the Study of Ethics at the University of Alabama. The DIT-2 is administered locally using Survey Monkey. Data is then compiled and sent to the Center for analysis. The Center issues a report with its analyses. Data is returned in SPSS format so that we can conduct additional tests on our own for correlations (based, for example, on demographic data) or for statistical significance (for example, comparing pre and post test results).
Even though improvement in and measurement of ethical reasoning is not the primary focus of my work, it remains an informative component. If the emotional engagement and understanding of professional and ethical responsibilities of my students improves, it would be logically consistent that their ethical reasoning skills would improve as well.

After all, using Kohlberg's theory, ethical reasoning is earlier stage of and necessary precursor to higher level moral development. I would not expect to find significant emotional engagement and understanding of ethics but decreased ethical reasoning skills; if that happened, it would be an indicator that something is amiss. So there should be a positive correlation between increased emotional engagement and understanding of professional and ethical responsibility and improved ethical reasoning skills. Of course, the reverse is not true – higher ethical reasoning skills do not necessarily lead to greater emotional engagement as observed, for example, by Newberry in his engineering ethics classroom (Newberry).

Ethical Sensitivity and its Measurement:

Ethical sensitivity, as used here, is not the same as it is used by Rest in the Four Component Module. For Rest, ethical sensitivity is more narrowly construed as the ability to recognize the presence of an ethical dilemma. Narváez describes a richer and broader scope of ethical sensitivity, one that includes seven skills: (1) understanding /reading and expressing emotions, (2) taking the perspectives of others, (3) caring by connecting to others, (4) working with interpersonal and group differences and responding to diversity (5) preventing or controlling social bias, (6) generating interpretations and options, and (7) communicating effectively (previously, identifying the consequences of actions and options) (Narvaez and Endicott; Narvaez 717). This is the type of ethical sensitivity I want to test and measure.

Researchers and educators are increasingly concluding that ethical sensitivity may be a more important indicator of ethical decision-making and behavior than ethical reasoning

as measured by the DIT-2 (Clarkeburn 2002). According to Narváez, ethical sensitivity is the most important of the four skills generally associated with moral development (ethical sensitivity, ethical judgment, ethical motivation, and ethical action): “Ethical sensitivity is the emphatic interpretation of a situation in determining who is involved, what actions to take, and what possible reactions and outcomes might ensue” (Narvaez and Endicott). So there is a growing demand for tests to measure ethical sensitivity as a learning outcome for students, and considerable efforts are going into developing such tests. Kuusisto, et al. used Narváez’s seven-dimension skillset for ethical sensitivity to create the quantitative Ethical Sensitivity Scale Questionnaire (ESSQ) and analyzed its psychometric qualities by testing it with Finnish teachers (Kuusisto, Tirri, and Rissanen). The developers consider the ESSQ to be an instrument that can be used “in all contexts and can be employed as a self-evaluation tool” (Kuusisto, Tirri, and Rissanen 2; Gholami and Tirri).

Shawver and Sennetti used the Multidimensional Ethics Scale (MES) (Reidenbach & Robin 1990) to develop a Composite MES that uses Likert-type scale measures to explain ethical evaluations and moral reasoning of accounting students responding to short ethical vignettes (Shawver & Sennetti 2009). Clarkeburn developed the Test for Ethical Sensitivity in Science (TESS) to assess the impact of a short ethics course on the ability of students to recognize ethical problems (Clarkeburn 2002). Building on Clarkeburn’s work, Swann, et al. developed the Test of Ethical Sensitivity in Science and Engineering (TESSE). Recently, Davis and Feinerman developed and tested a “proof of concept” ethical sensitivity pre- and post-test to assess progress in ethics sensitivity among engineering graduate students but concluded that the type of testing used (short

answers to ethic-related questions in a non-engineering course; answers were quantitatively scored) was too unreliable without any control over what was being taught across many engineering courses (Davis and Feinerman 2010).

My interest was in testing more than the ability to recognize ethical problems, so the ESSQ, because it is grounded in the seven skills associated with ethical sensitivity that were identified by Narváez, seemed to offer the possibility of testing ethical sensitivity from a broader scope, one that also had potentially overlapping elements with both ethical reasoning and emotional engagement. The ESSQ is a 28-item questionnaire that is divided into seven sections corresponding to Narváez's seven skills of ethical sensitivity. Participants rate themselves on a Likert scale of 1 (low) to 5 (high). The ESSQ is included in Appendix D. I had at first considered using the Test of Ethical Sensitivity in Science and Engineering (TESSE) – a more limited test of ethical sensitivity designed to test the ability to spot ethical issues in science and engineering contexts – but was advised, when I contacted its developers at Georgia Institute of Technology, that the instrument has not been fully developed and seems to be at a standstill with no plans to move forward. I was welcome to use the instrument, I was told, but no one would be able to provide guidance in the interpretation of results. So I didn't pursue that option. I chose to use only the ESSQ. I administered, compiled, and analyzed the ESSQ survey data.

Emotional Engagement and Understanding of Professional and Ethical Responsibilities and their Measurement:

Most research and assessment concerning the effectiveness of engineering ethics education excludes anything beyond the quantitative measurement of ethical sensitivity and ethical reasoning. This aligns squarely with Kohlbergian thinking about moral development and ignores the role of emotion in ethical decision-making and behavior. It also assumes that learning about ethics is purely cognitive or, at a minimum, that development of cognitive skills is the most important academic outcome for students. In terms of engineering ethics, this would assume that engineering ethics instruction is about students being able to recognize ethical problems, know the applicable rules and decision-models, apply them to an engineering ethical problem, and arrive at and justify an ethically-acceptable resolution (see, for example, Davis and Feinerman; Sindelar et al.). These approaches ignore the value of emotional engagement of students and its role in achieving student learning outcomes. There is an extensive body of educational and psychological research that demonstrates the connection between student engagement and student success. My purpose here is not to review this vast field of work. I take it as proven. Rather, I will consider two recent studies that together build a persuasive case for the importance of generating student emotional engagement in order to achieve student learning outcomes at the college level. More relevantly, these studies became a catalyst that shifted my focus from emotional engagement as an end in itself – an outcome to be achieved – to emotional engagement as a *mediator* of learning outcomes.

Handelsman, et al., whose research arose out of their frustration with teaching lower level undergraduate courses, asked this question: “How do we optimize the learning environment and outcomes?” (184). They review prior research on student engagement and general findings that affirmed “engaged students are good learners and that effective teaching stimulates and sustains student engagement” (184). But they also conclude that college level studies of student engagement had addressed the “macro level”, that is, institutional levels rather than individual courses. So their work undertook to examine student engagement at the coursework level with the intent to improve the courses they taught. They approached “engagement” as a “multidimensional” phenomenon that has both behavioral and emotional (affective) elements. They developed and tested the Student Course Engagement Questionnaire (SCEQ). The SCEQ asked participants to rate their responses to multiple behaviors and attitudes associated with engagement on a scale of 1 (not at all engaged) to 5 (very characteristic of me). There were additional questions related to their specific classes, their attitudes toward incremental theory (the idea that learning is not fixed), and their personal goal orientation. Using factor analysis, Handelsman, et al. identified four internally consistent engagement factors: skills engagement, emotional engagement, participation/interaction engagement, and performance (academic achievement) engagement. The researchers consider their work to be preliminary (the sample sizes were small and not randomly selected) and they draw no conclusions about causation. But one of the important findings to emerge was that, while all four of these engagement sub-types were positively associated with academic achievement, only emotional engagement was positively associated with the intrinsic outcomes of learning, in other words, students valued learning for its own sake rather than as a way to achieve grades or other extrinsic

goals (190). This correlation between emotional engagement and *learning* – as opposed to academic achievement or grades – was the strongest correlation found among the four factors. Their results suggest that college instructors who want to see improved student *learning* – something other than grades – may do well to foster emotional engagement of their students in the classroom.

Sagayadevan and Jeyaraj built on the work of Handelsman, et al. They define engagement as "the connection between an individual and the activity in which one is involved" and identify engagement as a "multidimensional construct consisting of three main sub-types: behavioral, emotional, and cognitive engagement" (1-2). Of these three sub-types, the researchers note that emotional engagement receives the least attention, in part, because it may be the most difficult to study and measure. They further divide the effects of emotional engagement into academic achievement marked by grades and standardized achievement tests and academic *learning.* They note that here, too, research has focused primarily on the impact of engagement on achievement outcomes, rather than learning, because grades are an easily obtained and applied standard of measurement. They also observe that prior studies typically combine all three engagement sub-types so that evidence of the influence of any one sub-type is inconclusive. Sagayadevan and Jeyaraj chose to study emotional engagement only. They proposed to test three hypotheses: (1) whether students who report that they have good interaction with their lecturer will have higher levels of emotional engagement than students who report poor interaction with their lecturer; (2) whether students who report good interaction with their lecturer will be more likely to have higher academic achievement (i.e., grades) than students who report poor interaction; and (3) whether

emotional engagement impacts lecturer-student interaction and academic achievement and/or lecturer-student interaction and student learning. They used multiple quantitative methods including questionnaires and grades (5-6) to test these hypotheses. Their findings affirmed hypothesis 1, that students who report good interactions with their lecturer have significantly higher levels of emotional engagement than students who report poor relationships. This was not a surprise. But they found that, as to hypothesis 2, students who reported good interactions with their lecturers did not achieve better grades than those who reported poor interaction. Finally, as to hypothesis 3, Sagayadevan and Jeyaraj concluded that emotional engagement had "no significant impact on *academic* achievement, but *significant impact on student learning outcomes*" (15, emphasis added), suggesting that instructional methods should include ways to enhance emotional engagement in order to maximize student learning (16).

The significance of these findings on my research is that I moved from an emphasis on emotional engagement as an *outcome* to emotional engagement as a *mediator* of student learning. The implication for my engineering ethics class is that I realized emotional engagement was not what I needed to measure. Rather, although I wanted to create a classroom environment that enhanced emotional engagement and, therefore, student learning, in the end, the learning outcome that I wanted my students to achieve and that I needed to assess was ABET's Engineering Criterion 3(f): "an understanding of their professional and ethical responsibility" That, after all, is what I am charged with accomplishing in this class. I previously examined how this criterion has been interpreted for assessment by various engineering programs and by ethics educators/scholars (see Table 1.1 in Chapter One). My observation was that no one has hit upon the essence of

what is or ought to be meant by this criterion and how its achievement can be meaningfully assessed or measured. So I now address what is meant by an "understanding of professional and ethical responsibilities" and how can we assess whether students have attained such understanding.

ABET offers little help. Terminology used by ABET is vague and undefined (Felder and Brent 7). Before ABET EC 3(f) was adopted in 2000, Harris, et al. distinguished between morality – where the standards of ethical behavior apply to everyone – and professional ethics – where the rules of ethical conduct apply to members of a group simply because they belong to that group. So, in the case of engineering ethics, the proper and limited focus of teaching should be on standards of conduct that apply to engineers because they are engineers ((Harris et al. 93). This focus hasn't necessarily changed since the adoption of EC 3(f). Davis and Feinerman, writing in 2010, continue to limit the study of engineering ethics to "those (morally permissible) standards of conduct that apply to members of a group simply because they are members of that group (and to the conduct those standards make appropriate). Engineering ethics is for engineers because they are engineers; research ethics is for researchers because they are researchers; and so on. We are not here concerned with ordinary morality as such or moral philosophy as such (two other senses of 'ethics')" (Davis and Feinerman 2). Pfatteicher advises that ethics instructors should "teach" rather than "preach." She offers three objectives for undergraduate engineering ethics education: provide students with "an understanding of the *nature* of engineering ethics", "an understanding the of *value* of engineering ethics, as opposed to the values of an ethical engineer", and "an understanding of the *resolution* of problems in engineering ethics" (Pfatteicher 138, emphasis in original). This means

that instructors should teach and evaluate students on their knowledge and skills, and not what they think about values or ethics (Sindelar et al. n.p.; Pfatteicher 138).

Pfatteicher refers to "understanding" in each of the three goals, but her emphasis is on what needs to be understood (which, I admit, is not unimportant) rather than on what constitutes "understanding." I think it's a fair characterization to say that most engineering ethics instruction focuses on the *what* – ethical knowledge and skills that engineering students are expected to demonstrate, rather than on their *understanding* of professional and ethical responsibilities. I contend that the explicit language of ABET EC 3(f) encompasses more than the "what." My thesis for what follows is that an "*understanding* of professional and ethical responsibility" is meaningful as a learning outcome for engineering students only when it is taken as a hermeneutic, prejudice-risking, dialogic, and "horizon-fusing" experience as explicated by Gadamer. Gadamer described the immanent conditions under which understanding takes place and the nature of what happens as understanding occurs. I posit that we can use this framework as a useful way to think about what an "understanding of professional and ethical responsibility" is and should be for engineering students and to help reveal evidence that students have achieved this understanding. I propose that a philosophical hermeneutic approach to assessment can be used, not only in this instance, but for the qualitative assessment of a wide range of student learning outcomes.

Hermeneutic phenomenology is a research method often used in educational research to investigate and understand experiences of students, teachers, and others who work in education (see, for example, *Hermeneutic Phenomenology in Education: Method and*

Practice; Cole). Neither hermeneutics nor phenomenology of any kind is regularly employed as a method for assessment of learning outcomes. Gadamer himself does not offer any "method" of philosophical hermeneutics (Schwandt, "Three Epistemological Stances for Qualitative Enquiry" 196). As Gadamer writes, "[I]t follows that [the work of hermeneutics] is not to develop a procedure of understanding, but to clarify the conditions in which understanding takes place" (Gadamer, *Truth and Method* 295). I propose, however, that the core work of hermeneutics, which is to explain the conditions for understanding – the conditions that are essential for understanding to take place at all – can be adapted into a set of markers that, when used to assess written student narratives, can reveal whether students have achieved an understanding of what they have studied. These markers need not be specific to a particular classroom or subject matter because the markers of understanding are universal. Rather, the instructor or assessor, by reading for evidence of the markers in the students' written work, can determine if understanding of particular subject matter has occurred.

Solloway and Brooks designed a model for assessment of student learning based on Gadamer's philosophical hermeneutics and, in particular, his concepts of *erlebnis* and *erfahrung*. *Erlebnis* is "something experienced in the moment and experienced in the moment as a jolt out of the ordinary, out of the familiar which awakens us to ourselves in a way we have not been awakened before" (Solloway and Brooks 46). Gadamer likens this to an adventure which "interrupts the customary course of events" as compared to an "episode" which is routine and not normally of any unusual significance (Gadamer, *Truth and Method* 69–70). *Erfahrung* is our way of being in the world, a very condition of our being, and "a basic structure of our experience of life" (Schwandt, "Three

Epistemological Stances for Qualitative Enquiry"; Solloway and Brooks 194). It is how we use experience and how we become experienced. Gadamer writes:

> The truth of experience always implies an orientation toward new experience. That is why a person who is called experienced has become so not only *through* experiences but is also open *to* new experiences. The consummation of his experiences, the perfection that we call "being experienced," does not consist in the fact that someone already knows everything and knows better than anyone else. Rather, the experienced person proves to be, on the contrary, someone who is radically undogmatic; who, because of the many experiences he has had and the knowledge he has drawn from them, is particularly well equipped to have new experiences and to learn from them. The dialectic of experience has its proper fulfillment not in definitive knowledge but in the openness to experience that is made possible by experience itself (350).

Solloway and Brooks provide a compelling argument for why Gadamer's philosophical hermeneutics offers a framework of assessment that better reveals student understanding than traditional assessment based on quantitatively measurable standards:

> Traditionally, assessment is disconnected from learning. The event usually requires an engagement of verbal linguistic or logical mathematical knowledges and demands that idiosyncrasies of personal relevance, cultural context, and historical context be eliminated. The assessment is disconnected from the learner. She leaves the event none the wiser as to how these knowledges have affected the meaning and purpose of her existence; she has not been invited to confront her own being in the space of a dialectical experience of the Other.
>
> A model of assessment that takes *erlebnis/erfahrung,* the hermeneutic imagination, as a framework for identifying what counts as evidence of learning would look for ways to engage the student more holistically. Such a model would allow the student to bring his personal history to the table. It would encourage the recognition of how knowledge is embodied rather than stored. It would encourage the exploration of the encounter with a text as an embodied experience. It would not ask for evidence of learning as a replication of what the dominant tradition already knows. It would instead suggest that learning be evidence that the student encountered the text as an aesthetic experience, evidence that the student's hermeneutic imagination came into play in the encounter (51).

Gadamer's conception of understanding rejected the Cartesian subject-object dichotomy. Interpretation and understanding were no longer conceived as a subject interpreter approaching an object text in order to discern or "understand" the objective meaning given it by the author, and such understanding then being added to the accumulated knowledge of the subject. Instead, "understanding *is* interpretation" (Schwandt, "Three Epistemological Stances for Qualitative Enquiry" 194) – we cannot understand without interpreting. Moreover, understanding and interpretation "has the nature of a dialogue in which the meaning of a text emerges through a conversation between the interpreter and the text . . . in which the interpreter puts questions to the text, and the text, in turn, puts questions to the interpreter. The questions put by the text challenge the truth of the interpreter's prejudices. The goal of this dialogue between the interpreter and the text (i.e., the goal of interpretation) is to find those questions to which the text constitutes the answers. . . . Indeed, it is only by finding out such questions that we can genuinely understand a text (as "logical," "reasonable," etc.), and not dismiss it as nonsense" (Prasad 20). This hermeneutic dialogue – which takes an interpreter as always already located within a foregrounded horizon with all one's biases and prejudices (Gadamer, *Truth and Method* 303), who encounters a new or alien text and is open to testing or risking one's existing horizon, enters into a conversation with the text and, through interpretation, and comes to a new understanding – is a "fusion of horizons" – a new horizon because the interpreter's foregrounded horizon has now changed. This is our ever-going process and our way of being (Prasad).

What, then, are these markers or conditions of understanding that can guide assessment of student learning? I suggest four: (1) a foregrounded horizon wherein are

found one's biases and prejudices, (2) an openness to engaging and placing those biases and prejudices at risk, (3) a dialogical encounter or conversation with a "text," and (4) interpretation and emergence of a new understanding or a "fusion of horizons." If we can locate evidence of these markers within the narratives written by students, I suggest we can be confident that understanding has occurred and that students have achieved understanding as a student learning outcome. I'll examine each of these within the theoretical grounding of Gadamer's philosophical hermeneutics and discuss how these markers or conditions of understanding would apply to assessment of undergraduate engineering students' understanding of professional and ethical responsibilities.

A foundational element of Gadamer's theory of hermeneutic experience is the *hermeneutic "horizon."* Gadamer describes it as follows:

> The horizon is the range of vision that includes everything that can be seen from a particular vantage point. Applying this to the thinking mind, we speak of narrowness of horizon, of the possible expansion of horizon, of the opening up of new horizons, and so forth. . . . A person who has no horizon does not see far enough and hence over-values what is nearest to him. On the other hand, "to have a horizon" means not being limited to what is nearby but being able to see beyond it. A person who has an horizon knows the relative significance of everything within this horizon whether it is near or far, great or small. Similarly, working out the hermeneutical situation means acquiring the right horizon of inquiry for the questions evoked by the encounter with tradition (301-302).
>
> The concept of "horizon" suggests itself because it expresses the superior breadth of vision that the person who is trying to understand must have. To acquire a horizon means that one learns to look beyond what is close at hand – not in order to look away from it but to see it better, with a larger whole and in truer proportion (304).

This hermeneutic horizon, in other words, is the foreground that exists for all of us at any given moment. It is "always already" there. Essentially, our horizons are "determined by *the prejudices* that we have. These prejudices constitute, then, the horizon of a particular

present, for they represent that beyond which it is impossible to see” (Gadamer, *Truth and Method* 304). These prejudices, biases, and prejudgments arise out of our histories and traditions and, far from being things that we can rid ourselves of or distance ourselves from at will, they are integrally part of who we are. They “define the limits and the potentialities of our horizon of understanding (or our ‘hermeneutic horizon’). Hence, rather than being viewed as obstacles to understanding, prejudices need to be regarded as the necessary conditions of all understanding” (Prasad 18). That said, Gadamer does not sanction a free-for-all for all prejudices: “Thus we can formulate the fundamental epistemological question for a truly historical hermeneutics as follows: what is the ground of the legitimacy of prejudices? What distinguishes legitimate prejudices from the countless others which it is the undeniable task of critical reason to overcome?” (Gadamer, *Truth and Method* 278). Legitimate prejudices are those that contribute to understanding and the “countless others” are those that impede or prevent understanding. “It is the tyranny of hidden prejudices that makes us deaf to what speaks to us in tradition” (272). “The point is not to free ourselves of all prejudice, but to examine our historically inherited and unreflectively held prejudices and alter those that disable our efforts to understand others, and ourselves” (Schwandt, "Three Epistemological Stances for Qualitative Enquiry”; see also Garrison). This is not a simple matter, to be sure. “The prejudices and fore-meanings that occupy the interpreter’s consciousness are not at his free disposal. He cannot separate in advance the productive prejudices that enable understanding from the prejudices that hinder it and lead to misunderstandings. Rather, this separation must take place in the process of understanding itself” (Gadamer, *Truth and Method* 295).

We gather from this that foregrounded horizons are never fixed and unchanging. “In fact the horizon of the present is continually in the process of being formed because we are continually having to test all our prejudices” (Gadamer, *Truth and Method* 305). And so the second condition of understanding is an *openness to engaging and putting those biases and prejudices at risk.* Unless we are open to contesting our prejudices, understanding cannot take place. “The fact that we ‘belong’ to tradition and that tradition in some sense governs interpretation does not mean that we merely reenact the biases of tradition in our interpretation. Although preconceptions, prejudices, or prejudgments suggest the initial conceptions that an interpreter brings to the interpretation of an object or another person, the interpreter risks those prejudices in the encounter with what is to be interpreted” (Schwandt, "Three Epistemological Stances for Qualitative Enquiry" 195). Gadamer explains: “All that is asked is that we remain open to the meaning of the other person or text. But this openness always includes our situating the other meaning in relation to the whole of our own meanings or ourselves in relation to it. . . . [A] person trying to understand a text is prepared for it to tell him something. That is why a hermeneutically trained consciousness must be, from the start, sensitive to the text’s alterity. But this kind of sensitivity involves neither ‘neutrality’ with respect to content nor the extinction of one’s self, but the foregrounding and appropriation of one’s own fore-meanings and prejudices. The important thing is to be aware of one’s own bias, so that the text can present itself in all its otherness and thus assert its own truth against one’s own fore-meanings” (Gadamer, *Truth and Method* 271–272). Gadamer compares the openness of hermeneutical experience to what he calls the “I-Thou” relationship: “Openness to the other, then, involves recognizing that I myself must accept some things that are against me, even though no one else forces me to do so” (355).

Our prejudices are put at risk in the course of a "*dialogical encounter* with what is not understood, with what is alien, with what makes a claim upon us" (Schwandt, "Three Epistemological Stances for Qualitative Enquiry" 195). Contrary to what is often an underlying approach in the teaching of texts, the meaning of a text is not fixed with only a single permissible or possible way to understand it. We must be open to this possibility when we encounter a text:

> The real meaning of a text, as it speaks to the interpreter, does not depend on the contingencies of the author and his original audience. It certainly is not identical with them, for it is always co-determined also by the historical situation of the interpreter and hence by the totality of the objective course of history. . . . [A]n author does not need to know the real meaning of what he has written; and hence the interpreter can, and must, often understand more than he. But this is of fundamental importance. Not just occasionally but always, the meaning of a text goes beyond its author. That is why understanding is not merely a reproductive but always a productive activity as well (Gadamer, *Truth and Method* 296).

The dialogical encounter is in the nature of a question and answer conversation. According to Gadamer, "[t]he hermeneutical task becomes of itself a questioning of things" (271):

> The close relation between questioning and understanding is what gives the hermeneutic experience its true dimension. However much a person trying to understand may leave open the truth of what is said, however much he may dismiss the immediate meaning of the object and consider its deeper significance instead, and take the latter not as true but merely as meaningful, so that the possibility of its truth remains unsettled, this is the real and fundamental nature of a question: namely to make things indeterminate. Questions always bring out the undetermined possibilities of a thing. That is why we cannot understand the questionableness of something without asking real questions, though we can understand a meaning without meaning it. *To understand the questionableness of something is already to be questioning.* There can be no tentative or potential attitude to questioning, for questioning is not the positing but the testing of possibilities.
>
> This is the reason why understanding is always more than merely re-creating someone else's meaning. Questioning opens up possibilities of meaning, and thus what is meaningful passes into one's own thinking on the subject (367-368).

Gadamer describes the qualities of hermeneutic questioning or dialectic: First, it is "reserved to the person who wants to know – i.e., who already has questions." Questioning is not the same as "resisting the pressure of opinion" or argumentation for the sake of winning a debate. Rather, "dialectic proves its value because only the person who knows how to ask questions is able to persist in his questioning, which involves being able to preserve his orientation toward openness. The art of questioning is the art of questioning ever further – i.e., the art of thinking. It is called dialectic because it is the art of conducting a real dialogue" (360).

This questioning is an interplay between the text and all that the interpreter already brings to the interpreting of the text, and this creates a "tension between the text and the present. The hermeneutic task consists in not covering up this tension by attempting a naïve assimilation of the two but in consciously bringing it out" (Gadamer, *Truth and Method* 305). This conversation between the interpreter and the text is where the interpreter brings his or her own preconceptions into play, puts them at risk, and allows the meaning of the text to "really be made to speak for us" (398).

> Hence the meaning of a text is not to be compared with an immovably and obstinately fixed point of view that suggests only one question to the person trying to understand it, namely how the other person could have arrived at such an absurd opinion. In this sense understanding is certainly not concerned with "understanding historically" – i.e., reconstructing the way the text came into being. Rather, one intends to *understand the text itself.* But this means that the interpreter's own thoughts too have gone into re-awakening the text's meaning. In this the interpreter's own horizon is decisive, yet not as a personal standpoint that he maintains or enforces, but more as an opinion and a possibility that one brings into play and puts at risk, and that helps one truly to make one's own what the text says. I have described this above as a "fusion of horizons." We can now see that this is what takes place in conversation, in which something is expressed that is not only mine or my author's, but common (Gadamer, *Truth and Method* 390).

Interpretation, understanding, and the "fusion of horizons" are not separable and distinct units of activity but comprise, instead, a seamless, ongoing, negotiated, and dialectic back-and-forth movement between the interpreter and a text. Gadamer writes repeatedly that understanding and interpretation are "indissolubly bound together" and that "understanding always includes interpretation" (*Truth and Method* 400). "Thus interpretation is not a means through which understanding is achieved; rather, it enters into the content of what is understood" (399). When we understand a text, we have actually created a new foregrounded horizon:

> In fact the horizon of the present is continually in the process of being formed because we are continually having to test all our prejudices. An important part of this testing occurs in encountering the past and in understanding the tradition from which we come. Hence the horizon of the present cannot be formed without the past. There is no more an isolated horizon of the present in itself than there are historical horizons which have to be acquired. *Rather, understanding is always the fusion of these horizons supposedly existing by themselves.*
>
> Projecting a historical horizon, then, is only one phase in the process of understanding; it does not become solidified into the self-alienation of a past consciousness, but is overtaken by our own present horizon of understanding. In the process of understanding, a real fusing of horizons occurs – which means that as the historical horizon is projected, it is simultaneously superseded (305-306).

The "fusion of horizons" is not unlike nuclear fusion in which atomic nuclei collide and join to form a new type of atomic nucleus. This is true in the sense that the new fused horizon emerges from but is not the same as either the previously foregrounded horizon or the text that was interpreted. However, we cannot predict what the fused horizon will be, only that it will never be the same for any two persons interpreting the same text. "[I]nterpretation in the medium of language itself shows what understanding always is:

assimilating what is said to the point that it becomes one's own" (Gadamer, *Truth and Method* 400).

> Understanding, like action, always remains a risk and never leaves room for the simple application of a general knowledge of rules to the statements of texts to be understood. Furthermore where it is successful, understanding means a growth in inner awareness, which as a new experience enters into the texture of our own mental experience. Understanding is an adventure and, like any other adventure is dangerous. . . . But. . . .[i]t is capable of contributing in a special way to the broadening of our human experiences, our self-knowledge, and our horizon, for everything understanding mediates is mediated along with ourselves (Schwandt 196, quoting Gadamer, *Reason in the Age of Science* 109-110).

That said, understanding is never a final, complete, certain, or correct interpretation:

> The text is made to speak through interpretation. But no text and no book speaks if it does not speak a language that reaches the other person. Thus interpretation must find the right language if it really wants to make the text speak. There cannot, therefore, be any single interpretation that is correct "in itself," precisely because every interpretation is concerned with the text itself. The historical life of a tradition depends on being constantly assimilated and interpreted. An interpretation that was correct in itself would be a foolish ideal that mistook the nature of tradition. Every interpretation has to adapt itself to the hermeneutical situation in which it belongs (Gadamer, *Truth and Method* 398).

Gadamer denies, however, that, because the fusion of horizons will be different for each individual interpreting a text in a particular situation, interpretation is thus relative or subjective:

> We saw that to understand a text always means to apply it to ourselves and to know that, even if it must always be understood in different ways, it is still the same text presenting itself to us in these different ways. That this does not in the least relativize the claim to truth of every interpretation is seen from the fact that all interpretation is essentially verbal. The verbal explicitness that understanding achieves through interpretation does not create a second sense apart from that which is understood and interpreted. The interpretive concepts are not, as such, thematic in understanding. Rather, it is their nature to disappear behind what they

> bring to speech in interpretation. Paradoxically, an interpretation is right when it is capable of disappearing in this way. And yet at the same time it must be expressed as something that is supposed to disappear. The possibility of understanding is dependent on the possibility of this kind of mediating interpretation (399).

Philosophical Hermeneutics as a Paradigm for the Assessment of Understanding Professional and Ethical Responsibilities:

For assessment purposes, faculty should not assume (or fear) that a qualitative interpretive method requires special skills that they do not already use in grading non-quantitative work. This is as true for engineering (STEM) faculty as it is for non-STEM faculty. As Goldman argues, engineering is inherently a value-laden profession, and the decisions engineers make in the daily course of their practices are almost always made in the realm of uncertainty and speculation. Yet, judgments must be made about how to proceed. This happens in the engineering classroom as well. Students are involved in the often ambiguous and largely uncertain work of engineering design; yet engineering faculty routinely evaluate and grade non-quantitative student work. From a practical perspective, a philosophical hermeneutic assessment approach requires a modification in what we are looking for, not a paradigm shift.

I propose that, if we can locate evidence of these four markers of hermeneutic understanding – (1) a foregrounded horizon characterized by the interpreter's biases and prejudices (2) an openness to engaging and placing those biases and prejudices at risk, (3) a dialogical encounter or conversation with a "text" (4) interpretation and emergence of understanding or a "fusion of horizons" – within the narratives written by students, we can then make an authentic assessment or judgment about whether students have

achieved an understanding of professional and ethical responsibilities. Before I discuss how we can use these markers, some foregrounding comments are needed. First, method and rigor are not disregarded. I will explain in detail the methods used in the assessment process later in this chapter. Because this project is also a research inquiry into whether a philosophical hermeneutic approach can be effectively used for assessment of student understanding, there will be more to the process than if this were a pure assessment project. For now I stress that the assessment method is necessarily interpretive and uses interpretive methods essential to qualitative research to arrive at themes that can reveal student understanding. This is a process of understanding in its own right because it requires a constant movement – an interpretive conversation – by the interpretive researcher/assessor between the coded and themed data and the narrative "texts" themselves, i.e., the narratives written by the students.

Second, just as understanding is not a sequential process with discrete units of activity, so the expressions of understanding written by the students do not align linearly with each of the four markers of understanding. Gadamer explained that "how hermeneutics works" can be envisioned as a hermeneutic circle: "We recall the hermeneutic rule that we must understand the whole in terms of the detail and the detail in terms of the whole. This principle stems from ancient rhetoric, and modern hermeneutics has transferred it to the art of understanding. It is a circular relationship in both cases. The anticipation of meaning in which the whole is envisaged becomes actual understanding when the parts that are determined by the whole themselves also determine this whole" (Gadamer, *Truth and Method* 291). So it is with understanding and interpreting these student essays. We must understand and allow that the interpretive assessment of these essays

mirrors the hermeneutic circle in that the whole and the parts are all in play simultaneously and inseparably. What this means is that the four markers of understanding are not likely to appear as discretely identifiable and sequential "steps" in students' essays because that is not how understanding occurs and it is not how understanding is expressed.

Third, I suggest that a philosophical hermeneutic approach for assessment of student understanding of professional and ethical responsibilities may be the best, and perhaps the only, means to acquire authentic feedback about what students are actually getting from the course. In the classroom, the traditional measures of ethics have focused on objective knowledge of codes and ethics theories and the skill of being able to pull out the relevant rule and apply it (usually by using a heuristic or decision-making model) to an engineering ethics problem. Most of the answers will look the same, and that is the expectation. Assessment by engineering programs and by institutions to ascertain if students are achieving academic learning outcomes often takes the form of "rubrics" or what has been referred to as the "quantitization" of data, a sort of hybrid between qualitative and quantitative assessment (Borrego, Douglas, and Amelink 59). The traditional approach is to develop and use an assessment rubric designed to minimize and control interpretation as much as possible by providing guidelines as to how a reader should "rate" narrative material and then locate a student's work on a quantitative scale. Philosophical hermeneutic assessment, on the other hand, depends on – indeed is – interpretation with no scale for measuring or categorizing understanding.

Whether for classroom grading or program/institutional assessment purposes, these tests and rubrics “rarely demonstrate something particular about how a student is thinking or assimilating new information” (Solloway and Brooks 44). A philosophical hermeneutic approach to assessment, on the other hand, can move from assessment of “knowledge“ or “the mastering of facts” to understanding whether or not students have achieved an understanding of the material, whether they are more than “repositories for discrete bits of knowledge” and prepared instead to “gain insight from the knowledge, opening up possibilities for transformation” (46–47). By using an interpretive approach, we can read student narratives as windows to student expressions of understanding about professional and ethical responsibilities. It is a perspective that is unavailable by any other traditional mode of assessment.

Fourth, an explication of how these markers might appear is not the same as specifying what those markers must say. This distinguishes assessment grounded in philosophical hermeneutics from most quantitative assessment that requires data to fit into pre-defined items of knowledge. We know what the markers of understanding are but we do not know how those “understandings” will be manifested or expressed. Importantly, it is identification that the markers are present and not what the specific content of the markers is that constitutes the substance of the assessment. We will not find student expressions of universal essences of what it is to be an ethical engineer. What we do expect to read are expressions that indicate a process of understanding has occurred and evidence that each student may have experienced some unique and individual fusion of horizons.

Fifth, although a philosophical hermeneutic approach can be used effectively for both assessment and grading purposes, my research addresses the assessment of student understanding of ethics. While grading is concerned with individual student outcomes, assessment is concerned with finding out if we are achieving intended student learning outcomes and using this information to inform our teaching. We evaluate student expressions, not to judge “better” or “worse” in order to assign a grade, but to understand if our students understand. We acquire this understanding through our own interpretations of the “thick” descriptions expressed by students in their essays. Interpretation does not end with identification of the presence or absence of the markers of understanding evidenced in these essays. The work of philosophical hermeneutic assessment asks what these expressions of understanding mean, for example, in terms of student learning and attitudes about professional and ethical responsibilities, their preparation to exit the university and enter the work of engineering, their dispositions toward citizenship, and their vision of how they see themselves being in the world. Although the expressions of these students cannot and should not be interpreted as generalizable to all engineering students who are about to graduate and enter the professional workforce, an interpretive assessment approach can nevertheless can give us a unique insight and perspective in order to inform stronger and more useful engineering ethics education.

So how can these four markers of understanding be used to assess undergraduate engineering students’ understanding of their professional and ethical responsibilities?

The hermeneutic horizon is a condition of understanding characterized by the interpreter's prejudices. If we are assessing student narratives for signs of understanding, it makes sense that one of the markers we should find in reading and interpreting the narratives written by our students is evidence of their foregrounded horizons and the prejudices or biases that shape that horizon. Gadamer writes that our prejudices are rooted in our traditions, and this constitutes our historic consciousness. I suggest that we can think of our prejudices as the values we hold. After all, our prejudices and biases – and the traditions from which they emerge – are a reflection and manifestation of our values and how we prioritize them. Our values determine who we are and what is important to us at any given moment. If students are to understand the texts related to ethics – be that a written work or an interview with another person – they must encounter those texts with some awareness of their foregrounded prejudices or values. Although it is neither possible nor desirable, as Gadamer reminds us, to disregard our prejudices or values, it is nevertheless necessary to sort out legitimate prejudices or values from the ones that impede understanding (*Truth and Method* 272), and this necessitates examination and reflection (Schwandt, "Three Epistemological Stances for Qualitative Enquiry" 195). In my engineering ethics class, students start by reflecting on values – their own values and the influence they have in everyday decision-making, the values that underlie rules and policies that govern their personal and professional behaviors, and how values help explain the complexity of ethical decision-making. If our values are a condition of understanding and if we are responsible for having an awareness of our values – prejudices, biases, and traditions – then this is an important place from which to approach the study of professional and ethical responsibilities. This position is in sharp contrast to the admonition that proper

engineering ethics instruction should avoid discussing the "values of an ethical engineer" and focus instead on an "understanding of the *value* of engineering ethics" (Pfatteicher 138). Reflection on values is not undertaken so as to tell students what values they should have but to give them the opportunity to become aware of the role of values and to engage their own values in the process of understanding professional and ethical responsibilities.

If we want to understand a text, we must not only have some awareness of the values or prejudices we bring to the text, we must also be open to ***engaging our values and testing them or placing them at risk***. If we approach a text with a determination to resist putting our values at risk or with a conviction that our horizon is acceptable as it is, if we "stick blindly to our own fore-meaning about the thing" (Gadamer, *Truth and Method* 271), we will never understand the meaning of another. "Rather, a person trying to understand a text is prepared for it to tell him something" (271). So, in assessing student narratives for signs that they understand professional and ethical responsibilities, we should look for expressions that evidence their openness to the texts they encounter, their preparedness to be told something, and their willingness to put their values or prejudices at risk.

Next, do students discuss their ***dialogical encounters or conversations with the various assigned "texts***" – written materials, interviews, class discussions, and so forth? "Questioning opens up possibilities of meaning, and thus what is meaningful passes into one's own thinking on the subject" (Gadamer, *Truth and Method* 368). Within and through the dialectic of these dialogs, interpretation and understanding occur.

Students emerge with a ***"fusion of horizons"*** – a different horizon of understanding that is no longer the prior foregrounded horizon or the mere reflection of the text they have "read."

There is a distinction to be made between applying knowledge and understanding knowledge. Gadamer articulates this distinction. The difference is also critical to meaningful assessment of whether students have reached an understanding professional and ethical responsibilities. Gadamer examined Aristotle's analysis of the virtue of moral knowledge and the question of whether moral knowledge is acquired and applied or, as Aristotle maintains, whether it arises out of one's life experiences. Gadamer says that the same problem exists for understanding in general. He clarifies that understanding is not a two-step process where a person first acquires an understanding and then applies this understanding to a situation: "We too determined that application is neither a subsequent nor merely an occasional part of the phenomenon of understanding, but codetermines it as a whole from the beginning. Here too application did not consist in relating some pregiven universal to the particular situation. The interpreter dealing with a traditionary text tries to apply it to himself. But this does not mean that the text is given for him as something universal, that he first understands it per se, and then afterward uses it for particular applications." (Gadamer, *Truth and Method* 320–321).

Traditional ethics instruction is a two-step process – acquiring knowledge of rules and theories and then applying them to an ethics problem. A phenomenological approach to ethics instruction asks students to encounter a variety of "texts" concerned with

professional and ethical responsibilities, to engage in a dialog with those texts, and to emerge from that interpretive experience with new understandings – "a fusion of horizons" – of professional and ethical responsibilities. Their foregrounded horizons have changed and "thus, nothing ever appears the same again following a hermeneutic experience. . . . Our 'world' undergoes a change, and we become changed as people along with it" (Kakkori 25). This means, for assessment purposes, that we should look, not for reports or reproductions of what students have studied, but for expressions of mutually negotiated meanings with and new understandings of these texts and new outlooks that have occurred in the process of interpretation and understanding.

Research and Assessment Design:

I now face the conundrum that has lingered in the background since I first identified this work as the focus of my graduate research: what am I going to do with my data? What is the methodological approach that I will use to understand the meaning of the narrative data (essays) that I have collected? The instruction methods I used for the design and delivery of my ethics course are informed by hermeneutic phenomenology – asking students to investigate and interpret the essences of what it is to be an ethical engineer. The qualitative assessment approach that I have developed uses conditions of understanding as markers of student understanding of professional and ethical responsibilities and is grounded in Gadamer's philosophical hermeneutics. But how do I apply this assessment approach to the narrative data and how do I interpret and understand meanings that are in the data?

I began by ruling out methods. I considered grounded theory but soon realized that my work was not concerned with generating or discovering a theory "in which the inquirer generates a general explanation (a theory) of a process, action, or interaction shaped by the views of a large number of participants" – a process in which the theory truly arises from the data itself such that it is "grounded" in that data (Creswell 62-63 citing Strauss and Corbin). Contrary to how grounded theory originates and proceeds with the investigation of data – without a theory but allowing a theory to emerge – I have already developed an assessment framework based on, first, ABET Criterion 3(f) and, second, on Gadamer's explication of the conditions of understanding. The question for me is how I will approach and interpret the textual data within the hermeneutic framework I have developed.

I returned to phenomenology – specifically "hermeneutic phenomenology" – as a research method. "Hermeneutic phenomenology" became problematic for me as well. I struggled with the fact that *my research* was not intended to investigate or reveal the essences of any lived experience. Although my students were asked to investigate the experience of being an ethical engineer, my research interest was not with their discoveries but with assessing if that process of inquiry had resulted in new understandings of professional and ethical responsibilities. I sought evidence of understanding and, while student expressions of essences might disclose evidence of understanding, the essences of an engineer's ethical experiences were not themselves the object of assessment. The more I read about hermeneutic phenomenology, the greater my recognition became that hermeneutic phenomenology as a research method is not the same as the philosophical hermeneutics of Gadamer.

But this distinction is seldom made. Schwandt is a stanch proponent of the philosophical hermeneutics of Gadamer, and he argues forcefully that the “interpretive” tradition in qualitative inquiry – which claims alignment with Gadamer and philosophical hermeneutics – actually remains much closer to a positivist paradigm. As he explains, although there are various interpretive approaches used, “interpretivists argue that it is possible to understand the subjective meaning of action (grasping the actor’s beliefs, desires, and so on) yet do so in an objective manner. . . .This, of course, does not necessarily deny the fact that in order to understand the intersubjective meanings of human action, the inquirer may have to, as a methodological requirement, ‘participate’ in the life worlds of others” (Schwandt, "Three Epistemological Stances for Qualitative Inquiry" 193). Kakkori argues that hermeneutics and phenomenology are distinct philosophies that were joined by Heidegger but in ways that most researchers do not recognize, practice, or acknowledge. Her critique focusses centrally on the hermeneutic phenomenological methods of van Manen, whom she credits for his “fruitful description of hermeneutic phenomenological reflection and hermeneutic phenomenological writing”, but critiques for his unacknowledged “theoretical problems and contradictions between hermeneutics and phenomenology in his argumentations.” She gave voice to the conundrum I faced: “It is not enough to say that phenomenological research eventually becomes hermeneutic-phenomenological research simply because we always understand and interpret things” (Kakkori 20, 25, 26).

To state this once again, philosophical hermeneutics is not a research method: “[The work of hermeneutics] is not to develop a procedure of understanding, but to clarify the conditions in which understanding takes place. But these conditions do not amount to a

‘procedure’ or method which the interpreter must of himself bring to bear on the text” (Gadamer, *Truth and Method* 295). “The goal of philosophical hermeneutics is philosophical – that is, to understand what is involved in the process of understanding itself” (Schwandt, "Three Epistemological Stances for Qualitative Inquiry" 196). “The method of phenomenology is that there is no method. The fact that there is ‘no’ method might leave us with a feeling of abandonment, of being left in the middle of nowhere. . . . In phenomenological philosophy and methodology we find the tools we need to design a method for our research question; the phenomenological scholars provide us with theoretical knowledge. But in the process of understanding this knowledge, there is an obvious danger that literature confuses more than it clarifies. When we find that there is a plethora of perspectives within phenomenology, our mind might turn into the antithesis – a closed mind” (Henriksson and Friesen 12).

This helped to explain my quandary and confusion about research methods. But how, then, am I supposed to know what to do? The answer, I discovered, is simple but not immediately apparent, and it returned me to where I had started: “If there is no method and if the philosophers we turn to do not challenge us, there is just one salvation on the road to method: the research question” (Henriksson and Friesen 12). Ah ha. Go back to my principal research question:

> Can a phenomenological approach to engineering ethics instruction improve students’ understanding of professional and ethical responsibilities?

Research is an effort to understand something. I realized that the most important part of my research design is to determine and invent as necessary a method that will help

discover the answer to my research question. I have already proposed using philosophical hermeneutics to design a framework for assessment of students' understanding professional and ethical responsibilities. My research will deploy and test that framework of understanding so that I, as an instructor, can better understand the "understanding" of my students. Phenomenological methods are amenable to adaptation for such an investigation. Schwandt advocates for such methodological adaptation. In an article entitled "On Understanding Understanding", Schwandt observes that qualitative researchers – and specifically those trained in philosophical hermeneutics – are "uniquely suited to help us understand what it means to understand" and then asks: "Might not we better grasp the significance of qualitative inquiry if we worried less about justifying and locating it as a particular form of research and more about linking it to the practices of teaching and learning?" (Schwandt, "On Understanding Understanding" 462–463). That is my perspective as well and it is what I aim to do.

Phenomenology research is concerned with discovering human meaning from the standpoint of lived experience, that is to say, "a return to embodied, experiential meanings" (Finlay, "Debating Phenomenological Research Methods" 17). Phenomenology is generally considered to be in the "interpretive" or "constructivist-interpretive" paradigm of qualitative research. The other three paradigms are variously referred to as positivist, postpositivist, and critical (Lindlof and Taylor 5–13) or, alternatively, positivist/postpositivist, critical (Marxist emancipatory), and feminist-poststructural (Denzin and Lincoln, "Introduction: The Discipline and Practice of Qualitative Research" 13). There is by no means universal agreement about these paradigms, how they should be defined, or what the appropriate research methods for

each one should be. Schwandt, for example, makes clear epistemological distinctions among interpretivism, philosophical hermeneutics, and social constructionism – three approaches that generally are lumped within the interpretive or constructivist-interpretive paradigms (Schwandt, Three Epistemological Stances for Qualitative Enquiry).

As a brief review, there are multiple variants and schools of phenomenology research (Finlay, “Debating Phenomenological Research Methods”). Most of these, whatever their differences, share certain common philosophical perspectives:

- Qualitative research marks philosophy’s return to the traditional task of philosophy, which is the search for wisdom instead of a focus on empirical science.
- Qualitative research requires researchers to suspend all judgments about what is real. This is also called “bracketing out” or “phenomenological attitude” or “reduction” – the researcher leaves behind the “natural attitude” and tries not to let his or her own presuppositions get in the way of data collection and to be open to whatever may be revealed about the phenomenon being studied.
- Qualitative research subscribes to the intentionality of consciousness, that is, that consciousness if always directed toward something (destroys the Cartesian duality of separate subjects and objects), and
- Following from this, qualitative research is premised on the understanding that reality is perceived within the meaning of the experiences of an individual. (Butler-Kisber 51, citing Creswell 58-59, citing Stewart and Mickunas).

The phenomenology research process generally consists of three broad steps (Orbe; Creswell; Lindlof and Taylor; Butler-Kisber; Finlay, “Debating Phenomenological Research Methods”) and there are abundant examples in the literature on the application of these steps (see, for example, Butler-Kisber; Orbe; Creswell; Finlay, *Introducing Phenomenological Research*; Smith and Osborn; Groenewald):

1. Data collection (descriptions of lived experiences). Data collection methods vary according to the research question and project. The most common form of data collection for phenomenology research is the personal interview (Seidman) but data can include observations, focus groups, already existing recordings (visual or audio), or texts such as documents or narratives.
2. Reduction of data into themes. This is a multi-step process of coding the written or transcribed data so that significant statements are first identified, the meanings of these statements are formulated, and these formulated meanings are then consolidated into emerging themes. There is much variation in how researchers choose to code data and what the steps in the process are called. Butler-Kisber gives an example in which “significant statements” are extracted from a transcribed interview, “formulated meanings of significant statements” are then compiled, and from these “clusters of common themes” are identified (Butler-Kisber 55–58). Perhaps the key outcome of this step is the elucidation of “thick rich descriptions” of the participants’ experiences. One notable exception to this process of data reduction by coding is the hermeneutic phenomenological approach of van Manen. Van Manen refers to “methodical reduction”, which asks the researcher to “[b]racket all established investigative methods or techniques and seek or invent an approach that seems to fit most appropriately the

phenomenological topic under study" (van Manen, "Inquiry: Methodology: Reduction" n.p.). Van Manen's hermeneutic phenomenology is remarkable for its absence of prescribed method.

3. Hermeneutic interpretation of themes or the search for essences. This step is highly integrated with the reduction of data into themes. Throughout the process of data reduction, the researcher is engaged in a back and forth conversation with the data, and interpretation is already occurring. This process is also iterative in that the researcher will need to consistently return to the data to re-examine and validate themes and interpretations. This includes the original data as well as coded data. The key for hermeneutic interpretation of qualitative data is to reveal themes that have an "emergent and inductive orientation" and that the analyst "see[s] the world through participants' eyes" (Daly 219).

Qualitative researchers aim for scholarly rigor. They want their research results to be trustworthy, accepted by their peers, and publishable. Leydens, et al. compiled an extensive listing of methods for establishing trustworthiness and scholarly rigor in qualitative research which includes an audit trail (tracking findings back to the data), clarifying researcher bias, coding and re-coding, external audit (external consultants to review process and product), member checking (asking participants to review and give feedback on transcripts and findings), peer examination (panel of peers to examine meanings and interpretations), purposeful sampling (deliberate selection of research participants), reflexivity, rich thick description, and triangulation (using more than one research method to compare results) (68).

Additional measures for ensuring trustworthiness and rigor include stating and maintaining theoretical consistency throughout one's research (Borrego, Douglas, and Amelink; Koro-Ljungberg and Douglas; Orbe; Prasad) and, according to van Manen, concern for factors such as orientation of the researcher in the lifeworlds of the participants, strength of the data in representing the intentions of the participants, richness or aesthetic quality of the summaries written by the researcher, and depth of the researcher in accessing the meanings given by the participants (*Researching Lived Experience*). Kafle adds a component that we don't often consider, particularly in hermeneutic phenomenological research – paying attention to the rhetoric – a language that "does justice to express what is intended by the participants" (Kafle 196). Reflexivity is an essential practice in rigorous and ethical scholarly qualitative research. Guillemin and Gillam distinguish between procedural ethics (complying with Internal Review Board requirements, for example) and ethics in practice. They remind us that researchers must constantly "take stock of their actions and roles in the research process and subject these to the same scrutiny as the rest of the data" (Guillemin and Gillam 274). "Reflexivity involves critical reflection of how the researcher constructs knowledge from the research process – what sorts of factors influence the researcher's construction of knowledge and how these influences are revealed in the planning, conduct, and writing up of the research. . . .Adopting a reflexive research process means a continuous process of critical scrutiny and interpretation, not just in relation to the research methods and the data but also to the researcher, participants, and the research context" (275). With this background on methodology and method, I describe the research methods chosen and designed for my project:

Research question: Can a phenomenological approach to engineering ethics instruction improve students' understanding of professional and ethical responsibilities?

Data Collection and Storage: Students in ENT3958 Fall Semester 2014 wrote a final research essay (approximately 1800 words), due at the end of the semester, addressing the question: what is it to be an ethical engineer? Essays were graded according to course standards. After grading and grade submissions were completed, I downloaded all essays from Instructure Canvas (online course delivery system used by Michigan Technological University) to my home personal computer. All names were removed from the essays. The essays were numbered and then compiled into a single file with each essay comprising a separate section of the document. Line numbers were added and numbering was restarted for each new section. Data storage is on Canvas (for the coursework only) and on my secure home personal computer (research data). Data is in Word format. Data is backed-up daily. No data is stored in any "cloud computing or data storage" site and is not subject to breach.

Identification of Themes: I decided to code the data twice using different approaches. There are two reasons for this. First, when I started this project, my focus was on measuring "emotional engagement with ethics" as an outcome. During the writing of this dissertation, that focus shifted from emotional engagement as an outcome *per se* to emotional engagement as a mediator of the learning outcome: "an understanding of professional and ethical responsibilities." Before this change, however, I had already started coding the narrative data with emotional engagement in mind. I had not attempted any intentional and conscious interpretive work with the preliminary coding

but I did have this work partially completed and did not want to discard that effort. So, second, I decided to complete this coding using conventional phenomenology reduction methods to discover what it might reveal in its own right (emotional engagement is still relevant) and to use it as a comparison for the second approach to coding. The second round of coding begins with the original data (numbered anonymous essays) and uses a combination of targeted reading and coding that centers on the four conditions of understanding but also keeps open the possibility that other significant themes may emerge. For convenience I will call the first round of coding “Emotional Engagement and Other Themes” and the second round of coding “Understanding Professional and Ethical Responsibility and Other Themes.”

1. Emotional Engagement and Other Themes: The essays will first be coded using a phenomenological inquiry method demonstrated by Kim Havard and included in Butler-Kisber (55–58). This work was done shortly after the end of the semester in December 2014. I had no specific theoretical perspective for either research or assessment in mind at that time, so coding was done completely without preconception. I did hope to find evidence of students’ emotional engagement with ethics though I attempted to code without reference to that outcome, to let the data speak for itself. This round of coding will serve two purposes: (1) the results can stand on their own for whatever themes and interpretations emerge and (2) those results can be compared to outcomes from the second round of coding. The coding process consists of the following steps:
    a. Read each essay in its entirety without making any notations. Then return to the beginning of the essay and proceed with the next step.

b. Identify "significant statements." In this study, I have in mind initially "engagement" – in particular, emotional engagement with ethics. I might be sensitive to trigger words that indicate emotion, such as enjoyment, anger, anxiety, pride (Pekrun et al.). But "engagement" is only one possibility. I approach this stage with an openness to all statements that have the possibility of significance.
c. Group together like statements ("formulated meanings of significant statements") to eliminate redundancy.
d. Cluster themes from the formulated meanings – identify common themes that begin to emerge. Requires movement back and forth with original data to "check that the themes were really grounded in the data." Note any discrepancies – conflicts or tensions between themes.
e. Description of phenomenon – identify the general and unique themes for all the essays and write a composite descriptions.
f. Prepare a composite summary and conclusions.

2. Understanding Professional and Ethical Responsibility and Other Themes: Here I will use a selective reading approach (van Manen, *Researching Lived Experience*). I will uses as my base position the philosophical hermeneutic model of assessment and the four markers of understanding (foregrounded horizon and values; placing prejudices at risk; dialogic conversation; and interpretation, understanding and fusion of horizons). In addition, I will be reading for other statements of significance. I will read each essay in its entirety, one at a time, and then begin selective reading. I am looking for what constitutes the essence of student experiences of "understanding

professional and ethical responsibility.” I will ask “What statement(s) or phrase(s) seem particularly essential or revealing about the phenomenon or experiences being described?” (van Manen, *Researching Lived Experience* 93). Selective reading assumes that markers of understanding will not be enumerated, discussed in any order, or identified by the participants as such. No student will describe his or her “foregrounded horizon” or refer to “prejudices” or “placing them at risk.” Instead, I will look for expressions that indicate these markers.

Rather than coding particular phrases, words, or a sentences, a selective reading approach requires me to look at the entirety of what is written as well as the parts. “The researcher must account for the contribution of each part to the whole. Everything is interrelated: the whole is more than the sum of its parts and the whole makes the parts what they are” (Guimond-Plourde 4). The aim here is to give know the data well enough in its entirety as well as in its specificity in order to, in the end, give “shape to the shapeless” (van Manen, *Researching Lived Experience* 88). This process of data analysis is often visualized as a hermeneutic cycle consisting of the rigorous practice of reading, reflective writing, and interpretation (Kafle 195–196).

In this process, it is essential that the researcher be open to possible meanings of “error” or “misunderstanding” because “every effort to understand runs the risk of misunderstanding, that every effort to interpret faces the possibility of misinterpretation” (Schwandt, “On Understanding Understanding” 462). This is important, first, because it is the ethical thing to do. Research is about understanding something – in this case, understanding whether students have an understanding of

their professional and ethical responsibilities. If I find that they do not, I have an ethical responsibility to report that finding as part of my research. Second, if students have “misunderstandings” (really off on the wrong track as opposed to an opinion or conclusion that differs from mine), then that is necessary information for me, as the instructor, to know. That is the purpose of assessment.

Prepare Descriptions and Interpretations: The key to interpretation is to be immersed in and well acquainted with the data and to have the ability to move across and within the data so that the interconnectedness of themes can emerge. Daly describes this process as a “double hermeneutic – a “dialectical interplay“ between subjective meaning as described by participants (students) and the researcher’s (my) “reconstruction” of those meanings. Rich, thick descriptions taken from the students’ essays will elucidate and support interpretations. I will compare the two sets of interpretations to identify synthesis between them and to reflect on how each way of looking at the data has yielded knowledge that can inform better undergraduate engineering ethics pedagogy. As Orbe reminds us, “The most important lesson of this process is the impossibility of a complete reduction/interpretation” (Orbe 616). Interpretation and understanding in qualitative research are never final, exhaustive, or perfect. But we should aim for the clearest and most honest interpretations we can give to our work.

Additional data: I wrote field notes and reflexive notes during the semester and during the research collection and explication process, as well as during the dissertation writing. I had in-person meetings with each student twice during the semester. Those

meetings were not recorded. I wrote field notes afterwards as reminders about possibly significant discussions but no student names or other identifying information appear on those notes. I'll use them to inform my perspectives and to help reflect on the process.

My Role as a Researcher: The students were aware that this class would be structured uniquely, that they would be studying ethics using a phenomenological approach, and that this pedagogy was somewhat experimental. However, my primary duty as the instructor was to instruct and not to experiment with my students or to have them feel they were being experimented with. In that regard, I intended to maintain a normal classroom environment and I think that was successful. I received IRB approval (exemption) before the semester started and so I did not need to secure informed consent from the students.

Procedures for rigor and trustworthiness: I selected several appropriate methods to ensure scholarly rigor. Not all methods are necessary or possible. For example, a common method in most qualitative research is member checking, going back to the participants with one's themes and interpretations and getting their perspectives on whether their experiences have been accurately described and the essences captured. That isn't an option in my case as most of the students have graduated. The methods I selected are varied and should ensure that the research is trustworthy.

1. State and maintain theoretical perspectives: I have identified, explained, and defended the theoretical perspectives underlying instructional methods (hermeneutic phenomenology), assessment methods and research methods (philosophical hermeneutics). My work is consistently grounded in theory.

2. Peer examination: When all coding (including clustering of themes, description of the phenomenon, and preliminary explication) was completed for both rounds of coding of the final research essays, I convened a small group of interdisciplinary peers to study the narrative data to solicit their independent interpretations of themes and meanings.
3. External audit: My dissertation committee serves in this capacity, to examine the credibility of the research process and products.
4. Audit trail: It will be possible to track back from findings to the data. Some data will be reproduced in the text of this Dissertation.
5. Reflexivity: Reflexive statements have been and will be included as appropriate. Reflexivity will address possible stances, preconceptions, biases, and orientations that might influence my interpretations.
6. Coding and re-coding: the double coding process for the final research essays may disclose meanings in the data that might not be apparent using one coding process only.
7. “Triangulation”: Measurements (quantitative) of ethical reasoning (DIT-2) and ethical sensitivity (ESSQ) skills should correlate with qualitative assessment results.

Chapter Four presents and discusses findings and outcomes of this research.

Chapter 4
Findings and Explication

The research question I am addressing is whether a phenomenological approach to engineering ethics instruction can result in improved ethical sensitivity and reasoning skills as well as increased emotional engagement with ethics and an understanding of professional and ethical responsibilities by undergraduate engineering students. All data was collected from students enrolled in ENT3958, Ethics in Engineering Design, during the fall semester of 2014. This class was chosen because it was the only ENT3958 class I taught in which data was collected for all three measures: ethical sensitivity, ethical reasoning, and understanding of professional and ethical responsibilities. This chapter presents the data, findings, and explications.

Summary of Findings

Measure	Findings
ESSQ – Quantitative testing of ethical sensitivity	No statistically significant change in results from pre-test to post-test
DIT-2 - Quantitative testing of ethical reasoning	Statistically significant improvement in ethical reasoning skills from pre-test to post-test
Qualitative Assessment of emotional engagement and understanding of professional and ethical responsibilities	1. Undergraduate engineering students enter their final year of studies ill-prepared for and with apprehensions about what it is to be an ethical engineer. 2. Students recognize their “foregrounded horizons” and the traditions and values that shape these horizons and they are open to putting their traditions and values at risk by encountering other points of view. 3. Students understand that professional and ethical responsibilities are complex, expansive, and not confined to the workplace. 4. Students understand that engineers have special duties to the public; they begin to problematize technology and recognize that engineers do not operate as ethically neutral technicians. 5. Students are developing a practice of reflection and questioning.

Ethical Sensitivity

Students completed the Ethical Sensitivity Scale Questionnaire (ESSQ) as a pre-test during the first week of the semester and as a post-test after completion of classes at the end of the semester. The ESSQ consists of 28 questions answered using a Likert scale of 1 (totally disagree) to 5 (totally agree). The ESSQ was developed based on the seven skills of emotional development identified by Narváez, and there are a set of questions on the ESSQ specific to each of these skills. The results are reported in Table 4.1. On the questionnaire completed by the students, the 28 questions were listed in the order shown in Table 4.1 but without identification of and association with any of the seven skills. Results in Table 4.1, however, are differentiated by each of the seven skills. Mean scores and standard deviations for all students are reported for each of the 28 questions, each of the seven skill categories (top line in each skill category) with percentage change from pre-test to post-test, and composite of all questions (bottom line of table) with percentage change from pre-test to post-test. Because the students took the tests anonymously and without any identifying information to pair pre and post-test scores, it was not possible to conduct a paired analysis that would compare results on a student-by-student basis. Also, students were not differentiated by gender but, of the 13 students completing both the pre and post ESSQ tests, there was only one female student. There was no control group due to the small number (13) of students enrolled in the ENT3958 class.

Table 4.1 - ESSQ Results for ENT3958 - Fall Semester 2014

Questions	Pre-Test		Post-Test	
	Mean	**S.D.**	**Mean / % change**	**S.D.**
Reading and expressing emotions:	**3.06**	**0.51**	**3.19 / +4.25%**	**0.56**
1. In conflict situations, I am able to identify other persons' feelings.	3.31	0.85	3.69	0.63
2. I am able to express my different feelings to other people.	2.92	0.86	3.00	0.91
3. I notice if someone working with me is offended by me.	3.46	1.05	3.46	0.78
4. I am able to express to other people if I am offended or hurt because of them.	2.54	0.88	2.62	0.96
Taking the perspective of others:	**3.50**	**0.95**	**3.79 / +8.29%**	**0.56**
5. I am able to cooperate with people who do not share my opinions on what is right and what is wrong.	3.23	1.17	3.62	0.77
6. I tolerate different ethical views in my surroundings.	3.69	1.11	4.08	0.64
7. I think it is good that my closest friends think in different ways.	3.62	1.04	4.08	1.04
8. I also get along with people who do not agree with me.	3.46	0.97	3.38	0.65
Caring by connecting to others:	**3.98**	**1.08**	**4.23 / +6.28%**	**0.45**
9. I am concerned about the well-being of my partners.	4.15	1.28	4.54	0.66
10. I take care of the well-being of others and try to improve it.	3.85	1.14	4.15	0.69
11. In conflict situations, I do my best to take actions that aim at maintaining good personal relationships.	3.85	1.21	4.00	0.58
12. I try to have good contact with all the people I am working with.	4.08	1.12	4.23	0.73
Working with interpersonal and group differences:	**3.48**	**0.62**	**3.94 / +13.22%**	**0.54**
13. I take other peoples' points of view into account before making any important decisions in my life.	3.15	0.90	3.77	0.93
14. I try to consider another person's position when I face a conflict situation.	3.15	0.90	3.92	0.64
15. When I am working on ethical problems, I consider the impact of my decisions on other people.	3.92	0.76	4.08	0.95
16. I try to consider other peoples' needs, even in situations concerning my own benefits.	3.69	0.75	4.00	0.41
Preventing social bias:	**3.38**	**0.93**	**3.75 / +10.95%**	**0.56**
17. I recognize my own bias when I take a stand on ethical issues.	3.62	1.45	3.77	0.93
18. I realize that I am tied to certain prejudices when I assess ethical issues.	3.77	1.17	4.15	0.80
19. I try to control my own prejudices when making ethical evaluations.	3.46	1.05	3.69	0.75
20. When I am resolving ethical problems, I try to take a position evolving out of my own social status.	2.69	0.75	3.38	0.65
Generating interpretations and options:	**3.60**	**0.84**	**3.85 / +6.94%**	**0.69**
21. I contemplate on the consequences of my actions when making ethical decisions.	3.85	1.28	4.15	0.38
22. I ponder on different alternatives when aiming at the best possible solution to an ethically problematic situation.	3.69	0.85	4.31	0.85
23. I am able to create many alternative ways to act when I face ethical problems in my life.	3.46	0.78	3.46	1.05
24. I believe there are several right solutions to ethical problems.	3.38	1.26	3.46	1.33
Identifying the consequences of actions and options:	**3.40**	**0.59**	**3.87 / +13.82%**	**0.40**
25. I notice that there are ethical issues involved in human interaction.	4.00	0.91	4.46	0.66
26. I see a lot of ethical problems around me.	3.62	0.65	3.77	0.83
27. I am aware of the ethical issues I face at school.	3.46	0.78	3.85	0.69
28. I am better than other people in recognizing new and current ethical problems.	2.54	0.78	3.38	0.65
Composite	**3.49**	**0.57**	**3.80 / +8.88%**	**0.33**

Findings:

Overall composite ESSQ scores increased from 3.49 (S.D. = 0.57) to 3.80 (S.D. = 0.33). However, this was not a statistically significant increase (2-tailed independednt t-test t(df=19) = -1.73, p=0.10) from the pre-test to the post-test using p>.05 as the indicator of statistical significance. So I cannot conclude that the course caused or contributed to a statistically significant improvement in ethical sensitivity skills.[13] Appendix E includes the statistical report on the ESSQ data.

Explication, Discussion, and Conclusions:

There are no comparable norms for the ESSQ (studies with scores of undergraduate engineering students in the U.S.) and there was no control group of students in this project, so there are no available direct comparisons to be made. Studies have shown that undergraduate engineering and science students demonstrate lower ethical sensitivity skills than students majoring in human services related fields, such as medicine or social sciences (Rasoal, Danielsson, and Jungert; Clarkeburn; Colby and Sullivan). The developers of the ESSQ hypothesized and found that the same holds true for science teachers as compared to elementary education, social science, and language teachers in Finland (Kuusisto, Tirri, and Rissanen 5, 7-8). They also found that ethical sensitivity increases as an individual moves from a “novice” to an “expert” in one’s field of practice (Kuusisto, Tirri, and Rissanen 3). If we were to compare the scores for the seven ethical sensitivity skills of student teachers (“novice” teachers) in Finland to

[13] I failed to consider in advance that administering the pre and post-tests so that data would be paired (that is, gathering data so the pre and post-test results were known on a student-by-student basis) – which is a more powerful statistical analysis – could yield different p-values. Also, refer to Appendix E statistical report for ESSQ which shows that a one-tail analysis would yield a statistically significant increase in scores from pre to post test.

those of the ENT3958 students ("novice" engineers), we would find that the range of scores for the teachers was 3.6 – 4.2 (Kuusisto, Tirri, and Rissanen 4), while the range of post-test scores for the ENT3958 students was 3.19 – 4.23. So the range of ethical sensitivity scores of ENT3958 students and the Finnish student teachers is comparable.

The data does offer some useful information about the different ethical sensitivity skills and the degrees to which our students have them. We can see some strengths of our students and also some skills to be improved. I did not expect and was surprised to find that students in ENT3958 had their highest scores in the skill of "caring by connecting to others" (3.98 pre-test and 4.23 post-test). "Reading and expressing emotions" had the lowest scores and the lowest percentage improvement. The skills with the highest percentage increase in scores were "identifying the consequences of actions and options" (13.82% increase), "working with interpersonal and group differences" (13.22% increase), and "preventing social bias" (10.95% increase). Because all the students were affiliated with Enterprise or senior design teams, it's possible that the increases in identifying consequences and working with interpersonal and group differences could be explainable to some extent by their team experiences during the semester. These undergraduate engineering students would still be "novices" and, based on prior findings of the ESSQ creators, we can expect that their ethical sensitivity scores will increase with career and life experiences (Kuusisto, Tirri, and Rissanen).

My conclusions for this part of the study are that students' ethical sensitivity skills improved overall but that the improvement was not a statistically significant increase. Improvement was uneven across the seven skills and students have some skills that are

stronger than others. The improvement that did take place could be attributed to other factors, such as students' involvement in design team work. If the ESSQ (or any similar test) is used again in ENT3958 or another class, it will be useful to have the students identified in some way so that the pre-test and post-test data can be paired for analysis because that could yield different results in terms of statistical significance.

Ethical Reasoning

The DIT-2 was used to measure ethical reasoning skills and possible improvements in those skills after taking ENT3958. Students completed the Defining Issues Test – 2 (DIT-2) as a pre-test during the first week of the semester and as a post-test at the end of the semester after all other coursework was completed. Thirteen students completed the pre-test and twelve students completed the post-test. All students are U.S. citizens and English is their primary language (important factors for the DIT-2). The tests were taken anonymously. Data for the two tests was not paired, and there was no control group of students, again, owing to the small enrollment in ENT3958.[14] There is, however, a substantial amount of DIT-2 data from other sources and other studies available for comparison.

Findings:

The results for ENT3958 are summarized in Table 4.2, along with a comparison of results from the SEED Study and the DIT-2 National Norms compiled by the Center for

[14] As previously noted, ENT3958 was offered in spring semester 2015 (it is usually offered only once a year in the fall semester). I intended to teach that class using a traditional ethics instruction approach and administer the same tests: ESSQ, DIT-2, and essay narratives. However only 2 students enrolled and the class was cancelled.

the Study of Ethics (Dong). A brief review of the scoring components of the DIT-2 will help in understanding these results. Recall that the DIT-2 is based on a Kohlbergian scheme of moral development which holds that a person's personal interest (stages 2 and 3) gradually decreases as the person gets older, his or her stage 4 or "maintains norms" stage develops and becomes stronger, and ideally the person achieves a post conventional stage where one's moral decisions are increasingly based on higher level principles such as justice. These were the stages associated with the original DIT. When the DIT-2 was introduced, the N2 score was added to take account of post-Kohlbergian theories (such as Gilligan's) and today the N2 score is considered a more accurate measure of ethical reasoning skills. All four scores continue to be reported by the Center for Ethical Development with its data analysis of DIT-2 tests. The Center maintains a national database of DIT-2 scores and periodically provides updated information about national norms. This now includes a table of norms for in-college students who take the DIT-2 because the test is used so pervasively as a testing measure for ethical reasoning skills of college students. Previously, data was reported by education level achieved but it did not differentiate by whether the subjects were still in their education setting when they took the DIT-2 or if they had left/graduated. So the in-college data offers a better comparison of the DIT-2 results for ENT3958. Because all but one of the students in ENT3958 were in their final year at Michigan Tech, I selected the national data for "senior" in-college students for comparison. This data covers all majors and is not engineering specific.

Table 4.2 - DIT-2 Results: ENT3958 2014, SEED, National Norms

DIT-2 Score	ENT3958 - 2014		SEED Study		DIT-2 National Norms (Senior) (S.D.) n=12207
	Pre-test (S.D.) n=13	Post-test (S.D.) n=12	MTU (S.D.) n=238	Other 17 Institutions (S.D.) n=~3700	
Personal Interest (Stage 2/3)	22.93 (16.44)	14.50 (11.35)	NA	NA	23.67 (12.27)
Maintain Norms (Stage 4)	39.38 (14.01)	37.33 (14.05)	NA	NA	35.71 (14.13)
Post Conventional (P Score)	30.77 (13.20)	43.33 (12.37)	29.9 (NA)	32.9 (NA)	35.97 (15.27)
N2 Score	34.08 (14.28)	47.16 (12.11)	29.7 (NA)	32.4 (NA)	36.01 (15.42)

I include the SEED study data because this study (see Introduction, supra) sought to measure the ethical development skills of undergraduate engineering students at eighteen U.S. institutions with high undergraduate engineering enrollment. Michigan Technological University was one of the participating institutions. About 800 students were randomly selected from Michigan Tech to participate in the study; 238 actually participated. One of the aspects of ethical development that was studied by SEED researchers was ethical reasoning, and the DIT-2 was used for this purpose. This study had no intervention (ethics instruction) and its purpose was to provide a snap-shot of the levels of ethical development of undergraduate engineering students across all grade levels (freshmen through seniors). Each participating institution received a written report of the results for that institution and some data for comparison to the other institutions (Carpenter, Harding, and Finelli). No Personal Interest or Maintains Norms scores were provided; nor were standard deviations for the P and N2 scores included in the results.

The SEED study data is relevant and informative because it gives us a picture of the average state of ethical reasoning skills of our students at Michigan Tech and how they compare nationally. It does not differentiate by whether or not students have taken an

ethics course or by any level of ethics instruction students may have received. The picture for Michigan Tech is not a healthy one. It was noted in the SEED report prepared for Michigan Tech that its undergraduate engineering students' DIT-2 scores were below the mean for the other seventeen institutions by a "statistically significant" amount (44). That said, the results for the engineering students at the other seventeen institutions that participated in the SEED study were, themselves, not stellar. The mean N2 score for Michigan Tech students was 29.7 and the mean N2 score for the other seventeen institutions was 32.4. Both are below the national norms for in-college students, which range from 34.11 for freshmen to 35.97 for seniors (Dong 12). One of the conclusions of the SEED study was that the ethical development of undergraduate engineering students is lower than their non-engineering peers, and part of the work of the study was to prompt a conversation about how ethics instruction and moral development experiences could be introduced or enhanced for undergraduate engineering students in order to improve these outcomes.

Explication, Discussion, and Conclusions:

ENT3958 students' P and N2 scores increased substantially – the mean P score increased from 30.77 to 43.33, and the mean N score increased from 34.08 to 47.16. The DIT-2 pre-and post-test scores were unpaired. Using the mean N2 pre and post-test scores for analysis (the N2 is considered the more reliable measure of ethical reasoning), the improvement was statistically significant (2-tailed independent t-test $t(df=23) = -2.48$, $p=0.02$) from the pre-test to the post-test. ($p<0.05$). Based on these results, I reject the null hypothesis of no change in DIT-2 scores; there was a statistically significant improvement in ethical reasoning skills as measured by the DIT-2 for students

who completed the ENT3958 ethics course. Based on these findings, I conclude that there is a correlation between the phenomenological approach to ethics instruction and improved ethical reasoning skills for undergraduate engineering students at Michigan Tech. There is also a strong possibility that the instructional approach used in the course may have had some positive causal effect on this improvement in ethical reasoning skills but this can be established only by testing with control groups. Perhaps the most important outcome with the greatest relevance for engineering ethics instruction is that undergraduate engineering students who take a one-credit engineering ethics course demonstrate a statistically significant improvement in their ethical reasoning skills.

Students began the semester with mean P and N2 scores that were lower than national norms for their peers but, after completing the course, achieved mean P and N2 scores that are well above the national norms both for their peers in all majors and for persons with graduate degrees in all fields (national norms for graduate degree are P score = 41.06 and N2 score = 41.33) (Dong 2-3). So the students in ENT3958 are outperforming, not only other engineering students, but students from all majors and students with advanced degrees. Moreover, in line with Kohlbergian theory, as the mean P and N2 scores increased, the students' mean "personal interest" scores decreased substantially, implying that they are motivated less by what is in their own best interests and more by higher ethical principles. Mean "maintains norms" scores decreased slightly but this score, which is based on a person's desire to uphold rules and laws, is not expected to decrease as much as the "personal interest" score.

There are several limitations of this study that could impact the results. First, there were no control groups. There was no group of students who took the class and received traditional ethics instruction. Nor was there a group of students who took no ethics course at all. For this reason, it isn't possible to conclude that the phenomenological approach to instruction was the cause of the improved DIT-2 scores or of improved ethical reasoning skills. Based on the SEED study results, which tell us the snapshot status of engineering students' ethical reasoning skills with no control for ethics instruction, it is reasonable to conclude that there certainly is a correlation and may be a causal relationship between taking a one-credit course in engineering ethics and improved ethical reasoning skills as measured by the DIT-2. Whether any ethics instruction – traditional, phenomenological, or something else – may produce the same or similar outcomes is admittedly not demonstrated by this work.

One of the problems with the DIT-2 – and something that becomes a problem when testing small populations for improvements in ethical reasoning scores and achieving changes that are statistically significant – is the large standard deviations that occur with the DIT-2. We can see from Table 4.2 that the S.D. in national norms is 15.27 for the P score and 15.42 for the N2 score. The S.D. for the post-test mean P and N2 scores for students in ENT3958, however, are 12.37 and 12.11 respectively, quite a bit lower than the national norms, indicating that the students are all closer to the average with more uniformity and less divergence in their scores than in the national averages.

Additionally, the number of students enrolled in the course each year is small. However, a total of 53 students have taken the pre-test and 45 have taken the post-test during the

2011, 2013, and 2014 terms, with all groups showing consistent and substantial improvement in ethical reasoning skills. When considered from that perspective, the numbers are more meaningful. It would be desirable to have larger numbers of students but, given that ENT3958 is an elective course and is not required for any major, the use of a control group does not seem likely. This is the third class in which I have used the DIT-2 as a pre-test and post-test, and results each year are consistent in that the mean P and N2 post-test scores are substantially higher than the pre-test scores. Table 4.3 reports the results from 2011, 2013, and 2014.

Table 4.3 - DIT-2 Results ENT3958: 2011, 2013, 2014

DIT-2 Score	ENT 3958					
	2011		2013		2014	
	Pre-test (n=20)	Post-test (n=16)	Pre-test (n=20)	Post-test (n=17)	Pre-test (n=13)	Post-test (n=12)
P Score	30.1	35.75	26.10	31.29	30.77	43.33
N2 Score	28.59	35.28	26.82	33.96	34.08	47.16

I don't include these results in the overall data for this study because the ESSQ and narrative analyses were not done during those years and because I do not have access to the full DIT-2 test data for analysis of statistical significance. But, at a minimum, the prior data show a consistent pattern of improved ethical reasoning test scores and would tend to affirm the results of the 2014 data.

Other studies have used the DIT or DIT-2 to measure the ethical reasoning skills of undergraduate engineering students. The SEED project is perhaps the largest study

conducted. The SEED researchers undertook a subsequent study that looked at changes in ethical development two years after the original SEED study. They selected a sub-set of ~450 undergraduate engineering students from the original study (this subsequent group did not include Michigan Technological University engineering students) and had these students complete a modified DIT-2 to measure ethical reasoning skills. As with the original SEED study, this follow-up study did not include or control for any ethics instruction or other intervention other than the passage of time in school. Perhaps the most noteworthy finding in their follow-up work is that students seemed to regress rather than progress in some respects of their ethical development as they advanced in their undergraduate studies (Harding, Carpenter, and Finelli). The researchers did not account for this regression. One conclusion that might follow from these results is the importance of maintaining a persistent presence of some sort of formal ethics instruction throughout the undergraduate engineering curriculum.

Other studies using the DIT or DIT-2 to test the impact of ethics instruction on the ethical reasoning skills of undergraduate engineering students show mixed results. Self and Ellison used the Defining Issues Test (DIT) as a pre-test and post-test to measure quantitative changes in ethical reasoning skills of undergraduate engineering students who took an engineering ethics course. They found that DIT scores improved significantly and concluded that students can be taught ethical reasoning skills (Self and Ellison). Their research, however, did not include a control group who did not take an ethics course so it is unknown if factors other than the course might have caused improved DIT scores. Loui tested undergraduate engineering students to determine if the instructional video *Incident at Morales,* designed as an aid for teaching engineering

ethics, could improve students' ethical reasoning and opinions. He used two tests, a five-item survey with a Likert-type scale ranging from "Strongly Agree" to "Strongly Disagree" and the DIT-2. Both tests were administered to groups of students at two universities before they watched the video and after they watched it. There were no control groups. Louis found that, after watching the video, students improved their ethics opinions on the survey and their DIT-2 ethical reasoning scores by statistically significant amounts. Louis concluded that a single watching of the video could improve moral reasoning but could not conclude if the video was the sole cause of the increases or if these improvements would be retained by students over the long term (Loui, "Assessment of an Engineering Ethics Video: Incident at Morales"). Drake, et.al, used pre and post DIT scores to compare the ethical reasoning skills of three groups of undergraduate engineering students: (1) students who took a three-credit semester-long ethics course, (2) students who received a few modules of ethics instruction included in a regular engineering course, and (3) a control group who received no ethics instruction. They affirmed results from prior work showing that it takes more than a few modules of ethics instruction to impact ethical reasoning. But, contrary to the findings of Self and Ellison, they found no significant increases in ethical reasoning of the students who took the three-credit ethics course when compared to the control group (Drake et al.).

The results of these studies affirm that testing for the impact of ethics instruction on undergraduate engineering students has not given us certain answers about what or how much ethics instruction is needed to make a difference, whether ethics instruction has an impact at all, what the impact is, whether any impact persists over a long term, or whether the DIT-2 is a good measure of impact. In this regard, my research contributes

to the evidence that an engineering ethics course can result in statistically significant improvement in ethical reasoning scores as measured by the DIT-2 but has limitations and leaves room for additional corroborating research and testing. My work strongly suggests that a one-credit engineering ethics course – in this case, one that uses a phenomenology-informed approach where the students investigate what it is to be an ethical engineer – can yield credible and important evidence of improvements in ethical reasoning. As with other studies, however, I cannot conclude if these improvements will persist over time or if they would occur with traditional ethics instruction. These are appropriate and worthwhile questions for future work.

It should be noted that the DIT-2 is not recommended for use as a pre and post-test because there is some concern that there could be an effect caused by simply taking the same test twice. Obviously, this hasn't prevented researchers from using the DIT-2 for pre and post-test purposes (Self and Ellison; Drake et al.; Loui, "Assessment of an Engineering Ethics Video: Incident at Morales"). Moreover, I have not been able to find data in the literature that confirms this double-test effect and I question the actual effect of taking the test twice, or at least the assumption that this could improve scores. The questions are designed so that "right" answers are not obvious, so it is just as likely that students would score lower on the post-tests because they have no point of reference from which to gauge how to answer the questions differently or "correctly." The consistency of the increases in scores each year would appear to confirm this. If I were to surmise anything, it would be that the tests, when taken anonymously, do not motivate students to care much about their answers. They are not tested on the content and grades do not typically depend on the actual answers. Yet, despite the absence of

grades as a motivation for good performance, student scores consistently improve in each class. If I were to use the DIT-2 again, I would now make two changes: first, I would not make it anonymous so that students might be more motivated to put forth an honest effort (even though I would not make grades dependent on actual results) and, second, I would use identities of students to pair pre and post-test results for analysis of statistical significance. That said, and considering both the criticisms of the DIT-2 and the increasing availability of validated alternatives to the DIT-2, I would consider using another measure, such as an ethical reasoning test that is engineering specific. I would make this change, not because I am convinced that another test would produce more reliable results (alternative tests that are currently available still use the same model as the DIT-2 – a collection of scenarios presenting ethical dilemmas with multiple choice answers) but because the students may be more engaged in taking a test that includes scenarios related to engineering.

An Understanding of Professional and Ethical Responsibilities

The narrative data – the final research essays written by the students addressing the question: what is it to be an ethical engineer? – were analyzed twice using difference analytical approaches. The first round, which I refer to as "Emotional Engagement and Other Themes," followed a standard hermeneutic phenomenological inquiry and data analysis model. As I undertook this process, I hoped to gain insight into the engagement of the students with ethics, with ethical engineering practice, and with being an ethical engineer – to find out what was going on for them. In the coding process, significant statements were identified in the narrative data; formulated meanings were developed

from the significant statements; finally, interpretive themes were considered, reflected on, and tested by continuous referencing back to the original essays.

The second round of analysis addressed whether the students in ENT3958 achieved ABET's ethics requirement that they have "an understanding of professional and ethical responsibilities." For this analysis, I used an assessment approach grounded in philosophical hermeneutics. This was informed by van Manen's approach to hermeneutic interpretive research which emphasizes holistic reading, writing, and interpretation – often reading between the lines – rather than a formal coding process. I read through each essay in its entirety, getting a feel for the whole picture, its possible holistic meaning. Then I returned to each essay and read them with an eye for understanding students' thoughts about their "foregrounded horizons," that is, their values, "traditions," and personal histories when they came into the course; their mindset toward consideration of new or alternative perspectives; descriptions of "dialogs" with the curriculum, texts, other people, and themselves about aspects of being an ethical engineer and professional and ethical responsibilities; and discussions of what came of this, how did they use these texts to arrive at meaning, how did they make sense of these texts, what changed for them, did they reach a new understanding? I asked: what does this essay tell me about this student's understanding of professional and ethical responsibilities, and does this student seem prepared to begin a career as an ethical engineer? I had no fixed or predetermined expectations because there were no "correct" answers. I was open to reading and trying to understand what each student had to say. I noted comments in the margins to note the presence of the four markers of understanding.

Finally, I considered the interpretive meanings from the individual essays and began thinking and writing about the coded themes from round one and the entire body of essays from round two. What seemed to hold true in general for the students' understanding of professional and ethical responsibilities? Were there problems that were common to students or anomalies with understanding that stood out for some students? Do these students, as a whole, have a sufficient understanding of professional and ethical responsibilities to enter the world of engineering practice? From this, what could I learn about teaching ethics to undergraduate engineering students and what could I do to strengthen the course so that student learning outcomes would improve?

When I considered the themes and findings that emerged from these two analytical strategies, I recognized that there was a great deal of common ground between them. That, of course, is reassuring and what I had hoped. The principle distinction was that analysis by coding yielded a set of specific significant statements, formulated meanings, and themes, all of which could be directly referenced back to the essay data. This traditional phenomenological inquiry is a rigorous and methodical process designed to allow the researcher to systematically identify and sort through significant statements so that, by employing a series of steps and with a back and forth reading of the statements and their context, a set of themes emerges. This was a classically inductive process. A philosophical hermeneutic approach, on the other hand, allowed me to consider trains of thought, to follow dialogs, and to "observe the mind in its processes" (Solloway and Brooks 60) without the constraint of coding and the necessity to always decide what "category" or theme a snippet might represent. The researcher becomes embedded in

the data in either type of analysis but philosophical hermeneutics really does throw the researcher into a "hermeneutic circle" of understanding.

As a beginning researcher and reflecting on both cycles of analysis, I would say that they offered complementary but not identical ways to investigate the data. They did serve as cross-checks on possible themes. My honest assessment must acknowledge that it took both approaches to complete the whole of the research and that neither approach would have opened the possibility for all insights and findings in itself. Hermeneutic phenomenological inquiry and coding yielded a set of specific "out-of-context" statements and themes[15] that, when considered alongside the broadly interpretive reading approach of philosophical hermeneutics whereby I highlighted contextual lines of thinking that signified the markers of understanding, provided a framework to integrate the data and answer the research and assessment questions – did these students emotionally engage with ethics and did they achieve an understanding of professional and ethical responsibilities? Going back and forth between the formulated meanings and themes identified in Round One coding and the thoughts expressed by students that I highlighted during my Round Two reading of essays (philosophical hermeneutics), I eventually arrived at five principal findings.

[15] Round One coding (hermeneutic phenomenology as method) resulted in identification of 295 "significant statements" that were then reduced to 11 "formulated meanings" (with multiple sub-meanings within each of the formulated meanings), and six "themes" (again, with multiple sub-themes within each theme). The formulated meanings and themes are included in Appendix G. In my Round Two reading for markers of understanding, I noted markers as "comments" – a sample of one of the thirteen essays is also included in Appendix G. The "comment" step of Round Two represents only the beginning of the interpretive process, which becomes highly iterative, involving multiple readings and comparisons of both Round One and Two original data and coding, reflecting on meanings and significances, note taking and writing, to arrive at final findings.

Findings:

Finding 1: Undergraduate engineering students enter their final year of studies ill-prepared for and with apprehensions about what it is to be an ethical engineer. One of the opportunities this phenomenology-informed class affords students is the chance to be reflective about their fast-approaching transition from student to practicing engineer. They are not judged or graded on the content of their thinking, so most students seem to trust that they can be honest. The interview with an experienced engineer – which is a one-on-one conversation between an engineering student and a practicing engineer that is centered on the experience of being an ethical engineer – is a unique chance to change the dialog from knowledge and skills associated with quantitative design to understanding what it is to be an ethical engineer. Reflecting on the interview, students reveal some key concerns about being an ethical engineer and how the knowledge they gained from the interviews helped fill gaps in their understanding of professional and ethical responsibilities. One student explained this well:

> At the beginning of the semester, I had a very general idea of what would be considered ethical behavior and what wouldn't. However, I never had given too much thought on either my personal values or how these values aligned with any professional engineering codes of conduct. In general, I'd like to believe I had a pretty good moral compass, but it wasn't especially calibrated. Additionally, I see now in retrospect that I had a misaligned idea of how working in the automotive industry would be as far as where the responsibility for ethically challenging decisions was placed. Thanks to the interview I conducted, I realized I held some misconceptions about the day-to-day realities of working as an engineer in the automotive industry.

Students expressed two concerns in particular about the transition to practicing engineer: the fear that they will be left to make ethical decisions in isolation and the concern that professional ethics is often a matter of choosing between job retention and being ethical.

Students express that they are afraid they will be on their own when an ethical dilemma occurs. The image they have is of the isolated and solitary engineer who discovers some design error that could cause grievous harm and now faces the ethical dilemma of what to do about it, without guidance or support from anyone. This image seems to be firmly assimilated by the students. During their interviews with engineers, students are surprised and palpably relieved to learn that this is rarely, if ever, the situation faced by engineers and that "being an ethical engineer" includes knowing that one is not alone in decision-making. One student wrote about this as follows:

> Some information that was a new way of thinking about was that you can go to your supervisor or other management staff for help resolving an ethical issue. You're never on your own completely to make a decision on anything, at least in the automotive industry (and especially when you're just starting out). This was never a consideration for me in the past. . . . I had always for whatever reason assumed that I would be all alone to make my decision; the revelation that that's never the case especially in the automotive industry was a bit of a paradigm shift in any imagined future scenarios I would be involved in. . . I won't be thrown into the thick of a project all on my own and be expected to fend for myself; there will be a lot of other engineers around with many years of experience whose experiences and advice I can utilize to develop professionally and personally. In retrospect, this seems obvious, but it just wasn't something I'd considered in the past. . . . I am a lot less nervous about starting full-time as I know I won't be expected to make big ethical decisions all by my own; I will have guidelines, coworkers, and my supervisor/management to get help with the decision. This may seem obvious but it had simply never occurred to me prior to conducting the interview.

Students are also concerned that ethical dilemmas will boil down to a choice between keeping one's job or remaining silent and going along with a potentially faulty design or other unethical conduct. Several students reflected on experiences described to them by the engineers they interviewed. Every engineer had examples of ethical dilemmas they had faced and how they had dealt with them. Students derived reassurance and even confidence from these examples, realizing that an engineer can be ethical and not

necessarily have to make a career-ending choice. Interestingly, only a few of the experiences described by the interviewed engineer involved ethical dilemmas concerning a design flaw or illegal activity, which are the predominant foci of engineering ethics case studies. This is important because the students are introduced as well to the socially situated nature of engineering and to the fact that the scope of being an ethical engineer is not singularly about avoiding or reporting design flaws.

In one example, the practicing engineer told of an experience when he was working for an oil company. The company decided to lay off over 3000 workers right before the Thanksgiving holiday but, at the same time, donated a large amount of money toward a golf outing for industry executives. The engineer believed this was an unethical decision and resigned because of it. When he interviewed for his next job, he explained this reason for leaving the prior company. He was hired by the new company and, later, was told that he was hired in part because he stood up for what he thought was right. The student wrote:

> With the pressure from the company I work for, it will not always be easy to carry out the most ethically ideal project. While I will want to follow the most ethical path, the resources or time will not always be there. Although many companies share the same ethical interests that I do, they may not be as strong. Also, the company has to make a profit. While I understand this is all necessary, I still must do my best with the resources they give me to reduce the risks of a project.
>
> At a certain point, however, I may have to draw the line where my company does not meet the ethical standards that I have put for myself. When this happens, it may be time to either compromise my beliefs or move on. This can be extremely difficult because of how intimidating and difficult it can be to try and find another job. However, after my interview with _______, I feel much more comfortable with making the decision to leave a company. . . . This story showed me that people value ethical decisions. Because of this, I am less afraid of quitting for a reason having to do with ethics.

Another student wrote of the engineer's experience with a company he worked for. The student had asked this question: "Has making an ethical decision ever held you back in your career?" The engineer explained that he had developed a new manufacturing process that would increase the safety of jet airplane engines. The president of the company he worked for chose to disclose this design with the broader industry out of concern for public safety although the company and its shareholders could have profited from a market advantage by keeping the process confidential. The student wrote:

> I received a story that would teach me a lesson that I have never considered before in my life. The ethical question here was whether or not to share this information with the rest of the industry, as it would result in greater safety for everyone who gets on a plane, but giving up this information would loss [sic] the market advantage that they had just obtained. The decision was brought to the owner of the company, who ultimately decided that the only way to be ethical in this situation was to share the information with every company in the industry to ensure the safety of everyone who flies. There were no laws pertaining to this situation, the decision was made in the name of safety for the human population, the owner of the company took to heart the first fundamental cannon of engineering, "hold paramount the safety, health, and welfare of the public" (Code of Ethics). This was a perfect example of this fundamental cannon in practice, as the company gave up a huge market advantage to offer safety to public.
>
> My take away from this answer was that the ethical decision is more important than having a market advantage over other companies even when there is no alternative reasoning to help your competition. It is always most important to first consider the safety of the public, and the betterment of society as a whole rather than the betterment of the company that you work for. A second take away from this is that a decision of this caliber does not lie solely on the shoulders of the engineer; other people need to be brought into the situation to make a fully informed ethical decision.

As I considered what the students wrote, I was struck by how troubling and prevalent these concerns are for the students. And I began to wonder how these students arrived at the threshold of their professional careers with no idea of the available support and

resources for handling the ethical problems they will encounter. After years of immersion in engineering coursework – preparing them for the day they enter the professional world – these students are still afraid that they will be abandoned and alone when ethical problems arise and that they will likely have to choose between ethics and employment. Engineering programs increasingly pride themselves on the fact that – with an emphasis on experiential engineering education – they are preparing graduates who can enter the professional workforce and be immediately productive. That is almost certainly true as to their technical training. But these students are not prepared for the realities of being an ethical engineer, and it appears that neither their engineering coursework nor prior ethics training has addressed these concerns. ENT3958 gave them an opening to express and address these authentic concerns.

Finding 2: Students recognize their "foregrounded horizons" and the traditions and values that shape these horizons and they are open to putting their traditions and values at risk by encountering other points of view. I never asked my students to think about their "foregrounded horizons" but I did ask them to think about their values and reflect on their significance. It's probable that most engineering students have not been asked to "reflect" about their values much at all during their undergraduate training. Rather than rejecting reflection about values as something that does not come naturally to engineering students, my students seemed to welcome the chance to think and write about their values, what they mean, how they influence who they are and how they act, and what role they might have in being an ethical engineer. Our values are rooted in our traditions, and it is through reflection that we begin to make sense of these traditions and how they account for who we are, how we interpret and understand all things including

ethics, and how we behave. This is the point of asking students to think about their values. Gadamer wrote: “Long before we understand ourselves through the process of self-examination, we understand ourselves in a self-evident way in the family, society, and state in which we live” (Gadamer, *Truth and Method* 278). On the practice of thinking about values, a student wrote:

> Too often in today’s society do we forget to take some time for introspection. Work, school, bills, family, friends, and to do lists fill our minds day in and day out, leaving no time to think about what we value most. I’ve learned each of these things I invest time in are in some way directly valuable to me, but how valuable are my own opinion and thoughts? Taking the time to reflect on what is important to me, what I find moral, or how I prioritize things in my life is a critical aspect in how I will respond ethically in future conflicts and situations in my life and career. Through this class I have taken that time to think for myself, discovered ideas regarding ethics in today’s world, and worked to understand how they will affect me in being an ethical engineer. I have created a basis of information that will guide me to only develop in recognizing what qualities make an ethical engineer

For most of the students, understanding that our values determine our priorities and that there is a connection between our values and our ethical decisions simply opened a space where they could put those values at risk by encountering ethics, ethical decision-making, and being an ethical engineer from perspectives not previously known to or considered by them:

> At the beginning of the semester, I had a very general idea of what would be considered ethical behavior and what wouldn’t. However, I never had given too much thought on either my personal values or how these values aligned with any professional engineering codes of conduct.
>
> ………………..
>
> One of the most important ideas that I have taken away from my studies is that these principles of human conduct concerning what is right and what is wrong has everything to do with someone’s point of view and beliefs. These views on what is morally right can be brought about by religious beliefs, political stances, scientific knowledge or even daily

observations and will highly influence an engineer's decision on how to proceed with a give [sic] task. For example, if you take the case of an engineer looking to construct a new mall into a heavily forested area. Some would believe that this would be a great idea to attract more people to spend more money in their area in order to stimulate their economy and create jobs, while others would believe that this would be considered unnecessary deforestation (contributing to higher amounts of C02 in the air), and could potentially kill off lots of animals, forcing the others to relocate to less suitable areas.

…………………..

For me, this could be learned through self-reflection and experience. Considering I will soon be an entry-level engineer, it's harder to have multiple experiences in the engineering industry for me to form my 'set of ethics'. However, I recognize that my ethics may change through experiences and years of working in industry. Each experience in a design process or a day at work may open my mind further and expand my understanding of ethics.

……………….

An important part of being an ethical engineer may be to take a class on ethics, and determine what it means to be ethical, but a big part of it seems to come from the values you were taught growing up. To quote _____ at NASA, "Sometimes ethical behavior is compared to 'Things I Learned in Kindergarten' (Share things, play fair, don't hit people, put things back where you found them, etc). If you learned these values early in life and have attempted to live by them, then you have a solid foundation for the ethical challenges in the workplace." Appears that the foundation of being an ethical engineer is the common sense and values engrained into each individual growing up.

…………………….

There was a lot of information for me to take away from this interview. Some helpful information was the advice to figure out where you stand on a given ethical issue before you're actually faced with it. Things may not especially be easy but then at least you already know your preferred outcome, all that's left is getting it to happen. I'm about to enter the automotive industry whereas he [interviewee] has 25+ years of industry experience, both with Chrysler and other companies. He said to make sure that one understands their beliefs about right and wrong, respect other people's health and safety, and make sure to live what you believe. You should do these things both to help your career and to help you live with yourself. This advice is very useful to me, as I hadn't ever really thought about ethics in this way. However, I now know some introspection

> is needed before I start working in the automotive industry, at least some of which I've hopefully captured in this paper.

Nearly all students commented on one of the assigned readings, "Engineering ethics and identity: Emerging initiatives in comparative perspective" (Downey, Lucena, and Mitcham) in which the authors compare how engineers perceive being an ethical engineer in French, German, and Japanese cultures. This excerpt exemplifies how one student used dialog with the text and the interview with an engineer to read between the lines and think about values:

> In each of these cultures, it is possible to identify the values which influence societal views of engineering. The French value human progress through technological advancement as it provides prosperity and comfort for French people. The Germans value advanced technology and its use in ways that are not in conflict with humanity or human rights. The Japanese value the Japanese household identity and seek its empowerment through the ingenuity of Japanese engineers. These values, not a code of ethics, guide engineers as they operate in their respective cultures. In reality, all engineers are guided – knowingly or not – by their values. When asked if he applied particular values to ethical decision in an engineering context, Dr. _____ said no. He does not have clearly defined values which he methodically applies to engineering ethics questions. However, it was clear when talking to him that Dr. _____ operates with a particular mindset that automatically keeps him within the realm of ethical engineering.

The following essay demonstrates a student's exploration of values and the new understanding that emerged about both values and an engineer's professional and ethical responsibilities following the student's dialogs with the assigned texts and the practicing engineer:

> Many of my previously believed ethical values still support my ethical foundation, such as honesty, integrity, reliability, accountability, perseverance, and capability. I hesitate to incorporate efficiency as a virtue because I believe a variety of increasingly important virtues, such as honesty, integrity, and accountability have the potential to conflict with efficiency. However, these virtues provide only one level of engineering morality to me, and I am just beginning to delve into the further

> categories. While I have always considered myself a fairly independent person, I have learned from my interview that independence is an extremely important trait for providing an unbiased judgment on ethical concerns, and, as such, needs to be practiced to the same extreme that honesty should be.

Importantly, students come to understand that values inform their professional and ethical responsibilities, influence their ethical decisions and actions, and can change and be shaped by experience:

> Ultimately, it seems that all engineers are guided by their values since values can quickly guide decisions. Codes of ethics are and other such tools are too cumbersome for the fast paced world of engineering decisions. In their paper considering the possibility of a global code of ethics for engineers, alZahir and Kombo cite some authors who suggest that codes of ethics are more a method to enhance the respectability of the engineering profession than to adjust the behavior of engineers [citation]. In this context, "making an honest effort" means developing good values and intentionally applying them, or reaching a state where they are applied naturally. For older engineers, this comes through learning from experience. For younger engineers, it is necessary to consult with veteran engineers to gain from their experience.
>
> [E]ngineers are mostly guided by their values when faced with ethical decisions. These values are developed through experience. Young engineers do well to enlist the help of those more experienced when faced with decisions that have real consequences in a fast paced world.
>
> I've grasped that most people, engineers specifically, are inherently good people. As said before, ethical engineers have a desire to improve the world, not destroy it. Very rarely do individuals use their talents to knowingly cause more harm over benefits. However, situations can skew people's values and cause them to act differently than they ideally would. In a future tough situation, I may see that a coworker does not want to blatantly make an unethical design, he or she may be driven by an outside factor: profit, reputation, or even job security. Engineers don't just decide to be careless or to be unethical with no reason

One student observed that personal and professional values do and ought to reinforce each other:

> Another interesting aspect involves flooding one's personal life with virtues from the ethical engineering life. As an ethical engineer is

> required to consistently uphold ethical values within one's work for any given situation, upholding these particular virtues at home assist the engineer in solidifying them as a part of oneself.

Finding 3: Students understand that professional and ethical responsibilities are complex, expansive, and not confined to the workplace. This finding covers a lot of ground. Almost every student wrote at some point in the essay that "ethics is a complicated subject" that "brings more questions than answers" and that "an ethical engineer, let alone ethics, cannot be defined in one word, sentence, or even an entire essay," and thoughts to this effect. All of the students comment that rules such as the NSPE Code of Ethics are guidelines but that this set of professional rules of conduct is inadequate for answering all the ethical questions they may face. These statements, as self-evident as they seem, represent a growing maturity and understanding of professional and ethical responsibilities than most of the students have when they begin the course:

> At the beginning of the semester, I may have simply defined ethics as "what is right or wrong". I now have a more complex understanding that ethics encompasses more than that; it is values, decisions, desires, and what drives an individual to do what they do.

We must remember that these are young adult engineering students who have no professional engineering experience. Changes in understanding are big – and challenging – steps:

> Over the course of this whole semester (thirteen weeks and counting) I've been contemplating the one question, "what does it mean to be an ethical engineer?" It has turned out to be one of the most ambiguous, complicated and debatable answers to a question I've been asked to explain. This might be hard for many engineers and technicians to answer as well due to the fact that most of us have been programed to think quantitatively through lots of our studies and research. Ethics isn't so cut-and-dry like solving a math problem, it has a lot more gray area compared

to the calculus classes most struggle through. Through my semester of research focused on thinking more qualitatively than usual and I've stumbled upon many interesting points of view concerning ethics including viewpoints from other parts of the world and treating technology as an ethical element, as well as learned a decent amount about myself and my own ideas on what it should mean to be an ethical engineer.

…………………..

First and foremost is the understanding that although the purpose of this class is to understand what it means to be an ethical engineer, it would be a mistake to try and treat the subject as if it were something separate from ethics at large. As an engineer it is easy for us to treat subtopics as if they are completely independent of other topics, mostly because what we work on tends to be complicated as a whole making concentration upon the particulars a necessity in order to perform any meaningful work. This is our strongest asset as engineers; the ability to filter out noise and focus on the substantive portions of a problem. However this is also our blind spot, as it makes it much easier to forget the whole picture. Therefore, as I see it, ethical engineering is designed, and ethics in general for everybody, is to draw us out of our narrow interests and remind us of the whole.

Students begin to understand that professional and ethical responsibilities are complex because the answers depend on so many factors. One student explained his understanding after he discussed the question with his interviewee:

The situational aspect of this question lead perfectly into the next question I had prepared which was, "Do you believe that ethics questions are all situational?" This is a question that I began thinking about after one of the class readings, Ethics and Competitive Advantage in a Fast-Paced Industry, which touched on the idea that ethical questions are entirely different depending on the situation in which they are presented in. It was stated in this article that "Ethical behavior may be seen differently from different perspectives" (Hylton). The Ethics and ICT article also held this same view, as the author stated "But what is right or what is wrong is not fixed, it may change over time and is context dependent" (Oortmerssen). I tend to agree with the idea that ethical questions change based on the situation and background of those involved, but I also wanted to hear the answer from a practicing engineer.

The answer I received to this question was "yes, ethical questions usually have a clear cut answer, but that is because of the situation at the moment, if the situation changed I may have made a different decision

> pertaining to the same question" (Engineering Ethics). There was more to the answer that I received, but I believe that this first sentence here was enough to explain his view on this question. All the sources I have looked into point me in the direction of all ethical decisions being a product of the entire situation, a look at the big picture. I believe that being able to see the whole picture in a situation is the most important part of being an ethical engineer, as the only way to make the ethical decision is to be fully informed of the situation at hand.

Another student wrote about the contextual nature of professional and ethical responsibilities of engineers:

> I have also determined from the assigned readings that many moral issues are contextual, so generalized solutions cannot be formulated that will properly apply to most situations; therefore, the ethical engineer must remain vigilant and critically apply themselves to solving any moral conflict that arises. This is further supported by the notion that future anticipation of potential product impacts on the world is a responsibility of the ethical engineer, and not just an added task that they may choose to complete.

Students encountered and considered issues of professional and ethical responsibilities that arise in contexts they'd not previously considered, such as risk versus reward in seeking competitive advantage, sustainability and profit, and ethical responsibilities of engineers in the public sector. Students are not expected to resolve these issues, but the dialog with these problems creates awareness of the complex scope of professional and ethical responsibilities, exposes students to ways of thinking about these issues, and better prepares them to deliberate these problems. As one student wrote:

> The numerous assigned readings exhibit various situations and the ethical aspects imbued within them; thus, they focus on the decision aspect of ethics. The texts strengthened my understanding of the importance of challenging the complex regions of ethics, as morality is not just a simple black-and-white choice. Furthermore, these articles provided numerous real-world examples that provided a foundation for me to begin questioning my own ethical habits.

Indeed, many students recognized that professional and ethical responsibilities must be an ongoing lived commitment for engineers:

> This led me to the question of how I will continue to educate myself further once I'm in the position of an engineer developing products used by humans. I believe one of the best ways for an engineer to understand ethics is to communicate and teach others. By helping to develop the understanding of ethics in my coworkers someday, I'll better understand my own view on ethics. In addition, discussion of ethics with coworkers may increase agreement on the design process.

Finding 4: Students understand that engineers have special duties to the public, they begin to problematize technology and recognize that engineers do not operate as ethically neutral technicians. Students recognize that engineers possess specialized knowledge and this gives them, not only a unique level of responsibility to the public, but also a great deal of power that they must use in ethical ways. Although they don't use this terminology, these students are thinking about the socially situated nature of engineering and the extent of an ethical engineer's responsibility:

> As an ethical engineer, I know that I must put the public's wellbeing before my own. With the power I will have, I must take care of those who do not have the knowledge from an engineering degree or the time to figure out the risks themselves. Therefore, it must be my duty to serve the public to the best of my ability without stepping over the line of controlling them. Although making every project perfectly ethical isn't realistic, I know that others will respect my choices if I ever need to go against the company I am working for. Engineering is much less clear cut than most people make it out to be. When designing products that people use every day, engineering, necessarily, becomes value-laden.
> …………....
>
> At the core of morality, being able to distinguish the best choice or deriving an alternative one with regard to ethical virtues and standards is considered ethical itself, which is sufficient for many engineers in the profession. Unfortunately, this is a very narrow-minded approach towards engineering morality, and it does not consider the long-term impact of the decisions they make; hence, most engineers do not fundamentally understand how far their responsibilities go for the goods/services they provide.

……………..

Engineers must care about ethics because of what engineering is. Because of their skills, position, the things they work on, they have power over others. Therefore it is their duty to make, to the best of their ability, ethical decisions.

……………….

I believe as engineers that we should look above just the interests of ourselves and look at the bigger picture of who we impact. That doesn't mean that you have to consider everything from a global perspective (although some technologies may require that); but at the perspective that is large enough to encompass everything and everyone that may be affected by what we are doing. Because we have specialized knowledge it is incumbent upon us to consider the wider aspect of what we are doing.

………………..

Often times when talking about ethics in engineering, or when ethical codes are written, they talk about how ethical decisions will affect the public. What do they mean when they say "public"? Downey talks a lot in his article about how ethics varies in countries such as France and Japan and contrasts them to the United States. He talks about how France doesn't get much formal education about ethics in Engineering, and how Germany has 8 metrics of value when determining ethical decisions. While it was super interesting to learn about, it got me pondering about what it means to affect people as engineers in different regions, and to serve the "public", and public shouldn't be divided by borders: state, country, or otherwise.

………………...

Ethical engineers need to keep everyone in mind when making ethical decisions, not just local people of a certain race, religion, or gender. Engineers are regarded as experts in their fields, and need to take that responsibility seriously. While engineers may not always be consciously thinking about ethics, those decisions affect people, the environment, health, and so much more, and engineers having a strong foundation of ethical values will allow mankind to thrive, and those decisions will be left behind and will lay the foundation for generations of engineers to come.

Students grapple with coming to terms with many concepts in their research for this class, and the socially situated nature of engineering is one of the most challenging because it removes them from the laboratory and places them squarely in the world. When they actually think about it, this isn't altogether problematic for them. But there is

one question that remains, justifiably, quite boggling to them, and that is the question concerning technology. Engineering students are prone to thinking that all technology is good as long as it is designed as safely as possible, and they are committed to the idea that it is technology that will solve the world's challenging problems. The questions concerning technology remain a problem for all of us, myself included. Most students wrote that their view of technology has changed and that they no longer think of technology as merely an "ethically neutral" object of their work. Instead, they consider that technology will and already does add to the complexity of being an ethical engineer. Still, they struggle with this relationship because they are generally conditioned to think that it will be someone else's responsibility to decide what technologies will be developed and how they will be used. The following selections from their essays reflect their diverse and unsettled thinking on the question of technology and the ethical engineer:

> As the field of engineering evolves, corresponding ethics for an engineer will need to as well. Technology has become such a great tool, yet may cause a strain in a set of ethics. As stated by Oortmerssen, "our values direct the development of technology, but at the same time technology has an effect on our values." New technology will mean new decisions to be made about what defines an ethical engineer. In addition, as technology and science develop, I will need to personally be aware my ethics will need to drive my decisions even more.
> ………………….
>
> As I have labeled technology to be the largest mediator for engineering design, I believe a large first step towards these predictions revolves around the philosophy of technology, and understanding that technical artifacts are much more than just neutral tools. This fact alone causes me to consider that many "ethical" engineers are very narrow-minded in their morals, and the true ethical engineer will need to draw upon multiple disciplines to properly succeed at their engineering work. All in all, I have concluded that ethical engineering takes on a dynamic form and followers will need to perform constant, consistent investigations in the field to properly become ethical in the discipline.
> …………………..

As an attempt to understand the extent of morality of my interviewee, I questioned him on his ethical views of technology. Expectedly, I received no indication that he would purposefully consider the long-term effects of his engineering and design decisions, nor the predictions of harm associated with the misuse of any engineered product/service. For him, these aspects are miniscule when compared to first party associates of the company, and the ethical standards he is expected to uphold. Therefore, I have concluded that many “ethical” engineers do not actively consider the impacts their engineering and design choices have on the world, especially for long periods of time.

…………………

When asking “what does it mean to be an ethical engineer,” one must research and weigh the effects for them working for a specific company where the product or job they are asked to complete could have ethical problems down the road. For example, if an engineer is offered a job working for Lockheed Martin and they will be working in their missiles and guided weapons department, that person must look inside and decide for themselves if they want to develop new weapons that kill people every day (bad and good people), because that is what Lockheed Martin needs in order to be able to make a profit. There is a risk versus reward element here as well due to the fact that if you will be rewarded with a nice paycheck to provide your family with, but might risk your own emotional wellbeing. A perfect example of this is the Manhattan Project during World War II when physicist J. Robert Oppenheimer and a team of US Army engineers conceived the first atomic weapons to use on the Japanese in order to end the war.

…………………

“Engineers should know that the product they design could end up injuring or killing people or being used in a manner to harm someone or something,” (interviewee) stated. “This applies to almost any product.” And if you really think about it, it makes sense. Do you think that the people who created the first cellphone thought that millions of automobile accidents and thousands of deaths a year would be a direct result of cellphone used in a car in a couple decade’s time? How many times in the medical field does a new vaccine give a handful of people an extreme (sometimes deadly) reaction? These kind of examples also show that sometimes things go wrong even when you are ethically in the right state of mind, with your product’s main function not intended to cause harm.

………………….

Although I’ve read several papers this semester that talk about how technology itself can be ethical, I have denied this opinion from the start. I believe that it is the developer and the user of the technology who have to

be held accountable for the actions that the technology takes. Those who see extreme ethical concerns and develop the product anyways are for sure to blame, and those who use a product not in the fashion for which it was intended are also to blame. For the Manhattan project, the engineers and physicists took it upon themselves to unveil nuclear weapons knowing that the world could never be the same, and that these weapons could be used for strategic political gain. In order for something to be ethical, I believe it must be able to think ethically itself.

…………………..

In “Engineering Ethics and Identity,” the Verein Deustcher Ingenieure’s Fundamentals of Engineering guideline states that an engineer should analyze “the societal, economic and ecological feasibility of technical systems; their usability and safety; their contribution to health, personal development and welfare of citizens; their impact on the lives of future generations [citation].” This seems a little overwhelming for any engineer who is unable to foresee events in the distant future. An engineer is probably concerned with the usability and safety of a product on a daily basis, but looking into a product’s impact on society and future generations seems like a rather nebulous task to carry out. It is easier to agree with the implications of the guideline; that an engineer is responsible for the products they make and should be on the lookout for products that will clearly have a negative impact on the welfare of The Public. This idea is particularly meaningful when considered in the context of the role that German engineers played in enhancing the efficiency of the Holocaust.

…………………..

Nevertheless, analyzing the problems with engineering ethics and implementing solutions are two very drastic problems. As many issues and concerns revolving around engineering ethical fissures are contextual, generalized ideas do not provide much reconstruction. However, being able to consciously predict the implications engineered products constitute is an immense act of ethical responsibility in both my opinion and Verbeek’s.[citation] Procedures such as eliminating all brainstormed ideas for a new product that do not satisfy an ever increasing list of important moral values provide powerful ethical enforcing tools to a variety of situations, and should be applied whenever possible. It is the responsibility of an ethical engineer to consider all moral virtues and decisions, functional or not, and act accordingly for the “…safety, health, and welfare of the public.”[citation] While this is a daunting task, at the very least, engineers should attempt to think, and possibly philosophize, about all the impacts the potential products they are designing have on the world.

Finding 5: Students are developing a practice of reflection and questioning. In my individual meetings, students often raised the question about what I expected from them. My answer to them was to develop a habit of questioning and reflection and to take that lesson with them from the course.

> I personally have found that ethics is a very ambiguous subject that will challenge the best thinkers and I know now that it is not something to take lightly when one enters the work force I have given tons of examples debating ethical risks versus rewards, how ethics are perceived based on your upbringings, beliefs and experiences, and how an engineer must think ethically in all phases of their work and research. And when I say think, I don't mean just quantitatively, but qualitatively as well! Think about how the quality of life will be with your product in it. Will it be a presence of good in the world, or something that is made to harm? How will affect the quality of your life? Will the financial reward be worth the risk of a clear conscience? So what does it mean to be an ethical engineer? I think that if an engineer can honestly look inside and have a clear moral sense and understanding of what they are working towards, then they can be considered ethical, no matter what background or point of view they have!
>
> ……………….
>
> In the following years, as I aspire to be an ethical engineer, I will need to ask myself many questions. I'll be challenged with the task of self-accountability to uphold and maintain my standards of ethics, even in a profit driven society. I'll need to be aware of what I'm uncertain about. I'll need to make a decision on my personal boundaries of what will drive my choices: my values or profit? I'll grow to understand that ethics won't just impact decisions I'll make at work; ethics will be in my everyday life. And I understand the ethics I practice in my life outside of my career will influence my set of ethics in my career, and vice versa. I'll need to establish for myself how far my responsibility as an engineer goes. Reading the provided article "Engineering Ethics and Identity: Emerging Initiatives in Comparative Perspective" made me consider how I will interact with international colleagues. As many companies are developing into international business, understanding how ethics differ in different countries will become incredibly crucial. How will I determine which countries set of ethics overrule the others? Also, will I design products that may replace a human worker? How will I decide which is ethical in my opinion, or in the opinion of my employer? I will ask all of these questions, but may not have definite answers. Rules are black and white, but ethics in real life have infinite gray lines. Ethics is not completely definable, but it is unique to the individual. Simply put by Robison, "no choice is ethically neutral".

Explication of Research and Assessment Findings

Emotional Engagement

I began this research with the hypothesis that a phenomenological approach to engineering ethics instruction could help emotionally engage engineering students with the study of ethics. Although I subsequently gave less prominence to emotional engagement with ethics as a primary outcome of this project, I found that the students in ENT3958 did, in fact, express emotional engagement with the study and practice of ethics. In their essays, students in ENT3958 revealed various personal anxieties and emotions about being an ethical engineer, such as the fear of being abandoned to make ethical decisions in isolation and that they would be forced to choose between their jobs and being ethical engineers. As the students wrote about their interview experiences and reflected about the meaning of what they have read and heard, an underlying “care” about ethics materialized. This was most apparent when students wrote about aspects of being an ethical engineer with which they could relate, when they could see themselves in the situation, and as they considered how some aspect of professional and ethical responsibilities would concern them in their engineering careers. This finding is consistent with the higher scores associated with “caring” skills that students achieved on the ESSQ .

Engineering students are able and willing to care about the study and practice of ethics but they must have a reason and context to do so. I suggest that the immanent nature of phenomenology research provides both the reason and the context. “Phenomenology not only finds its starting place in wonder, it must also induce wonder” (van Manen, *Researching Lived Experience* 44–45). Guimond-Plourde writes that “this evocation of

wonder refers to a kind of attentiveness to a lived experience" (4) and goes on to describes how phenomenology research necessarily draws the researcher into a relationship of meaning and wonder with the research participants even though the researcher has not personally experienced the phenomenon being studied:

> For the purpose of understanding a phenomenon described by those who have experienced it, this hermeneutic phenomenological dynamic offers an original and relevant framework; it makes it possible to look more closely at the existential dimensions of the lived experience in order to access its essential qualities and to formulate an intersubjective reflection through interpretation. The listening and reflecting that are the central pillars of this kind of dialogue do not merely constitute passive reflection but illuminate thinking (Guimond-Plourde 4).

When the students in ENT3958 assume the role of researcher and use principles of phenomenology to investigate the lived experience of being an ethical engineer, they move from passive reflection to thought and wonder – engagement with and attentiveness to the lived experience they are investigating. Because emotional engagement of students is a known mediator of learning outcomes (Sagayadevan and Jeyaraj), if the students in ENT3958 are emotionally engaged in the study and practice of ethics, that has positive implications for their achieving an understanding of professional and ethical responsibilities.

Understanding Professional and Ethical Responsibility

Philosophic hermeneutic assessment is, in effect, a "double hermeneutic" – I am trying to understand what my students understand (Daly 211). I have argued that traditional engineering ethics pedagogy and assessment methods aim to inculcate and measure

“knowledge” rather than “understanding” of professional and ethical responsibility.

Schwandt elucidates the distinction between knowledge and understanding:

> [W]hen we say that we *understand* what others are doing or saying, we are stating something quite difference than that we *know.* To *understand* is literally to stand under, to grasp, to hear, get, catch, or comprehend the meaning of something. To *know* is to signal that one has engaged in conscious deliberation and can demonstrate, show, or clearly prove or support a claim. In Anglo-American thought, at least, knowing and knowledge are more often than not associated with intellectual achievement, cognitive performance, or a special kind of mastery of subject matter” (Schwandt, “On Understanding Understanding” 452).

From their investigation into what it is to be an ethical engineer, did the students in ENT3958 “stand under, grasp, hear, get, catch, or comprehend the meaning” of professional and ethical responsibilities? A central question of assessment is: how will a reader of an essay know if the student has an understanding of these responsibilities? What would that look like and how would it be expressed? Solloway and Brooks tell us that a hermeneutic model of assessment “would allow the student to bring his personal history to the table. It would encourage the recognition of how knowledge is embodied rather than stored. It would encourage the exploration of the encounter with a text as an embodied experience. It would not ask for evidence of learning as a replication of what the dominant tradition already knows. It would instead suggest that learning be evidence that the student encountered the text as an aesthetic experience, evidence that the student’s hermeneutic imagination came into play in the encounter” (Solloway and Brooks 51). In assessing student work, Solloway and Brooks go on to suggest that we look for how a student’s encounter with a “text” affected the student’s thinking – did it confirm positions, did it deepen the student’s understanding and bring about a shift in thinking, did it raise new questions? (51). Kakkori writes that “Thus, nothing ever appears the same again following a hermeneutic experience. We see ordinary things

(‘ordinary things’ in the former horizon, world view or paradigm) in a different light, and we also become able to conceive of totally new entities. Our ‘world’ undergoes a change, and we become changed as people along with it” (Kakkori 25).

As I read the essays written by the students and as I considered my findings, I kept in mind what the essays themselves are: “The language of the interpretation does not merely offer what is understood a means of presenting itself. Rather the presenting *is* the understanding” (Dunne 142, emphasis in original). This is to say, these essays are not mere instrumental representations of student thinking; the writing of these students *is* their understanding. To assess whether the students in ENT3958 left the class with an understanding of professional and ethical responsibilities, we can ask questions that reveal the conditions of understanding – performance indicators, if you will – and that, in turn, will tell us if there is understanding. These questions might include:

- Do the students bring their own values – their own personal histories and traditions – to their research inquiries into what it is to be an ethical engineer? Were they willing to and did they place these values at risk?
- Do they encounter the “texts” – readings, interviews, discussions – as aesthetic experiences? “Aesthetic” is not meant as finding something beautiful or pleasing, but rather as an approach to the texts that is imaginative, that is open to different perspectives, and that leaves the student somehow changed.
- Did they engage in a dialog with these “texts”? Are they interpreting the texts? Is there evidence of a “hard road journeyed with the respectful engagement of the Other (whether texts, ideas, objects, or persons)” (Solloway and Brooks 44)?

- Did the encounter with the “texts” affect the students’ thinking about professional and ethical responsibilities – did it confirm what they already thought, did it change their thinking, did it raise new questions?
- Did their “worlds” undergo any change; did they change as people; do they express new ways of being ethical engineers? Do they understand themselves in new ways?

Referring back and forth between the five findings and the various excerpts from student essays that support them, I asked: do these students on the whole have an understanding of professional and ethical responsibilities such that I am comfortable sending them off to begin their careers as novice engineers? They do. This is not to say that I agree with all the ideas and understandings that the students express. It is also not to say that every one of them will always make ethical choices. Nor does it mean that every student has the same understanding of professional and ethical responsibilities and what it is to be an ethical engineer. But each one has had the opportunity for deep reflection about these topics and to begin a practice of questioning engineering practice and their professional and ethical responsibilities in ways they had not previously done. Every one of them has a personal view of what it is to be an ethical engineer and how they might be personally in the practice of engineering. They are more confident about facing ethical problems in that they understand that other people are there as resources for them and that ethical decisions needn’t be career-ending decisions. They also better appreciate and understand the complex nature of ethical decision-making and that it nearly always involves difficult trade-offs, not tidy win-win solutions. They understand that engineering practice and ethical decision-making occur in broader and underlying

contexts that are not necessarily engineering-specific. I can say that these students, as a group, when they step into the world of engineering practice, will be less surprised by the ethical problems they encounter and better prepared than most of their peers to be mindful of what it is be ethical engineers.

These students understand that ethical decision-making is more than heuristics; they are exposed to and think about ethical decision-making in new and complex ways; they demonstrate that engineering students are fully able to think outside the objective, rational, and ethically neutral "box" of engineering. They are taking account of alternative perspectives on the place of engineers in the world, for example, by considering that this place for engineers may exist outside as well as inside the design lab, by thinking about and redefining who the "public" is that they are responsible to, and by questioning technology and the engineer's relationship to it. They are asking new questions they never before thought to ask about the professional and ethical responsibilities of engineers. For at least the brief semester that they spent in ENT3958, being an ethical engineer and all that entails became personal for them. Their relationship to the knowledge they learned was embodied and contextualized, not merely replicated or repeated by rote. Without a longitudinal study, it isn't possible to speculate on what these students will retain over the long term. But creating a temporary space to investigate what it is to be an ethical engineer and to have a dialog about professional and ethical responsibilities is a good beginning.

These conclusions apply generally to the entire class. But I must acknowledge that not every student in ENT3958 fit into this overall characterization of outcomes. There was

one student whose final essay consisted of a set of rules that [chemical] engineers must follow if they are to be ethical. The paper did not refer to or incorporate any of the assigned readings or the student's interview with an engineer, though I know he did this work. During our meetings, the student repeatedly asserted that he intended to work in a laboratory and that he could not see how ethics would be relevant to him as long as he complied with all the rules. We talked about possible scenarios where rules might not apply or why his work in a laboratory might have ethical implications he hadn't considered, but his "foregrounded horizon" was quite rigid. During our meetings, I explained that the final paper needed to integrate the assigned readings and the interview, yet he did not do this. Do I think this student will be an ethical engineer? Yes, at least in the sense that traditional assessment of and interpretations of ABET E.C. 3(f) would define an ethical engineer. Will he be reflective about his professional and ethical responsibilities beyond the laboratory? Probably not, though I am mindful of the optimism expressed by Solloway and Brooks. They acknowledge that there are students who have difficulty putting their values and traditions at risk and who demonstrate a "passion for ignorance" as they resist any new understandings. Nonetheless, they write "If the students continue to engage life in the open-ended reflection of mindfulness, each may move beyond today's limited horizons" (Solloway and Brooks 58). We never know what seeds may have taken root.

I also considered the value of asking students to think about values. This can be a contentious issue – recall, for example, the admonition that engineering ethics educators "ought to provide students with an understanding of the *value* (why should an engineer be ethical) of engineering ethics, as opposed to the values of an ethical engineer"

(Pfatteicher 138, emphasis in original). Bucciarelli advises that engineering ethics should be concerned with values and suggests that the “collective of persons who are members of the profession – better said, participants in the professional culture – share certain values and beliefs and abide by (mostly unwritten) norms about what contributes to, or denigrates, the public welfare, that these shared values define the integrity of the profession, and guide engineers in their day-to-day efforts” (Bucciarelli 12). Building on this, “. . . professionals need to think through their own ethical standards before situations arise in which they will have to apply those standards by making choices. The moment of choice is no time to begin figuring out what you stand for . . .” (Stephan 11 citing Staudenmaier). Students begin ENT3958 by examining their personal values and the professional values that guide engineering, for example, the values that underlie the NSPE Code of Ethics. In their interviews, engineers regularly talked to the students about their own reliance on values for guidance in ethical decision-making. Several students were advised by their interviewees to do exactly what Staudenmaier counseled – to think about their values ahead of time so they will have some idea of where they stand when issues arise that require them to deploy those values. As Wike wrote, an understanding of personal and professional values can help students get over the “hope for easy answers” attitude toward ethics. Values are ubiquitous and are implicated in nearly all our personal and professional decisions. Understanding our values “we don’t get caught up in technicalities; instead we focus on what is of importance” (Wike, n.p.). Values are not something the students in ENT3958 were, by their own admission, ever asked to think much about, but they demonstrated an aptitude for doing so and a new understanding of why values are important and why they should think about them.

Although the DIT-2 quantitatively measures ethical reasoning skills, whereas this qualitative work is intended to assess emotional engagement and whether students have an understanding of professional and ethical responsibilities, we would expect there to be a correlation between these skills. Ethical reasoning, emotional engagement, and ethical understanding are increasingly sophisticated skills. So, if we find that students do demonstrate emotional engagement with the study and practice of ethics and evidence that they have an understanding of professional and ethical responsibility, then we can justifiably expect that students will have improved their ethical reasoning skills, that being a lesser skill but a prerequisite to emotional engagement and understanding. Indeed, that is the case in this research. There is a positive correlation between the statistically significant improvement in DIT-2 scores of the students in ENT3958 and both their emotional engagement with ethics and their understanding or professional and ethical responsibilities.

My research findings both support and are supported by theoretical assumptions concerning the potential problems with traditional engineering ethics instruction. Particularly implicated is the case study method. I discussed the shortcomings of the case study method in Chapter One. Much of the criticism I presented of the case study method is theoretical and not supported by actual research. So it is revelatory and relevant that the findings of my research – which derive directly from the work of my students – are consistent with the theory about the case study method. One of the principal allegations made about the case study method is that it promotes an "individualist" or "agent-centered" approach to engineering ethics which creates and perpetuates myths about ethical decision-making. Most of the standard case studies

used in engineering ethics education depict the engineer as the “individual actor who, alone, must make the ethical decision between ‘personal sacrifice’ or doing nothing” (Conlon and Zandvoort 220; see also Kline 16–17). Students in ENT3958 expressed considerable anxiety about this very situation – that they will be alone with the full weight of an ethical decision riding on his or her shoulders. Prepackaged case studies leave students with the impression that “the only choices one is given are to challenge superiors, potentially losing one’s job, or accept the status quo, potentially leading to serious, negative outcomes” (Lynch and Kline 208). This concern was also prevalent among the students in ENT3958 and was expressed in their essays.

Case studies promote the unrealistic reliance on the NSPE Code of Ethics to resolve ethical questions and “gives the false impression that rules of codes of ethics are clear and unambiguous” (Conlon and Zandvoort 220–221; see also Bucciarelli 9; Loui, “Ethics and the Development of Professional Identities of Engineering Students”). Nearly every student acknowledged a new realization that codes of ethics are, at best, general guidelines but do not resolve ethical issues. Case studies encourage students to see problems as dichotomies with a “win-win” solution and selectively omit the complex trade-offs and underlying contexts in which engineering and ethical decision-making are practiced in the world (Colby and Sullivan 331; Conlon and Zandvoort 221). Most students, learning from their interviews and interpretations of the readings, expressed an understanding of the necessity of seeing the whole picture and the reality of complex trade-offs without win-win answers.

Case studies reinforce the idea that the engineering domain is ethically neutral and lead engineering students to understand ethical problems as “specific troubling incidents within what are assumed to be otherwise harmonious patterns in ongoing institutions” (Winner, “Engineering Ethics and Political Imagination” 50) without ever questioning or engaging the social situatedness of their work (Burbules, Lang, and Ramsey; Bucciarelli). This might be the most difficult aspect of engineering ethics for students to grasp, but student essays reflect that the concept at least took root in their thinking about professional and ethical responsibilities. They are asking questions that, by their own admission, they had not asked before, and that is an act of understanding.

These research results suggest that the long-standing, ubiquitous, and sacrosanct case study method needs to be reexamined through further research that investigates its unquestioned efficacious utility. Blending the theory that critiques case studies with the perspectives expressed by my students, a more harmful than helpful picture of the traditional case study method emerges. Importantly, I note that this research will necessarily be qualitative because validation of the theoretical and actual inadequacies of the case study method is not discoverable by quantitative means, which arguably conceals more than it reveals. This, I submit, is a significant outcome of my research, even though it is not one that I set out to find.

Rigor and Trustworthiness

Qualitative research requires rigor and trustworthiness, just as quantitative research requires validity and reliability. If we want our research to be accepted, we must strive for

and meet high standards for trustworthiness (Creswell; Borrego, Douglas, and Amelink; Koro-Ljungberg and Douglas; Leydens, Moskal, and Pavelich). I have incorporated several methods that help establish trustworthiness of my work on this project. My qualitative research has been consistent in stating and maintaining its theoretical perspectives grounded in phenomenology and philosophical hermeneutics. Findings are tracked to the supporting data and to the underlying theoretical support. As much as possible, I have addressed and taken account of my own biases and orientations as I worked with the data and arrived at interpretations. I have employed multiple methods or "triangulation", both quantitative and qualitative, to measure and understand results; this included the ESSQ, the DIT-2, and both a traditional phenomenological approach and a philosophical hermeneutic approach to qualitative data interpretation.

As a final check on the findings and conclusions about student understanding of professional and ethical responsibilities, I convened a group of interdisciplinary external reviewers who used philosophical hermeneutic principles to review the student essays. The group of five included two engineers who had graduated from Michigan Tech and worked in industry for decades, a person who graduated from Michigan Tech with a degree in business and who has worked in several corporate and government positions, a mathematician with a career background in information technology, and an assistant teacher in the local Copper Country Intermediate School District. I provided the group with a briefing on my research and teaching, including a description of the phenomenology-informed approach I am using. I explained current dissatisfactions with engineering ethics instruction in preparing students to deal with ethical issues, especially those posed by emerging technologies. I did not discuss my own findings, but I did say

that the goal of the class is to get engineering students to care about and to have an understanding of personal and professional ethics. Each person received two anonymous essays, selected randomly, for a total of ten essays. I asked them to read the essays and think about what they thought the students got from the course. I explained that this would involve occasionally “reading between the lines” to understand and interpret what students meant. We then had a short discussion of their findings and feedback.

The following summarizes their comments. Each person selected key words or passages from the essays that helped shape their thinking and conclusions about the essays. They looked for sincerity (versus trying to please the instructor to get a good grade). They also looked for elaboration about personal meaning and interpretation rather than mere reporting of interview results or readings. Everyone commented that the two essays each of them read were different in content and style but there were some common themes. The engineers both agreed that, based on their own experiences, new engineers who enter the workforce have no clue about what their ethical expectations will be and that they need something that better prepares them. All five reviewers thought that, with one exception, each student seemed to genuinely care about ethics and being an ethical engineer and that perhaps the class had contributed to that outcome.

A couple of reviewers commented that students seemed perplexed about ethics, most notably when they were discussing technology and its ultimate uses. These reviewers seemed to think that the students should have a better idea of where they stand on the

issue of technology. They were, however, expressing their own point of view and, when pressed, admitted they didn't have answers for themselves either and acknowledged that being able to raise the question is probably better than most engineers will do. Another reviewer said that the students showed a maturing attitude in that their circle of empathy seemed to be expanding. One reviewer commented that he could see students almost "thinking their way through the paper." They also agreed that these students were prepared – at least as prepared as we can expect young, inexperienced engineering students to be – to enter the workforce. One of the engineers put it this way: "Most new engineers don't even know that there is something out there that they ought to know about; these students are aware that there is something there and that they are going to have to know about it – that puts them a step ahead of the game." Everyone thought that overall the students "got it" – that they had a personal idea of what it meant to be an ethical engineer. This review process was certainly more cursory than was my own research, and none of the reviewers had the benefit of reading all of the essays to form judgments about general themes. It seemed, however, that this format allowed them to come to some conclusions about their own assigned essays and, when they had the opportunity to talk with the other four reviewers, their individual thoughts coalesced into a general consensus that the students had a better understanding of professional and ethical responsibility than most young engineering students and that, if it came from the course, that was a good outcome.

Part of trustworthiness of research includes recognizing and acknowledging the limitations of one's work. Throughout this chapter I have acknowledged that the results from the ESSQ and the DIT-2 tests did not include tests using control groups, that is, a

group of engineering students who took an ethics course that was taught using traditional methods and another group of engineering students who had not taken any separate ethics course at all. Control groups (ideally, randomly selected) are part of the gold standard of evidence-based research. This creates a tension between quantitative and qualitative research because qualitative research is often faulted for the absence of control groups. “Indeed, within the evidence-based community there is the understanding that qualitative research does not count as research unless it is embedded in a randomized control trial (RCT!). Further, within this community, there are no agreed upon procedures, methods, or criteria for extracting information from qualitative studies” (Denzin 140).

As I reached this place in my research, I have some thoughts about control groups and the quantitative and qualitative work I have done on this project. First, my original plan was to teach ENT3958 in the spring semester 2015 using a traditional ethics instruction approach. The course is normally offered once a year during the fall semester. Only two students registered for the spring 2015 course and so it was cancelled. As a practical matter, it isn’t likely that a control group class can be obtained at Michigan Tech as long as an engineering ethics standalone course remains elective. Arguably, I could use the fall semester 2015 class as a control. Quite frankly, based on my research and the student outcomes achieved, I think it would be a disservice to my students if I did so. Second, my intent is not to prove that a phenomenological approach to engineering ethics pedagogy is the “cause” of the student learning outcomes, though some of the quantitative and qualitative results suggest that it is, and there is certainly a correlation. Nor is my intent to prove that this approach is the best or only way to teach engineering

ethics. Other educators and researchers are continually testing new methods and outcomes, and that work should continue. Third, I can make a reasonable argument that the *status quo* of undergraduate engineering student learning outcomes and ethical skills does serve as a control group. The SEED study, for example, which included students from Michigan Tech and 17 other domestic engineering programs, gave us that snapshot or *status quo* of the overall level of ethical development of the general population of undergraduate engineering students, and it was not a positive one. The consensus within the engineering education community itself is that engineering students fall short in their ethical development (see, for example, Pine; Colby and Sullivan). We know the outcomes we get with what we are doing, and by engineering educators' own admission, it is not satisfactory. If we can develop engineering ethics pedagogical methods that correlate with improved ethical sensitivity and reasoning and that also help students and engineering programs meet the ABET ethics criterion of "an understanding of professional and ethical responsibility", why would we reject those possibilities because they haven't been tested on control groups? As the ancient maxim holds, "the proof of the pudding is in the eating." If we've tried it, we don't have to compare the pudding to something else to know if we like it. Denzin contends that we need "flexible guidelines that are not driven by quantitative criteria" (140), that we "must resist the pressure for a single gold standard" and that we "can not let one group define the key terms in the conversation" (152). I suggest that, if qualitative research satisfies the field's and peer standards for rigor and trustworthiness, then the results can stand on their own, without the corroborating evidence of a control group.

A related objection often raised about qualitative research is the small sample size included in qualitative studies, making it difficult – it is argued – to “trust” that the results have meaning. I previously addressed this objection in Chapter Three’s section on “Qualitative Research in Engineering Education,” but this is a good place to reiterate comments made earlier. Quantitative research is usually designed in order to find results that can be generalized across a population. This is not, however, the intended outcome of qualitative research. Rather, qualitative research focuses on the particular and the local, with care taken to secure “thick, rich descriptions” of the phenomenon or experience under study to better understand the complexities of these experiences. Qualitative research is “not meant to provide fodder for cross-case generalization” (Leydens, Moskal, and Pavelich, 65). The concern is to ensure that the particular experience under study is done in a thorough, rigorous, and trustworthy manner. In my work, the qualitative research is intended, first and most importantly, to tell me whether or not my ENT3958 class achieved an understanding of their professional and ethical responsibilities and, second, to inform me about how the course can be strengthened to achieve better learning outcomes for my students and to highlight best practices in the course. The thick, rich descriptions taken from student essays and subjected to rigorous interpretive methods are the sources of “evidence” to support my conclusions that my students do understand their professional and ethical responsibilities after taking this course. Whether these outcomes will be generalizable to all undergraduate engineering students who take a similarly designed ethics course is not my principle concern. I offer this pedagogy as an option to consider and the results from my class as simply that – the results from my class. Whether results are transferable will be left to future studies and applications.

Using philosophical hermeneutic assessment to inform the future design and delivery of the ENT3958 course curriculum:

What qualitative researchers must do, however, is provide guidance so that the quantitative community can make sense of and use the results from qualitative research and assessment in engineering education in order to conduct their own studies and to improve learning outcomes for students. With that in mind, this work has undertaken to test whether qualitative methods – in particular, the practice of philosophical hermeneutics – can be used to assess the student learning outcomes required by ABET Engineering Criterion 3(f) for my students in ENT3958 and to assess and improve ethics curriculum design and teaching. A philosophical hermeneutic approach to assessment allows me to read the student essays with eye toward understanding what is being said beyond the explicit "author's intention," – reading between the lines so to speak – so I can discover the strengths and the weaknesses of the course. What have I learned about ENT3958 as it was designed and delivered in the fall semester of 2014?

The course syllabus explains that the course design is premised on several assumptions: "First, most engineering students don't care about learning ethics philosophy – that's a general observation made by most instructors who teach engineering ethics. Second, most engineering students don't actually engage with the study of ethics even though this is one of the learning outcomes that we expect. Third, engineering students prefer to investigate a question rather than study about it in books – you want hands on projects. Fourth, engineering ethics will be more meaningful if you study it in the context of everyday real engineering work. This is especially true because most of you in the class are preparing to graduate very soon and enter the engineering

profession." Based on my experience teaching ENT3958 with this phenomenological approach and considering student feedback at the end of the semester, I can confirm that these assumptions are valid. The students respond positively to a pedagogical approach to professional and ethical responsibility that gives them guided autonomy and a way to investigate a question that has a meaningful context.

The class assignments differed in 2014 from prior years in one important respect. I required two in-person individual meetings with each student during the semester, and I think these meetings helped to emotionally engage the students in the coursework. Several students commented about the value of these meetings in the course evaluations completed at the end of the semester. These meetings narrowed the difference between me and the students. It was an opportunity for them to briefly have all my attention and to talk about anything that mattered to them in the class. Often this included clarifying concepts and expectations, and I think this contributed to their willingness to actually care about the class in general. When I decided to structure the course to give students increased research autonomy, I added these individual meetings as a way to track their progress and hold them accountable for getting the required work done. I didn't expect that the meetings would have as much benefit to the students as they reported. These one-on-one meetings were effective for purposes of accountability but, more important, they sent a message to the students that I cared about their work and I wanted them to succeed. That was a surprise to me. I will retain these meetings in future ENT3958 classes.

By far, the most influential class activity for the students is their interview of an engineer. The power of this experience cannot be overstated. While no student expressed it this way, the understandings they derived from the interviews could not be reproduced in a textbook or film case study. There is something about meeting one-on-one to have a dialog with an experienced engineer about a topic that is probably the most unlikely thing they could image themselves discussing. When I first included this assignment, I did so without any idea of how meaningful it would be for the students. Van Manen writes of the “wonder” that a phenomenology researcher finds in the work of investigating experience. Although their research takes place on a very limited and simple scale, my students consistently found “wonder” when they interviewed engineers about the experience of being an ethical engineer. Of all the new understandings acquired by my students during the class and described by them in their research essays, the most insightful arose during these interviews or when students reflected on them afterwards. If this course were offered for more than one credit, I would consider expanding the interview requirement so that students could gain one or two additional perspectives on this subject. I will also consider inviting engineers to talk to the class about what it is to be an ethical engineer; this would be in addition to the individual interviews.

I paid attention to how the students wrote about the assigned readings. What I learned is that it is important to review the course readings at least annually and to select readings that engage the students. The case studies presented in most engineering coursework or ethics instruction are well-known but ancient history as far as the students are concerned – the space shuttle disasters, the exploding Pinto gas tank, collapsing hotel walkways, and leaked chemicals. It isn’t that these problems are no longer relevant but

the specific cases are not. Similarly, the standard fictional films developed for teaching engineering ethics are boring and contrived. The students themselves report this *when asked!* There are so many sources for fresh, engaging, and relevant readings that there is simply no excuse not to review and update course readings regularly. Often, there's a good reason to keep historic readings, such as Heidegger's *The Question Concerning Technology*, as long as I explain why it is included. Students want to engage. I need to be attuned to that and do my best to give them a reason to engage.

I have discussed the need to keep students accountable for doing the assignments. This was especially important because students were given so much leeway in doing their research work. Maintaining students' accountability is always a problem for educators and perhaps we need to let students do as little or as much as they want. But I am responsible for creating conditions for success and that is why I required individual meetings with the students. From those meetings, I learned that the absence of regular class meetings was occasionally an excuse to delay the reading assignments. In the end, they did the work, but some students had to scramble to get it done. In the future, I have decided to include a timetable for the readings and to require my students to turn in written notes from their interviews and summaries of how they relate the readings to the research inquiry.

Concluding Thoughts on Qualitative Assessment in a Quantitative World

Qualitative assessment is far more difficult, time consuming, and complex than traditional assessment (Koro-Ljungberg and Douglas). Nonetheless, the work I've done here is intended to show that qualitative methods – in particular, assessment grounded

in philosophical hermeneutics – can offer insight and understandings about students that traditional assessment cannot. If an understanding of professional and ethical responsibilities means that my students identified and engaged their foregrounded horizons – their own values and traditions, that they were willing to place those values and traditions at risk in dialogic encounters with new texts, and that they emerged with some changed outlooks on professional and ethical responsibilities and what it is to be an ethical engineer, then philosophical hermeneutics is an approach that can help me get an authentic understanding of what my students understand as well as insight into how the course can be continually improved to meet student-centered needs. This is the work of philosophical hermeneutics, and it can arguably work far beyond the engineering ethics classroom.

A positivist perspective will claim that we cannot assess students' understanding of professional and ethical responsibilities without specific, concrete, standardized performance indicators that can be represented by quantitative values, what Dunne calls the "behavioral objectives model" (Dunne 3–8). What I want to do here is demonstrate how a philosophical hermeneutic approach to assessment can enhance and enrich ABET assessment practices to give a deeper, thicker, and student-centered understanding of whether and how students meet the requirements of E.C. 3(f). In doing so, I do not suggest replacing institutional and program ABET assessment practices, but I do support adding a method that gives us information about our students' learning that we wouldn't otherwise have.

ABET defines assessment as a process that “uses relevant direct, indirect, quantitative *and qualitative measures as appropriate to the outcome being measured*” (ABET 2, emphasis added). ABET mandates a set of student outcomes for accreditation of engineering programs. Engineering programs, as part of the accreditation process, must identify their own “performance indicators” which are “specific, measurable statements identifying the performance(s) required to meet the outcome; confirmable by evidence” (Rogers 7). ABET offers training for educators in assessment practices in order to prepare for the accreditation review process. One of these has been the five-day IDEAL (Institute for the Development of Excellence in Assessment Leadership) Scholars program. I completed this program in 2010 and am considered an “ABET IDEAL Scholar” with skills in program assessment. So I have some background and understanding from which to critique these assessment practices.

Although ABET requires that we select measures – performance indicators – that are appropriate to the outcome being measured, the actual practice is that all performance indicators must be convertible into a quantitative rubric. A good part of assessment practice is developing the content of these rubrics for each of the ABET Criteria, including the eleven mandated Student Outcomes of Criterion 3. I will focus on E.C. 3(f), an understanding of professional and ethical responsibilities. I previously examined several rubrics used to assess E.C. 3(f) and included them in Appendix A for reference (see also Chapter One, Table 1.1). An important feature of many of the performance indicators used in rubrics is that they begin as qualitative measures but are then converted to quantitative values expressed in a rubric format. My point is not to argue with the quantitative format of a rubric but rather to highlight that we are already

engaged in qualitative thinking when we begin to develop a rubric to assess students' understanding of professional and ethical responsibilities. Rubrics represent a conversion of qualitative thinking into quantitative measurement and an attempt to reduce as much as possible the need for interpretation.

Ethics rubrics typically require an assessor to evaluate a student's ability to identify ethical issues in a case study, apply selected skills (knowledge of ethics codes, ethical reasoning skills) to the case, and justify the ethical decision. There is nothing wrong with this provided we acknowledge that the rubric aims to judge performance based on this single structured case and that the assessor is [unrealistically] using the results from one case study to represent students' overall understanding of professional and ethical responsibilities. We must question, in the first place, whether the use of a single case study (which may well be a case or issue that the students have already studied) reflects their understanding of professional and ethical responsibility. Moreover, this approach toward assessment may prove Newberry's observation that undergraduate engineering students can apply ethics principles to engineering ethics problems and arrive at ethically satisfactory answers but that they remain unengaged and uncaring about ethics (Newberry). In the end, the single case study and the rubric assessment methods don't tell us much about students' understanding of professional and ethical responsibilities.

And this takes us to the heart of the matter of assessment – how much do we want to know and why do we want to know it? Is this a *pro forma* activity designed to look good for accreditation purposes or do we really want to understand how our students understand professional and ethical responsibilities? Do we want to be able to express

something meaningful about whether and how we are preparing our undergraduate engineering students to be ethical engineers? I suggest that the value of philosophical hermeneutic assessment – its potential to add new dimensions to what we learn from assessment – has been evidenced by my work on this project. This work has demonstrated that philosophical hermeneutics can be used to meaningfully assess undergraduate engineering students' understanding of professional and ethical responsibilities by giving us deeper insight about our students' preparation to enter the world of engineering practice. Additionally, philosophical hermeneutic assessment tells us what is working and what needs to be improved in our ethics curriculum in order to achieve better student learning outcomes.

Chapter Five
Concluding Thoughts

Significance and Implications

The foremost question I ask is whether and how my work has added to knowledge. When I first conceived of turning my classroom instruction into a research project, I felt confident that the results could be transformative for engineering ethics pedagogy. Nearly four years later, an honest assessment would be that my work suggests propitious possibilities for engineering ethics pedagogy and assessment. My research has been inspired by the work of many others before me who have been and continue to be committed to the design and testing of best practices in engineering ethics instruction. Were it not for their work, I would not likely have undertaken this project. I have always sought to build on what has already been done.

I draw two primary conclusions from my work. The first is that a one-credit course in engineering ethics can substantially improve undergraduate engineering students' ethical sensitivity, ethical reasoning skills, emotional engagement with ethics, and their understanding of professional and ethical responsibilities. I will go one step farther and add that my work strongly suggests that a phenomenology-informed approach to engineering ethics may account for the degree of improvement in student outcomes shown by my research. I have been careful in this dissertation not to claim this method is the cause of the improved student outcomes. Yet, for all that, I do have the experience of teaching engineering ethics for several years using a traditional approach and being able to observe and compare – albeit anecdotally – the differing student outcomes from traditional versus phenomenological methods. Although I have no ESSQ or DIT-2 data

for my earlier classes, I recall what prompted me to try something new in the first place. Students did not care about studying ethics, and that attitude did not change appreciably over the course of the semester. Students relied on rules and heuristics to make ethical decisions when they entered the class and, with my reinforcement, left the class with the same skill perhaps slightly improved. Students did not, in my opinion and with the benefit of hindsight, have an understanding of their professional and ethical responsibilities. From my personal point of view – and irrespective of the data that supports a phenomenological approach – I would not return to a traditional ethics instruction model because I do not find that it best serves student interests in preparing them to enter the profession of engineering and to be ethical engineers.

The second conclusion I make is also an observation and critical comment. I have learned from my research that we educators – of engineering, of ethics – are not attuned to what is important to our undergraduate engineering students about being ethical engineers. While we are concerned with imparting ethical knowledge, our students are concerned with understanding how they are going to fit into the world of engineering as ethically competent professionals when they make the leap from undergraduate student to practicing engineer. This is the gap we must fill if we expect our students to graduate with an understanding of their professional and ethical responsibilities. Why have we not realized this about our students? I suggest that our focus on accreditation and the attendant quantitative assessment of student outcomes is largely to blame. This approach doesn't allow for nuance and personal concerns to emerge. Some might argue that the students don't complain about their ethical preparation, giving us no reason to question what we are doing. The SEED study that I've often referenced in this

dissertation confirmed the ironic result that 92% of Michigan Tech undergraduate engineering students are either “Very satisfied” or “Satisfied” with the quality of their professional engineering ethics education although these same students demonstrate ethical reasoning skills that are lower than their peers at other engineering schools by statistically significant margins (Carpenter, Harding, and Finelli 37, 44). So it would be a mistake to argue that it’s up to our students to initiate a change in ethics education. We are the educators, after all.

Others will argue that our engineering programs are meeting ABET accreditation standards, thereby proving that students are satisfying the engineering ethics requirement of E.C. 3(f). That is a more difficult position to contest. But I respond that, given the findings of my qualitative assessment using philosophical hermeneutics, we must question, first, our definition of what is intended by E.C. 3(f) and, second, what outcomes we genuinely want for our engineering students. Clearly, students have legitimate fears about engineering ethics, and these are concerns that ethics instruction can address and help prepare them to face, even if we cannot alleviate them altogether. One of the most useful results of the peer review of student essays was an affirmation that these students are expressing an understanding of professional and ethical responsibility in ways that most young novice engineers do not, and that this would be an advantage for them when they enter the engineering profession. Certainly the small group of reviewers cannot speak for the entire engineering profession, but their feedback should carry some weight. Isn’t this the reception we’d like our engineering students to have when they graduate and go to work?

As a result of my work on this project, I have concluded that a phenomenological approach to engineering ethics education – where students are given the opportunity to investigate, encounter, and understand the real, lived experience of what it is to be an ethical engineer – can help fill this gap and that qualitative assessment – in particular the use of philosophical hermeneutics – can tell us so much more about our students' true understanding of professional and ethical responsibility.

Recommendations

The question is what this means for engineering ethics instruction and the duty of engineering programs to ensure that graduates meet the requirements of E.C. 3(f). I offer two recommendations that correspond to my two principle conclusions. First, I recommend that engineering programs require all undergraduate engineering students to complete, at a minimum, a one-credit engineering ethics course or its equivalent. I qualify this recommendation with the suggestion that the course be modeled, at least in part, on the phenomenology-informed approach I have described and tested in my research. I support this suggestion with several reasons. While future research can test the causative aspects and outcomes of a traditional versus phenomenological approach, my own work suggests that students will be more engaged in the study of engineering ethics using a phenomenology approach and that they will emerge from the class with a different and better understanding of their professional and ethical responsibilities than they get from traditional ethics instruction or, as per the *status quo,* from engineering programs that require no formal ethics instruction at all. The suggested phenomenological approach doesn't attempt to turn engineering students into philosophers. Rather, it gives them a hands-on investigative role; it studies engineering

ethics in the context of everyday real engineering work; and it gives them the unique opportunity for a one-on-one conversation about being an ethical engineer. If the students are engaged in the coursework, they are more likely to take something beneficial from it.

The second recommendation is that engineering programs regularly conduct qualitative assessment to find out what is going on with their students. In the case of my work, such assessment would be with engineering ethics. I suspect that engineering programs might be surprised to find significant differences between what they learn by quantitative accreditation assessment and what they learn by qualitative assessment. If engineering program faculty and administrators do not feel competent to conduct qualitative assessment, they do have access to professionals on campus who could do this work for and with them. It isn't magic; it isn't a mystery; it isn't something that is too far "out there." I am not recommending that quantitative assessment be scrapped altogether, but that qualitative be added to the process. Qualitative assessment will yield information that engineering programs cannot secure through quantitative methods alone.

Future Directions for this Research

This work is a start. Where I or anyone else takes it from here depends on objectives and resources. If the researcher is intent on testing whether a phenomenological approach to engineering ethics education causes improved ethical sensitivity, ethical reasoning, emotional engagement, and understanding of professional and ethical responsibility, then it would be appropriate to expand the work that was done here to include at least two control groups – one control group that studies engineering ethics

using a traditional approach and a second control group that takes no engineering ethics course at all. The same method could also be used to test other ethics instructional approaches.

As to establishing statistical significance of changes in quantitative measurements (ESSQ, DIT-2, or other tests for ethical sensitivity or ethical reasoning), my suggestion is to use paired comparisons for pre-tests and post-tests. This approach can make a difference in terms of whether the changes are statistically significant. I did not do this because I did not recognize in advance that this could be true and that outcomes could be different. When I retroactively and hypothetically assumed some paired data comparisons for the ESSQ, for example, I found that those improvement in scores could have been statistically significant.

It would also be worthwhile to try an alternative to the DIT-2 as a test of ethical sensitivity, in particular, one of the new tests being developed with engineering-specific scenarios. While I do not think that results would necessarily be different (both forms of tests use ethical dilemmas and, when we think about it, there should be no difference in outcomes), the comparison would be interesting to make. It is arguable that an engineering specific test would operate to affirm that engineering ethics has only to do with engineering design and work issues, but students may also be more engaged in taking such a test.

For the past two years, I’ve worked with faculty from Engineering Fundamentals to redesign the ethics modules used in the first year, first semester, introduction to

engineering course. The new modules are a highly condensed version of the materials students read in ENT3958. Additionally, because there is such great value for students to interview an engineer about what it is to be an ethical engineer – but recognizing that 900 first year engineering students cannot realistically find and interview engineers – we have devised an alternate approach. The instructors invite a panel of engineers to talk with the students about what it is to be an ethical engineer. Two special evening sessions are held and students must attend one of those sessions. Students are also required to prepare five questions for this session. The feedback from students to the instructors is that this is one of their most meaningful assignments of the semester. We have attempted pre-tests and post-tests using the DIT-2 with a pilot group of Engineering Fundamentals students who received instruction using the new module and another group who received instruction with the traditional module. From the results gathered, there has been no statistically significant change in scores for either group. This was not an unexpected result as prior studies have shown that an ethics module delivered in an engineering course is not effective in improving ethical reasoning scores. Also there were problems with instructor buy-in which included objections to the time the DIT-2 required for the students to take it (twice) and the fact that it was not engineering related. Nonetheless, there are faculty in Engineering Fundamentals who are committed to continuing this work. We will continue to work on the modules and attempt to measure outcomes.

My focus will be on dissemination of results through publishing. I am still considering the possibility of writing an ethics instruction workbook using the approach and assignments developed in my ENT3958 course. Perhaps the most compelling outcome of my work is

the discovery that a one credit ethics course can produce significant improvements in ethical sensitivity, ethical reasoning and – most important – understanding of professional and ethical responsibility for undergraduate engineering students. I will encourage the adoption of some form of mandatory engineering ethics instruction for all undergraduate engineering students.

Ideally, though this seems unrealistic for many reasons – but there is nothing wrong with dreaming – I would like to study engineering ethics and the philosophy of engineering at an institution such as Delft University of Technology in the Netherlands. Their Values, Technology and Innovation Department includes an “Ethics/Philosophy of Technology” section that focuses on engineering ethics education. Oh, to be a couple decades younger.

Finally, and on a more realistic plane, I will be open to working with anyone else interested in pursuing this work. This may include seeking sponsored research funding through sources such as NSF’s Research in Engineering Education Program. I believe that my work provides a solid place from which to launch focused engineering ethics research, and I hope that this work continues. Important issues beyond the efficacy of a phenomenological approach to instruction have also been raised. For example, the philosophical hermeneutic assessment results must ask us to question how we use case studies in ethics education. The case study is such a staple in engineering ethics and we have to ask whether it is truly producing the intended results, at least in the ways it is currently used.

One aspect of engineering ethics that hasn't been explored much but that could have considerable significance for the effectiveness of pedagogical method is the long term impact of engineering ethics instruction on students post-graduation. I referenced earlier the work of Harding, et al. who followed up with some of the students who participated in the SEED study to try to assess the impact of engineering ethics instruction two years after the original SEED project. Their findings were mixed – ethical reasoning skills had improved somewhat but ethical knowledge had not – but this study was conducted while the students were still at their institutions and prior to graduation (Harding, Carpenter, and Finelli). My interest would be in a more extensive longitudinal study of students from ENT3958, following them post-graduation and after they had been working for five years and, ideally, again after 10 years or even 15 years. Makkai undertook a longitudinal study of engineering students – when they entered the university, after four years at university, and as professionals 13 years after graduation – to ascertain the values they identified and the extent to which those values remained stable over the 19 years of the study. Her study was concluded in 1991, quite a while ago (Makkai). This area for research is wide open, but it clearly requires appropriate financial resources to conduct such studies.

So I hope that this work creates new education and research possibilities through the questions that have been raised. That would be a gratifying legacy.

Works Cited

ABET. "2013-2014 Criteria for Accrediting Engineering Programs." 27 Oct. 2012. Web. 31 Oct. 2014.

---. "Engineering Criteria 2000." N.p., n.d. Web. 1 July 2014.

Adorno, T. *Minima Moralia*. London: Verso Editions, 1974. Print.

alZahir, Saif, and Laura Kombo. "Towards a Global Code of Ethics for Engineers." Chicago, IL: IEEE, 2014. Print.

Arendt, Hannah. *The Human Condition*. 2nd ed. Chicago, IL: University of Chicago Press, 1958. Print.

Aristotle. "Metaphysics Book I (A)." *The Complete Works of Aristotle*. Vol. 2. Princeton, NJ: Princeton University Press, 1984. Print.

---. "Nichomachean Ethics." *Philosophy of Technology: The Technological Condition*. Malden, MA: Blackwell Publishing, 2003. 19–31. Print.

---. *The Art of Rhetoric*. London: Penguin Group, 1991. Print.

Asimov, Isaac. "Isaac Asimov Asks, 'How Do People Get New Ideas?'" *MIT Technology Review* (2014): n. pag. Web. 23 Oct. 2014.

Baron, Marcia, Philip Pettit, and Michael Slote. *Three Methods of Ethics*. Malden, MA: Blackwell Publishing, 1997. Print.

Bebeau, Muriel J., and Stephen J. Thoma. *Guide for DIT-2*. 3.0 ed. Center for the study of Ethical Development: University of Minnesota, 2003. Print.

Bentham, Jeremy. *An Introduction to the Principles of Morals and Legislation*. Clarendon Press, 1879. *Google Scholar*. Web. 22 Oct. 2014.

Bizzell, Patricia. "Beyond Anti-Foundationalism to Rhetorical Authority: Problems Defining 'Cultural Literacy.'" *College English* 52.6 (1990): 661–675. Print.

Blackburn, Simon. *Being Good: A Short Introduction to Ethics*. Oxford University Press, 2002. *Google Scholar*. Web. 22 Oct. 2014.

Booth, Wayne C. *The Rhetoric of Rhetoric: The Quest for Effective Communication*. Malden, MA: Blackwell Publishing, 2004. Print.

Borges, Mario Neto, Maria Do Carmo Narciiso Silva Goncalves, and Flavio Macedo Cunha. "Teaching and Learning Conceptions in Engineering Education: An Innovative Approach on Mathematics." *European Journal of Engineering Education* 28.4 (2003): 523–534. Print.

Borrego, Maura, Elliot P. Douglas, and Catherine T. Amelink. "Quantitative, Qualitative, and Mixed Methods Research Methods in Engineering Education." *Journal of Engineering Education* 98.1 (2009): 53–66. Print.

Bowie, Norman. "Are Business Ethics and Engineering Ethics Members of the Same Family?" *Journal of Business Ethics* 4.1 (1985): 43–52. Print.

Broome Jr, Taft H. "The Concrete Sumo." *Presented at the OEC International Conference on Ethics in Engineering and Computer Science*. N.p., 1999. *Google Scholar*. Web. 21 Oct. 2014.

Bucciarelli, Louis L. "Ethics and Engineering Education." *European Journal of Engineering Education* 33.2 (2008): 141–149. Print.

Bunge, Mario. "Philosophical Inputs and Outputs of Technology." *Philosophy of Technology: The Technological Condition*. Malden, MA: Blackwell Publishing, 2003. 172–181. Print.

Burbules, Nicholas C., John Lang, and B.J. Ramsey. "Models of Teaching Professional and Research Ethics: A Literature Overview and Typology of Approaches." *National Ethics Resource Center*. N.p., 7 Feb. 2013. Web. 25 Nov. 2014.

Burch, Robert. “On Phenomenology and Its Practices.” *Phenomenology + Pedagogy* 7 (1989): 187–217. Print.

---. “Phenomenology, Lived Experience: Taking a Measure of the Topic.” *Phenomenology + Pedagogy* 8 (1990): 130–160. Print.

Butler-Kisber, Lynn. *Qualitative Inquiry: Thematic, Narrative and Arts-Informed Perspectives*. Sage Publications, 2010. *Google Scholar*. Web. 22 Oct. 2014.

Callahan, Daniel. “Goals in the Teaching of Ethics.” *Ethics Teaching in Higher Education*. Springer, 1980. 61–80. *Google Scholar*. Web. 31 Oct. 2014.

Carpenter, Donald D., Trevor S. Harding, and Cynthia J. Finelli. *Survey of Engineering Ethical Development Report for Michigan Technological University*. N.p. Print.

Chung, C. et al. “DIT-2: Moral Schema Norms—the Updates from Recent Data Sets.” *American Educational Research Association Annual Conference, San Diego, CA*. N.p., 2009. Print.

Clarkeburn, Henriikka. “A Test for Ethical Sensitivity in Science.” *Journal of Moral education* 31.4 (2002): 439–453. Print.

Colby, Anne, and William M. Sullivan. “Ethics Teaching in Undergraduate Engineering Education.” *Journal of Engineering Education* 97.3 (2008): 327–338. Print.

Cole, Marilyn. “Hermeneutic Phenomenological Approaches in Environmental Education Research with Children.” *Contemporary Approaches to Research in Mathematics, Science, Health and Environmental Education* 2010 (2010): 1–5. Print.

Conlon, Eddie, and Henk Zandvoort. “Broadening Ethics Teaching in Engineering: Beyond the Individualistic Approach.” *Science and Engineering Ethics* 17.2 (2011): 217–232. Print.

Creswell, J.W. *Qualitative Inquiry and Research Design: Choosing among Five Traditions*. 2nd ed. Thousand Oaks, CA: Sage, 2007. Print.

Cummings, Mary L. "Integrating Ethics in Design through the Value-Sensitive Design Approach." *Science and Engineering Ethics* 12.4 (2006): 701–715. Print.

Daly, Kerry J. *Qualitative Methods for Family Studies and Human Development*. SAGE, 2007. *Google Scholar*. Web. 21 Oct. 2014.

Davis, M. "Thinking like an Engineer: The Place of a Code of Ethics in the Practice of a Profession." *Philosophy & Public Affairs* (1991): 150–167. Print.

Davis, Michael. "Does 'Public' Mean an Engineer's Nation?" Chicago, IL: IEEE, 2014. Print.

---. "Rhetoric, Technical Writing, and Ethics." *Science and Engineering Ethics* 5.4 (1999): 463–478. Print.

Davis, Michael, and Alan Feinerman. "Assessing Graduate Student Progress in Engineering Ethics." *Science and engineering ethics* 18.2 (2012): 351–367. Print.

Denzin, Norman K. "The Elephant in the Living Room: Or Extending the Conversation about the Politics of Evidence." *Qualitative Research* 9.2 (2009): 139–160. Print.

Denzin, Norman K., and Yvonna S. Lincoln. "Introduction: The Discipline and Practice of Qualitative Research." *The Sage Handbook of Qualitative Research*. Thousand Oaks, CA: Sage Publications, 2005. 1–32. Print.

---. *The Sage Handbook of Qualitative Research*. Sage, 2005. *Google Scholar*. Web. 21 Oct. 2014.

Dong, Yangxue. "Norms for DIT-2: From 2005-2009." Web. 29 Oct. 2014.

Dostoevsky, Fyodor. *The Karamazov Brothers*. Oxford: Oxford University Press, 1994. Print.

Downey, Gary Lee, Juan C. Lucena, and Carl Mitcham. “Engineering Ethics and Identity: Emerging Initiatives in Comparative Perspective.” *Science and engineering ethics* 13.4 (2007): 463–487. Print.

Drake, Matthew J. et al. “Engineering Ethical Curricula: Assessment and Comparison of Two Approaches.” *Journal of Engineering Education* 94.2 (2005): 223–231. Print.

Dunbar, W. Scott. “Emotional Engagement in Professional Ethics.” *Science and Engineering Ethics* 11.4 (2005): 535–551. Print.

Dunne, Joseph. *Back to the Rough Ground Practical Judgment and the Lure of Technique*. Notre Dame, Indiana: University of Notre Dame Press, 1993. Print.

Dzialo, Michael G. “Legal and Philosophical Fictions: At the Line Where the Two Become One.” *Argumentation* 12.2 (1998): 217–232. Print.

Ellul, Jacques. “On the Aims of a Philosophy of Technology.” *Philosophy of Technology: The Technological Condition*. Malden, MA: Blackwell Publishing, 2003. 182–186. Print.

---. “The ‘Autonomy’ of the Technological Phenomenon.” *Philosophy of Technology: The Technological Condition*. Malden, MA: Blackwell Publishing, 2003. 386–397. Print.

---. “The Search for Ethics in a Technicist Society.” *Research in Philosophy and Technology* 9 (1989): 23–36. Print.

Ethical Theory: An Anthology. Second. Mal: Wiley-Blackwell, 2013. Print.

Felder, Richard M., and Rebecca Brent. “Designing and Teaching Courses to Satisfy the ABET Engineering Criteria.” *Journal of Engineering Education* 92.1 (2003): 7–25. Print.

Finelli, Cynthia J. et al. “An Assessment of Engineering Students’ Curricular and Co-Curricular Experiences and Their Ethical Development.” *Journal of Engineering Education* 101.3 (2012): 469–494. Print.

---. “An Assessment of Engineering Students’ Curricular and Co-Curricular Experiences and Their Ethical Development.” *Journal of Engineering Education* 101.3 (2012): 469–494. Print.

Finlay, Linda. “Debating Phenomenological Research Methods.” *Hermeneutic Phenomenology in Education: Method and Practice*. Rotterdam: Sense Publishers, 2012. 17–37. Print.

---. *Introducing Phenomenological Research*. N.p. Audio Recording. The Academy of Play and Child Psychotherapy.

Fleming, J.S. *Piaget, Kohlberg, Gilligan, and Others on Moral Development*. 2006.

Freire, Paulo. “Education and Conscientizaçã.” *Education: The Practice of Freedom*. London: Writers and Readers Publishing Cooperative, 1976. 46–58. Print.

Frey, William J. “Teaching Virtue: Pedagogical Implications of Moral Psychology.” *Science and engineering ethics* 16.3 (2010): 611–628. Print.

Gadamer, Hans-Georg. *Reason in the Age of Science*. Cambridge, MA: MIT Press, 1981. Print.

---. *Truth and Method*. 2nd rev. New York, NY: Continuum Publishing Group, 1989. Print.

Gallagher, Shaun, and Denis Francesconi. “Teaching Phenomenology to Qualitative Researchers, Cognitive Scientists, and Phenomenologists.” *Indo-Pacific Journal of Phenomenology: Teaching of Phenomenology: Special Issue 3* 12 (2012): 1–10. Print.

Garrick, John. “Doubting the Philosophical Assumptions of Interpretive Research.” *International Journal of Qualitative Studies in Education* 12.2 (1999): 147–156. Print.

Garrison, J. “A Dewyan Theory of Democratic Listening.” *Educational Theory* 46 (1996): 429–451. Print.

Gholami, Khalil, and Kirsi Tirri. “The Cultural Dependence of the Ethical Sensitivity Scale Questionnaire: The Case of Iranian Kurdish Teachers.” *Education Research International* 2012 (2012): 1–9. Print.

Gilligan, Carol. *In a Different Voice: Psychological Theory and Women’s Development*. Cambridge, MA: Harvard University Press, 1982. Print.

Goldman, Steven L. “Why We Need a Philosophy of Engineering: A Work in Progress.” *Interdisciplinary Science Reviews* 29.2 (2004): 163–176. Print.

Gorman, M.E. “Turning Students into Ethical Professionals.” *Technology and Society Magazine, IEEE* 20.4 (2001): 21–27. Print.

Greene, Joshua D. et al. “An fMRI Investigation of Emotional Engagement in Moral Judgment.” *Science* 293.5537 (2001): 2105–2108. Print.

Groenewald, Thomas. “A Phenomenological Research Design Illustrated.” *International Journal of Qualitative Methods* 3.1 (2004): 1–26. Print.

Grondin, Jean. “Gadamer’s Basic Understanding of Understanding.” *The Cambridge Companion to Gadamer*. Cambridge: Cambridge University Press Cambridge, 2002. 36–51. Print.

Gross, Daniel M. “Being Moved: The Pathos of Heidegger’s Rhetorical Ontology.” *Heidegger and Rhetoric*. Albany, NY: State University of New York Press, 2005. 1–46. Print.

Guillemin, Marilys, and Lynn Gillam. “Ethics, Reflexivity, and ‘Ethically Important Moments’ in Research.” *Qualitative Inquiry* 10.2 (2004): 261–280. Print.

Guimond-Plourde, Renee. “A Hermeneutic Phenomenological Approach to Understanding Stress-Coping as an Existential Phenomenon Lived by Healthy Adolescents.” *Indo-Pacific Journal of Phenomenology: Teaching of Phenomenology: Special Issue 3* 9.2 (2009): 1–13. Print.

Haidt, J. “The Emotional Dog and Its Rational Tail.” *Psychological Review* 108 (2001): 814–834. Print.

Handelsman, M.M. et al. “A Measure of College Student Course Engagement.” *The Journal of Educational Research* 98.3 (2005): 184–192. Print.

Harding, Trevor Scott, Donald D. Carpenter, and Cynthia J. Finelli. “Two Years Later: A Longitudinal Look at the Impact of Engineering Ethics Ed-Ucation.” Atlanta: N.p., 2013. *Google Scholar*. Web. 21 Oct. 2014.

Harris, Charles Edwin et al. “Engineering Ethics: What? Why? How? And When?” *Journal of Engineering Education* 85.2 (1996): 93–96. Print.

Harris Jr, Charles E. “The Good Engineer: Giving Virtue Its Due in Engineering Ethics.” *Science and Engineering Ethics* 14.2 (2008): 153–164. Print.

Harvey, David. *The Limits to Capital*. London: Verso, 2006. Print.

Hashemian, Golnaz, and Michael C. Loui. “Can Instruction in Engineering Ethics Change Students’ Feelings about Professional Responsibility?” *Science and engineering ethics* 16.1 (2010): 201–215. Print.

Haws, David R. “The Importance of Meta-Ethics in Engineering Education.” *Science and Engineering Ethics* 10.2 (2004): 204–210. Print.

Heidegger, Martin. *Basic Writings: From Being and Time (1927) to The Task of Thinking (1964)*. N.p., 1977. *Google Scholar*. Web. 21 Oct. 2014.

---. *Being and Time*. San Francisco, CA: Harper & Row, 1962. Print.

Henriksson, Carina, and Norm Friesen. "Introduction." *Hermeneutic Phenomenology in Education: Method and Practice*. Rotterdam: Sense Publishers, 2012. 1–14. Print.

Herkert, Joseph R. "ABET's Engineering Criteria 2000 and Engineering Ethics: Where Do We Go from Here." *Proceedings of International Conference on Ethics in Engineering and Computer Science*. N.p., 1999. Print.

---. "Engineering Ethics Education in the USA: Content, Pedagogy and Curriculum." *European Journal of Engineering Education* 25.4 (2000): 303–313. Print.

---. "Ways of Thinking about and Teaching Ethical Problem Solving: Microethics and Macroethics in Engineering." *Science and Engineering Ethics* 11.3 (2005): 373–385. Print.

Hermeneutic Phenomenology in Education: Method and Practice. Rotterdam: Sense Publishers, 2012. Print.

Huff, Chuck, and William Frey. "Moral Pedagogy and Practical Ethics." *Science and Engineering Ethics* 11.3 (2005): 389–408. Print.

Hultgren, Francine H. "Phenomenology: The Pursuit of Meaning in Everyday Life." *Home Economics Forum* 4.2 (1990): 14–17. Print.

"Human Head Transplants Now Possible, Italian Neuroscientist Says." *Huffington Post* 6 July 2013. Web. 6 July 2013.

Hursthouse, R. "Virtue Theory." *Ethics in Practice: An Anthology*. Fourth. Hoboken, NJ: Wiley-Blackwell, 2014. 60–70. Print.

Hylton, Pete. “Ethics and Competitive Advantage in a Fast-Paced Industry.” Chicago, IL: IEEE, 2014. Print.

Ilsley, P.J., and K. Krasemann. “Phenomenological Methodology.” Web. 11 Nov. 2013.

Johnson, Deborah G. “The Social/professional Responsibility of Engineers.” *Annals of the New York Academy of Sciences* 577.1 (1989): 106–114. Print.

Kafle, Narayan Prasad. “Hermeneutic Phenomenological Research Method Simplified.” *Bodhi: An Interdisciplinary Journal* 5 (2011): 181–200. Print.

Kakkori, Leena. “Hermeneutics and Phenomenology Problems When Applying Hermeneutic Phenomenological Method in Educational Qualitative Research.” *Paideusis* 18.2 (2009): 19–27. Print.

Kant, Immanuel. “On a Supposed Right to Lie from Altruistic Motives.” *The Philosophy of Immanuel Kant*. Chicago, IL: University of Chicago Press, 1949. Print.

---. “The foundations of the metaphysics of morals.” *The Philosophy of Immanuel Kant*. Chicago, IL: University of Chicago Press, 1949. 80–87. Print.

Kennedy, George A. *Classical Rhetoric & Its Christian and Secular Tradition from Ancient to Modern Times*. Second. Chapel Hill, NC: University of North Carolina Press, 1999. Print.

Kenny Feister, Megan W. et al. “Making Sense of Ethics in Engineering Education: A Discursive Examination of Students’ Perceptions of Work and Ethics on Multidisciplinary Project Teams.” *Ethics in Science, Technology and Engineering, 2014 IEEE International Symposium on*. Chicago, IL: IEEE, 2014. 1–5. Print.

Kerferd, G.B. *The Sophistic Movement*. Cambridge: Cambridge University Press Cambridge, 1981. Print.

Kline, R.R. “Using History and Sociology to Teach Engineering Ethics.” *IEEE Technlogy and Society Magazine* 20.4 (2001): 13–20. Print.

Koro-Ljungberg, Mirka, and Elliot P. Douglas. “State of Qualitative Research in Engineering Education: Meta-Analysis of JEE Articles 2005-2006.” *Journal of Engineering Education* 97.2 (2008): 163–175. Print.

Kuusisto, Elina, Kirsi Tirri, and Inkeri Rissanen. “Finnish Teachers’ Ethical Sensitivity.” *Education Research International* 2012.Article ID 351879 (2012): 1–10. Print.

Latour, Bruno. “Do You Believe in Reality? News from the Trenches of the Science Wars.” *Philosophy of Technology: The Technological Condition*. Malden, MA: Blackwell Publishing, 2003. 126–137. Print.

Lester, S. *An Introduction to Phenomenological Research*. Taunton: Stan Lester Developments, 1999. Print.

Leydens, Jon A., Barbara M. Moskal, and Michael J. Pavelich. “Qualitative Methods Used in the Assessment of Engineering Education.” *Journal of Engineering Education* 93.1 (2004): 65–72. Print.

Lindlof, Thomas R., and Bryan C. Taylor. *Qualitative Communication Research Methods*. Sage, 2010. *Google Scholar*. Web. 21 Oct. 2014.

Loui, Michael C. “Assessment of an Engineering Ethics Video: Incident at Morales.” *Journal of Engineering Education* 95.1 (2006): 85–91. Print.

---. “Ethics and the Development of Professional Identities of Engineering Students.” *Journal of Engineering Education* 94.4 (2005): 383–390. Print.

Lynch, William T., and Ronald Kline. “Engineering Practice and Engineering Ethics.” *Science, Technology & Human Values* 25.2 (2000): 195–225. Print.

MacIntyre, Alasdair. *After Virtue*. Second. Notre Dame, Indiana: University of Notre Dame Press, 1984. Print.

Makkai, Toni. “The Formation and Evolution of Professional Engineering Values.” *Australian and New Zealand Journal of Sociology* 27.3 (1991): 332–350. Print.

Markoff, John. “Making Robts More Like Us.” *New York Times* 28 Oct. 2013. Web. 28 Oct. 2013.

Marx, Karl. “Preface to A Contribution to the Critique of Political Economy.” *The Portable Karl Marx*. New York, NY: Penguin Group, 1983. 158–161. Print.

Matthews, Eric. *Merleau-Ponty: A Guide for the Perplexed*. London: Continuum, 2006. Print.

McGinn, R.E. “Mind the Gaps: An Empirical Approach to Engineering Ethics, 1997-2001.” *Science and Engineering Ethics* 9.4 (2003): 517–542. Print.

Merleau-Ponty, Maurice. *Phenomenology of perception*. London: Routledge & Kegan Paul, 1962. Print.

Millar, Jason. “Technology as Moral Proxy: Autonomy and Paternalism by Design.” Chicago, IL: IEEE, 2014. Print.

Miller, Carolyn R. “A Humanistic Rationale for Technical Writing.” *College English* 40.6 (1979): 610–617. Print.

---. “What’s Practical about Technical Writing?” *Technical Writing: Theory and Practice*. New York: MLA, 1989. 14–24. Print.

Mill, John Stuart. *2002. Utilitarianism*. New York: Hackett Publishing Co, 1861. Print.

Mischler, E.G. “Representing Discourse: The Rhetoric of Transcription.” *Journal of Narrative and Life History* 1.4 (1991): 255–280. Print.

Mitcham, Carl. *Thinking through Technology: The Path between Engineering and Philosophy*. University of Chicago Press, 1994. *Google Scholar*. Web. 21 Oct. 2014.

Mumford, Lewis. “Tool-Users vs. Homo Sapiens and The Megamachine.” *Philosophy of Technology: The Technological Condition*. Malden, MA: Blackwell Publishing, 2003. 344–351. Print.

Narvaez, Darcia. “Integrative Ethical Education.” *Handbook of Moral Development*. Mahwah, NJ: Erlbaum, 2006. 703–733. Print.

Narvaez, Darcia, and Leilani Gjellstad Endicott. *Ethical Sensitivity: Nurturing Character in the Classroom*. Alliance for Catholic Education Press, 2009. Print. Nurturing Character in the Classroom, Ethex Series Book 1.

“National Institute for Engineering Ethics.” N.p., n.d. Web.

“National Society of Professional Engineers Code of Ethics.” N.p., n.d. Web. 1 Dec. 2014.

Newberry, Byron. “The Dilemma of Ethics in Engineering Education.” *Science and Engineering Ethics* 10.2 (2004): 343–351. Print.

Nucci, Larry. “Goethe’s Faust Revisited: Lessons from DIT Research.” *Journal of moral education* 31.3 (2002): 315–324. Print.

Nussbaum, Martha. “Non-Relative Virtues: An Aristotelian Approach.” *Ethical Theory: An Anthology*. Malden, MA: Wiley-Blackwell, 2013. 630–644. Print.

Orbe, Mark P. “Centralizing Diverse Racial/ethnic Voices in Scholarly Research: The Value of Phenomenological Inquiry.” *International Journal of Intercultural Relations* 24.5 (2000): 603–621. Print.

Pekrun, Reinhard et al. "Measuring Emotions in Students' Learning and Performance: The Achievement Emotions Questionnaire (AEQ)." *Contemporary Educational Psychology* 36.1 (2011): 36–48. Print.

Perelman, Ch., and L. Olbrechts-Tyteca. *The New Rhetoric*. Notre Dame: University of Notre Dame Press, 1969. Print.

Pfatteicher, Sarah K.A. "Teaching vs. Preaching: EC2000 and the Engineering Ethics Dilemma." *Journal of Engineering Education* (2001): 137–142. Print.

Pine, Art. "Grave New World." *ASEE Prism* 22.3 (2012): 35–38. Print.

Plato. "Gorgias." *Readings from Classical Rhetoric*. Carbondale and Edwardsville: Southern Illinois University Press, 1990. 59–74. Print.

---. *The Republic of Plato*. London: Oxford University Press, 1941. Print.

Porra, Veikko. "A Phenomenological Approach to Ethics Education." *Proc. Int. Conf. on Engineering Education and Research "Progress Through Partnership", VŠB-TUO, Ostrava, Czech R*. N.p., 2004. *Google Scholar*. Web. 21 Oct. 2014.

Poulakos, John. "Rhetoric, the Sophists, and the Possible." *Communication Monographs* 51.1 (1984): 215–226. Print.

---. "Toward a Sophistic Definition of Rhetoric." *Philosophy and Rhetoric* 16.1 (1983): 35–48. Print.

Prasad, Anshuman. "The Contest over Meaning: Hermeneutics as an Interpretive Methodology for Understanding Texts." *Organizational Research Methods* 5.1 (2002): 12–33. Print.

Prasad, Anshuman, and Pushkala Prasad. "The Coming of Age of Interpretive Organizational Research." *Organizational Research Methods* 5 (2002): 4–11. Print.

Pritchard, Michael S. “Professional Responsibility: Focusing on the Exemplary.” *Science and Engineering Ethics* 4.2 (1998): 215–233. Print.

---. “Responsible Engineering: The Importance of Character and Imagination.” *Science and Engineering Ethics* 7.3 (2001): 391–402. Print.

Putnam, Linda L. “The Interpretive Perspective: An Alternative to Functionalism.” *Communication and Organizations: An Interpretive Approach*. Beverly Hills, CA: Sage, 1983. 31–54. Print.

Rasoal, Chato, Henrik Danielsson, and Tomas Jungert. “Empathy among Students in Engineering Programmes.” *European Journal of Engineering Education* 37.5 (2012): 427–435. *Google Scholar*. Web.

Rawls, John. *A Theory of Justice*. Revised. Cambridge, MA: The Belknap Press of Harvard University Press, 1971. Print.

Rest, James, and Darcia Narvaez. *Guide for DIT-2*. 1998.

Rest, James R. “A Psychologist Looks at the Teaching of Ethics.” *Hastings Center Report* 12.1 (1982): 29–36. Print.

---. “DIT2: Devising and Testing a Revised Instrument of Moral Judgment.” *Journal of Educational Psychology* 91.4 (1999): 644. Print.

---. *Moral Development: Advances in Research and Theory*. New York, NY: Praeger, 1986. Print.

Rest, James R., and Robert Barnett. *Moral Development: Advances in Research and Theory*. Praeger New York, 1986. Print.

Rest, James R., S. J. Thoma, and L. Edwards. “Designing and Validating a Measure of Moral Judgment: Stage Preference and Stage Consistency Approaches.” *Journal of Educational Psychology* 89 (1997): 5–28. Print.

Reynolds, Jack. “Phenomenology and Virtue Ethics: Complementary Anti-Theoretical Metholdological and Ethical Trajectories.” *Phenomenology and Virtue Ethics*. London: Continuum, 2013. Print.

Rizzo, Ann-Marie, and Laura Lee Swisher. “Comparing the Stewart–Sprinthall Management Survey and the Defining Issues Test-2 as Measures of Moral Reasoning in Public Administration.” *Journal of Public Administration Research and Theory* 14.3 (2004): 335–348. Print.

Robison, Wade L. “Ethics in Engineering.” Chicago, IL: IEEE, 2014. Print.

Rogers, Gloria. “ABET’s Institute for the Development of Excellence in Assessment Leadership (IDEAL).” 2008: n. pag. Print.

Ruspoli, Tao. *Being in the World*. N.p., 2010. Film.

Russell, David R. “The Ethics of Teaching Ethics in Professional Communication: The Case of Engineering Publicity at MIT in the 1920s.” *Teaching Technical Communication Critical Issues for the Classroom*. Boston, MA: Bedford/St. Martin’s, 2004. 165–186. Print.

Russon, John. *Human Experience: Philosophy, Neurosis, and the Elements of Everyday Life*. Albany, NY: State University of New York Press, 2003. Print.

Sadala, Maria Lucia Araujo, and Rubens de Camargo Ferreira Adorno. “Phenomenology as a Method to Investigate the Experience Lived: A Perspective from Husserl and Merleau Ponty’s Thought.” *Journal of advanced nursing* 37.3 (2002): 282–293. Print.

Sagayadevan, Vathsala, and Senthu Jeyaraj. “The Role of Emotional Engagement in Lecturer-Student Interaction and the Impact on Academic Outcomes of Student

Achievement and Learning." *Journal of the Scholarship of Teaching and Learning* 12.3 (2012): 1–30. Print.

Scenters-Zapico, John. "The Case for the Sophists." *Rhetoric Review* 11.2 (1993): 352–367. Print.

Schimmel, K. "ABET 2000–can Engineering Faculty Teach Ethics?" *Proc. 3rd Christian Engineering Education Conference CEEC99, Waxhaw North Carolina USA*. N.p., 1999. *Google Scholar*. Web.

Schmidt, Lawrence E., and Scott Marratto. *The End of Ethics in a Technological Society*. Montreal: McGill-Queen's University Press, 2008. Print.

Schultz, A., and T. Luckmann. *The Structures of the Life-World*. Evanston, IL: Northwestern University Press, 1973. Print.

Schwandt, Thomas. "A.(2000), Three Epistemological Stances for Qualitative Inquiry: Interpretivism, Hermeneutics, and Social Constructionism in Denzin, Norman, K. and Lincoln, Yvonna, S." *Handbook of qualitative research* n. pag. Print.

---. "On Understanding Understanding." *Qualitative Inquiry* 5.1 (1999): 451–464. Print.

Seidman, Irving. *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences*. Teachers college press, 2012. *Google Scholar*. Web. 22 Oct. 2014.

Self, Donnie J., and Elizabeth M. Ellison. "Teaching Engineering Ethics: Assessment of Its Influence on Moral Reasoning Skills." *Journal of Engineering Education* 87.1 (1998): 29–34. Print.

Shawver, Tara J., and John T. Sennetti. "Measuring Ethical Sensitivity and Evaluation." *Journal of Business Ethics* 88.4 (2009): 663–678. Print.

Shrader-Frechette, Kristin. “Technol-Ogy and Ethics.” *Technology and Values: Essential Readings* (2009): n. pag. *Google Scholar*. Web. 22 Oct. 2014.

Shuman, L.J. et al. “Can Our Students Recognize and Resolve Ethical Dilemmas?” Session Number 1526. Salt Lake City, UT: N.p., 2004. Web. 4 Dec. 2014.

Sindelar, Mark et al. “Assessing Engineering Students’ Abilities to Resolve Ethical Dilemmas.” Vol. S2A-25. Boulder, CO: N.p., 2003. Print.

Singer, Peter. “Famine, Affluence, and Morality.” *Philosophy & Public Affairs* (1972): 229–243. Print.

Smith, Jonathan A., and Mike Osborn. “Interpretive Phenomenological Analysis.” *Qualitative Psychology*. Sage, 2007. Print.

Solloway, Sharon G., and Nancy J. Brooks. “Philosophical Hermeneutics and Assessment: Discussions of Assessment for the Sake of Wholeness.” *Journal of Thought* (2004): 43–60. Print.

Staudenmaier, J.M. *Course Notes for The Politics and Ethics of Engineering*. 1999. Detroit, MI: University of Detroit Mercy.

Stephan, K.D. “Is Engineering Ethics Optional?” *Technology and Society Magazine, IEEE* 20.4 (2001): 6–12. Print.

Stewart, D., and A. Mickunas. *Exploring Phenomenology: A Guide to the Field and Its Literature*. 2nd Ed. Athens, OH: Ohio University Press, 1990. Print.

Stovall, Preston. “Professional Virtue and Professional Self-Awareness: A Case Study in Engineering Ethics.” *Science and engineering ethics* 17.1 (2011): 109–132. Print.

Strauss, Anselm, and Juliet M. Corbin. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques.* Sage Publications, Inc, 1990. *Google Scholar*. Web. 21 Oct. 2014.

“The Interpretive Perspective: An Alternative to Functionalism.” *Communication and Organizations: An Interpretive Approach*. Sage, 1983. 31–54. Print.

Thoma, Stephen J. “Research on the Defining Issues Test.” *Handbook of moral development* (2006): 67–91. Print.

Timmons, Mark. *Moral Theory An Introduction*. Second. Lanham, MD: Rowman & Littlefield Publishers, 2013. Print.

Troesch, Valorie. “A Phenomenological Approach to Teaching Engineering Ethics.” *Ethics in Science, Technology and Engineering, 2014 IEEE International Symposium on*. IEEE, 2014. 1–9. *Google Scholar*. Web. 21 Oct. 2014.

Upcraft, M. Lee, and John H. Schuh. “Assessment vs. Research: Why We Should Care about the Difference.” *About Campus* 7.1 (2002): 16–20. Print.

van Manen, Max. “Inquiry: Methodology: Reduction.” *Phenomenology Online*. N.p., n.d. Web. 19 Mar. 2015.

---. “Phenomenology of Practice.” *Phenomenology & Practice* 1.1 (2007): 11–30. Print.

---. *Researching Lived Experience: Human Science for an Action Sensitive Pedagogy*. Albany, NY: Suny Press, 1990. *Google Scholar*. Web. 21 Oct. 2014.

van Manen, Max. *Researching Lived Experience: Human Science for an Action Sensitive Pegagogy*. Albany, NY: State University of New York Press, 1990. Print.

van Oortmerssen, Gerard. “Ethics and ICT: Beyond Design.” Chicago, IL: N.p., 2014. Print.

Varshney, Lav R. “Engineering for Problems of Excess.” Chicago, IL: IEEE, 2014. Print.

Walzer, Arthur E., and Alan Gross. “Positivists, Postmodernists, Aristotelians, and the Challenger Disaster.” *College English* (1994): 420–433. Print.

Whitburn, Merrill D. *Rhetorical Scope and Performance: The Example of Technical Communication*. Stamford, CT: Ablex Publishing Corporation, 2000. Print.

Wike, Virginia S. “Professional Engineering Ethical Behavior: A Values-Based Approach.” Albuquerque, NM: N.p., 2001. Print.

Wild, John. “Plato’s Theory of Texnh a Phenomenological Interpretation.” *Philosophy and Phenomenological Research* 1.3 (1941): 255–293. Print.

Winner, Langdon. *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*. Cambridge, MA: The MIT Press, 1977. Print.

---. “Engineering Ethics and Political Imagination.” *Broad and Narrow Interpretations of Philosophy of Technology*. Vol. 7. Springer Netherlands, 1990. 53–64. Print.

Zeng, Jianping. *A Brief Introduction to Chinese Ethics*. Houghton, Michigan: N.p., 2013. Film.

Zhao, Shanyang. “Rhetoric as Praxis: An Alternative to the Epistemic Approach.” *Philosophy and Rhetoric* 24 (1991): 255–266. Print.

Appendices

Appendix A

Course Syllabus ENT3958
Fall Semester 2014

Michigan Tech
Michigan Technological University

Course Syllabus
ENT3958 – Ethics in Engineering Design
Fall 2014

Instructor Information

Instructor:	Valorie Troesch, J.D.
Office Location:	By appointment
Telephone:	Office – (906) 482-4041
E-mail:	vtroesch@mtu.edu (best way to contact me)
Office Hours:	By appointment

Course Identification

Course Number:	ENT 3958-R01
Course Name:	Ethics in Engineering Design
Course Location:	104A Chem Sci (Building 19)
Class Times:	Thursday, 7:05 p.m.

Course Description/Overview

The goal of this course is for students to leave with an advanced understanding of his or her professional and ethical values and responsibilities.

Course Learning Objectives

At the end of this course, the student will be able to:

1. Demonstrate a working knowledge of the principles of ethical theory (rules, utilitarianism, virtues, etc.) and how these theories influence actual personal and professional ethical decision making.
2. Explore and articulate your own understanding of what it is to be an ethical engineer based on the research work you do in the class.
3. Demonstrate proficient communication skills.

Course Website(s)

Course syllabus and readings are posted on Canvas. Details for all Writing Assignments are on Canvas. All writing assignments must be submitted on Canvas. Assignments must be submitted prior to class on the date shown on the syllabus.

Required Course Text

There are no books that must be purchased for this course. Assigned readings are on Canvas (under Pages – select "Course Readings" page) and must be read prior to the class for which they are assigned (see course schedule on page 3).

Course Overview

Your work in this class will be a research project, but not the kind of research you are accustomed to doing as engineering students. The research you will do is qualitative rather than quantitative. It is also interpretive and will find no "right" or "wrong" answers. Everyone's work will be personal and unique. Your research will address the question: What is it to be an ethical engineer? You will use multiple resources to help you discover some answers and insights into this question. At the end of the semester, you will submit a research paper that reports what you have discovered and understand about being an ethical engineer.

The class structure is designed to give you the guidance on how to conduct your research as well as the time and flexibility to do it. As you can see from the course schedule, we will meet as a class only a few times – at the beginning of the semester to review the basics of ethics and the course focus and again at the end of the semester to present some of your research findings to the rest of the class. I will meet with you individually at least twice – once to review your research plan and, later, to review your research progress. You will also be required to submit a short written assignment and to bring information with you to our meetings to help me track your research progress and to give you feedback. Finally, for course assessment purposes, you will also be required to complete two surveys that assess your ethical reasoning skills and your sensitivity to ethical issues – you are required to complete these but you are not graded on the results.

This class is premised on multiple assumptions. First, most engineering students don't care about learning ethics philosophy – that's a general observation made by most instructors who teach engineering ethics. Second, most engineering students don't actually engage with the study of ethics even though this is one of the learning outcomes that we expect. Third, engineering students prefer to investigate a question rather than study about it in books – you want hands on projects. Fourth, engineering ethics will be more meaningful if you study it in the context of everyday real engineering work. This is especially true because most of you in the class are preparing to graduate very soon and enter the engineering profession. This course takes all of these things into consideration.

The goal is for you to investigate this question about what it is to be an ethical engineer – the lived everyday experience, not just when big issues arise. Ethics isn't something engineers choose to do; ethics and ethical decision-making are part of being an engineer. What you are seeking to understand is: what is the experience of being an ethical engineer in the routine day to day work I will do? You will explore this question by examining your own values, by talking with other engineers, by reading about being an ethical engineer, and by observing and listening. Your final essay will draw on your research as you begin to answer this question.

Your final research report will be about 1800-2000 words long. I don't intend to count words. Quality will count more than quantity. But I do expect a seriously reflective report that considers the research work you have done and attempts to interpret and find meaning in that work. This classwork is intended to benefit you and to help prepare you for the real and everyday ethical practice of engineering.

Course Schedule and Assignments

You are responsible for managing your research project during the semester. This means that you have to take responsibility for setting a timetable to ensure that you complete the readings, schedule and conduct your interviews, and organize/write your final research paper so that course deadlines are met. I suggest you plan to complete at least 2 or 3 readings a week (they are short) and that you start early in the semester.

Required course readings are posted on Canvas (Pages: Course Readings). The order in which you complete the readings is up to you but you should either take notes or highlight portions of the readings that are important to you so you can refer to these when you write your paper. You are welcome to add other readings to this list that you consult for your research, and you should add these readings to the list of "References Consulted" at the end of you research paper. You can also consult and draw on other sources, such as movies or games (or other ideas – you can be original) if you think they are relevant to your research.

The following schedule shows when class meets, when assignments are due, and when I will meet with you individually.

Date	Topic	Assignment Due
September 4 Class meets 90 minutes	Introduction and Course Overview: What is it to be an ethical engineer? Review of principal ethical theories	Complete the DIT-2 (Defining Issues Test) and the TESSE (Test of Ethical Sensitivity in Science and Engineering). Links to these tests are below (page 4). They must be completed **by September 11** to count toward class participation grade.
September 11 Class meets 90 minutes	A phenomenological approach to understanding what it is to be an ethical engineer	Film: "Being in the World" Reading: Bunge: *Philosophical Inputs and Outputs of Technology* (Canvas – Pages: Course Readings) Completion of DIT-2 and TESSE.
September 18 90 minutes	Ethical Theories, continued	Writing Assignment due: Autobiographical Reflection on Values. See below (page 4).
October 7 and 9 (Tuesday and Thursday evenings 6:00-8:30)	Individual meetings with students – sign up on Canvas.	Bring a list of the readings you have completed and your interview plan. Also any additional sources you want to include as part of your research.
November 4 and 6 (Tuesday and Thursday evenings 6:00-8:30)	Second set of individual meetings with students – sign up on Canvas	Bring a draft or detailed outline of your research paper and interview notes. Be prepared to discuss some of your findings, observations, discoveries, etc.
November 20 Class meets	Presentations and discussion of research papers	Students will give brief presentations on highlights of their research. Class discussion as time permits.
December 4		Final Research Papers are due. See page 4.
December 11		Complete the DIT-2 and TESSE as post-assessments. They must be completed between December 4 and December 11 to count toward class participation grade.

General Instructions about Assignments
Written assignments and the final paper must be submitted on Canvas. Written work should in in 11 point Arial or similar font, 1" margins, single spaced with double spaces between paragraphs. I expect your work to demonstrate your original thought, reflection, and analysis. This is an advanced Ethics course (you all had some introductory Ethics study in Engineering Fundamentals) and your work should rise to this higher level. You are expected to use your own words and do your own work. You are welcome (and encouraged) to do research beyond the readings that are required. If you do so, be certain to use appropriate attribution and citation. Do not simply quote other sources; restate in your own words without plagiarizing. Finally, write so that you are understood – read and review to make sure this happens!

Writing Assignment: Autobiographical Reflection on Values
This is an introspective assignment. It is part of the process of answering the question that is the focus of this course: what does it mean to be an ethical engineer? This assignment requires you to reflect on your life experiences, to examine your own values and to explain how you see yourself. In this paper, please address the following (your paper should be about 500-800 words in length):

- Why do you want to be an engineer? What motivates you to choose this over other careers?
- What field of engineering did you choose? Why? What does this choice say about you and your values (talk about explicit values that contributed to your decision)?
- I will assume you want to be an ethical engineer. What values do you think you will need to be an ethical engineer? Identify some of these values and describe what you mean by them.
- Explain relevant experiences (without betraying confidences!) that helped you learn more about yourself as an ethical engineer. Give a couple of examples. These can be examples in which you or others were involved. Think about what values motivated actions you took or that others took and how these values impacted ethical judgment.

Writing Assignment: Final Research Paper
This research paper draws on all the research work you have done this semester to answer the following question: What is it to be an ethical engineer? Your paper should be 1800-2000 words long (again, I'm not counting words but quality will be the paramount consideration). This is an interpretive form of research. In other words, I do not expect you to merely report or repeat what you have read, watched, discussed, or observed. What I expect you to do is take all of this input and use it to describe how you interpret and understand the essences of what it is to be an ethical engineer. You should refer to readings, interviews, etc. to support your ideas. Remember that, **in addition to the assigned readings, you must also interview an engineer who has experience working in industry. This is a required part of the research for this class.** You can interview an engineer currently in academia as long as the engineer has significant (more than 5 years) experience working in industry. The focus of your interview is to help you answer the question: what is it to be an ethical engineer? Note that the interview is not about learning what it is to work as an engineer, but the focus is on the everyday practice of being an ethical engineer – discovering what that means. I will post a list of possible questions used by earlier classes for the interview but you can add any of your own. Keep notes about the interview that (1) summarize answers to the interview questions and (2) reflect on your interview experience and what it contributed to your own knowledge of what it is to be an ethical engineer: what was helpful, surprising, new, not helpful, etc.?

DIT-2 Survey
The Defining Issues Test-2 is a nationally-tested and used survey that attempts to measure ethical judgment. I am using the DIT-2 as an assessment tool to measure the effectiveness of the teaching methods in this class. Other methods include your actual classroom work and instructor evaluations. Your responses to the DIT-2 are anonymous. But I do require that you participate in the DIT-2, and this will count as part of your participation grade in the course. To receive credit, you will need to take a screen shot of the "Thank You" page that you get at the end of the survey and email that to me as verification of your participation. If you have any questions about your participation in the DIT-2, I'd be happy to discuss them with you. The pre-test survey can be accessed at:
https://www.surveymonkey.com/s/NBFLKHW
A different second link will be provided for the post-test survey to be completed at the end of the course.

Grading

Grading System

Letter Grade	*Percentage*	*Grade points/credit*	*Rating*
A	93% & above	4.00	Excellent
AB	88% – 92%	3.50	Very good
B	82% – 86%	3.00	Good
BC	76% – 81%	2.50	Above average
C	70% – 75%	2.00	Average
CD	65% – 69%	1.50	Below average
D	60% - 64%	1.00	Inferior
F	59% and below	0.00	Failure
I	Incomplete; given only when a student is unable to complete a segment of the course because of circumstances beyond the student's control. A grade of incomplete may be given only when approved in writing by the department chair or school dean.		
X	Conditional, with no grade points per credit; given only when the student is at fault in failing to complete a minor segment of a course, but in the judgment of the instructor does not need to repeat the course. It must be made up within the next semester in residence or the grade becomes a failure (F). A (X) grade is computed into the grade point average as a (F) grade.		

Grading Policy

Grades will be based on the following (there is no Final Exam):

Final Paper	300
Writing Assignment (Values Autobiography, Paper outline)	100
Class participation (includes class attendance, individual meetings with me, completion of pre and post DIT-2 and TESSE, and paper presentation)	200
Total Points	**600**

Late Assignments

Late assignments are not accepted.

Course Policies

Cell phones, Blackberries, iPods, PDAs, or any other electronic devices are not to be used in the classroom. They should be turned off prior to coming into the classroom.

Collaboration/Plagiarism Rules

Unless an assignment specifies that it is a group or team project, each student is expected to work individually on assignments and not to consult with or collaborate with other students on the assignment. University policies against plagiarism are strictly followed, and suspected violations are referred to the Dean of Students for investigation.

University Policies

Academic regulations and procedures are governed by University policy. Academic dishonesty cases will be handled in accordance the University's policies.

If you have a disability that could affect your performance in this class or that requires an accommodation under the Americans with Disabilities Act, please see me as soon as possible so that we can make appropriate arrangements. The Affirmative Programs Office has asked that you be made aware of the following:

Michigan Technological University complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act of 1990. If you have a disability and need a reasonable accommodation for equal access to education or services at Michigan Tech, please call the Dean of Students Office at 487-2212. For other concerns about discrimination, you may contact your advisor, Chair/Dean of your academic unit, or the Affirmative Programs Office at 487-3310.

Appendix B

IRB Board Action

Appendix B

IRB Board Action

Subject: IRBNet Board Action
From: Cheryl Gherna <no-reply@irbnet.org>
Date: 7/25/2014 9:25 AM
To: Valorie Troesch <vtroesch@mtu.edu>

Please note that Michigan Tech University Human Subjects Committee (IRB) has taken the following action on IRBNet:

Project Title: [637104-1] Phenomenological Approach to Engineering Ethics Pedagogy:

ENT3958 (2014)
Principal Investigator: Valorie Troesch, J.D.
Submission Type: New Project
Date Submitted: July 23, 2014

Action: EXEMPT
Effective Date: July 25, 2014
Review Type: Exempt Review

Should you have any questions you may contact Cheryl Gherna at cagherna@mtu.edu.
Thank you,
The IRBNet Support Team
www.irbnet.org
IRBNet Board Action
1

Appendix C

Defining Issues Test – 2

Permission to include a copy of the Defining Issues Test-2 was granted in writing (email) by the Center for the Study of Ethical Development, The University of Alabama, on May 26, 2015. Reprint of permission is included in Appendix F.

Defining Issues Test-2 US version

1. Informed Consent

2. Defining Issues Test-2

This questionnaire is concerned with how you define the issues in a social problem. Several stories about social problems will be described. After each story, there will be a list of questions. The questions that follow each story represent different issues that might be raised by the problem. In other words, the questions/issues raise different ways of judging what is important in making a decision about the social problem. You will be asked to rate and rank the questions in terms of how important each one seems to you.

PLEASE TRY TO FINISH THE QUESTIONNAIRE IN ONE SITTING.

3. EXAMPLE of the task

Imagine you are about to vote for a candidate for the Presidency of the United States. Before you vote, you are asked to rate the importance of five issues you could consider in deciding who to vote for. Rate the importance of each item (issue) by checking the appropriate box.

***1. Rate the following issues in terms of importance.**

	Great	Much	Some	Little	No
1. Financially are you personally better off now than you were four years ago?	○	○	○	○	○
2. Does one candidate have a superior moral character?	○	○	○	○	○
3. Which candidate stands the tallest?	○	○	○	○	○
4. Which candidate would make the best world leader?	○	○	○	○	○
5. Which candidate has the best ideas for our country's internal problems, like crime and health care.	○	○	○	○	○

Note. Some items may seem irrelevant or not make sense (as in item #3). In that case, rate the item as "NO".

After you rate all of the items you will be asked to RANK the top four items in terms of importance. Note that it makes sense that the items you RATE as most important should be RANKED as well. So if you only rated item 1 as having great importance you should rank it as most important.

***2. Consider the 5 issues above and rank which issues are the most important.**

	1	2	3	4	5
Most important item	○	○	○	○	○
Second most important	○	○	○	○	○
Third most important	○	○	○	○	○
Fourth most important	○	○	○	○	○

Again, remember to consider all of the items before you rank the four most important items and be sure that you only rank items that you found important.

Note also that before you begin to rate and rank items you will be asked to state your preference for what action to take in story.

Thank you and you may begin the questionnaire!

Defining Issues Test-2 US version

4. Story 1

Famine

The small village in northern India has experienced shortages of food before, but this year's famine is worse than ever. Some families are even trying to feed themselves by making soup from tree bark. Mustaq Singh's family is near starvation. He has heard that a rich man in his village has supplies of food stored away and is hoarding food while its price goes higher so that he can sell the food later at a huge profit. Mustaq is desperate and thinks about stealing some food from the rich man's warehouse. The small amount of food that he needs for his family probably wouldn't even be missed.

***1. What should Mustaq Singh do? Do you favor the action of taking food?**

○ Should take the food ○ Can't decide ○ Should not take the food

***2. Rate the following issues in terms of importance.**

	Great	Much	Some	Little	No
1. Is Mustaq Singh courageous enough to risk getting caught for stealing?	○	○	○	○	○
2. Isn't it only natural for a loving father to care so much for his family that he would steal?	○	○	○	○	○
3. Shouldn't the community's laws be upheld?	○	○	○	○	○
4. Does Mustaq Singh know a good recipe for preparing soup from tree bark?	○	○	○	○	○
5. Does the rich man have any legal right to store food when other people are starving?	○	○	○	○	○
6. Is the motive of Mustaq Singh to steal for himself or to steal for his family?	○	○	○	○	○
7. What values are going to be the basis for social cooperation?	○	○	○	○	○
8. Is the epitome of eating reconcilable with the culpability of stealing?	○	○	○	○	○
9. Does the rich man deserve to be robbed for being so greedy?	○	○	○	○	○
10. Isn't private property an institution to enable the rich to exploit the poor?	○	○	○	○	○
11. Would stealing bring about more total good for everybody concerned or wouldn't it?	○	○	○	○	○
12. Are laws getting in the way of the most basic claim of any member of a society?	○	○	○	○	○

***3. Consider the 12 issues above and rank which issues are the most important.**

	1	2	3	4	5	6	7	8	9	10	11	12
Most important item	○	○	○	○	○	○	○	○	○	○	○	○
Second most important	○	○	○	○	○	○	○	○	○	○	○	○
Third most important	○	○	○	○	○	○	○	○	○	○	○	○
Fourth most important	○	○	○	○	○	○	○	○	○	○	○	○

5. Story 2

Reporter

Defining Issues Test-2 US version

Molly Dayton has been a news reporter for the *Gazette* newspaper for over a decade. Almost by accident, she learned that one of the cadidates for Lieutenant Governor for her state, Grover Thompson, had been arrested for shop-lifting 20 years earlier. Reporter Dayton found out that early in his life, Candidate Thompson had undergone a confused period and done things he later regretted, actions which would be very out-of-character now. His shoplifting had been a minor offense and charges had been dropped by the department store. Thompson has not only straightened himself out since then, but built a distinguished record in helping many people and in leading constructive community projects. Now, Reporter Dayton regards Thompson as the best candidate in the field and likely to go on to important leadership positions in the state. Reporter Dayton wonders whether or not she should write the story about Thompson's earlier troubles because in the upcoming close and heated election, she fears that such a news story could wreck Thompson's chance to win.

*1. Do you favor the action of reporting the story?

○ Should report the story ○ Can't decide ○ Should not report the story

*2. Rate the following issues in terms of importance.

	Great	Much	Some	Little	No
1. Doesn't the public have a right to know all the facts about all the candidates for office?	○	○	○	○	○
2. Would publishing the story help Reporter Dayton's reputation for investigative reporting?	○	○	○	○	○
3. If Dayton doesn't publish the story wouldn't another reporter get the story anyway and get the credit for investigative reporting?	○	○	○	○	○
4. Since voting is such a joke anyway, does it make any difference what reporter Dayton does?	○	○	○	○	○
5. Hasn't Thompson shown in the past 20 years that he is a better person than his earlier days as a shop-lifter?	○	○	○	○	○
6. What would best service society?	○	○	○	○	○
7. If the story is true, how can it be wrong to report it?	○	○	○	○	○
8. How could reporter Dayton be so cruel and heartless as to report the damaging story about candidate Thompson?	○	○	○	○	○
9. Does the right of "habeas corpus" apply in this case?	○	○	○	○	○
10. Would the election process be more fair with or without reporting the story?	○	○	○	○	○
11. Should reporter Dayton treat all candidates for office in the same way by reporting everything she learns about them, good and bad?	○	○	○	○	○
12. Isn't it a reporter's duty to report all the news regardless of the circumstances?	○	○	○	○	○

*3. Consider the 12 issues you rated above and rank which issues are the most important.

	1	2	3	4	5	6	7	8	9	10	11	12
Most important item	○	○	○	○	○	○	○	○	○	○	○	○
Second most important	○	○	○	○	○	○	○	○	○	○	○	○
Third most important	○	○	○	○	○	○	○	○	○	○	○	○
Fourth most important	○	○	○	○	○	○	○	○	○	○	○	○

6. Story 3

School Board

Defining Issues Test-2 US version

Mr. Grant has been elected to the School Board District 190 and was chosen to be Chairman. The district is bitterly divided over the closing of one of the high schools. One of the high schools has to be closed for financial reasons, but there is no agreement over which school to close. During his election to the School Board, Mr. Grant had proposed a series of "Open Meetings" in which members of the community could voice their opinions. He hoped that dialogue would make the community realize the necessity of closing one high school. Also he hoped that through open discussions, the difficulty of the decision would be appreciated, and that the community would ultimately support the school board decision. The first Open Meeting was a disaster. Passionate speeches dominated the microphones and threatened violence. The meeting barely closed without fist-fights. Later in the week, school board members received threatening phone calls. Mr. Grant wonders if he ought to call off the next Open Meeting.

*1. Do you favor calling off the next Open Meeting

◯ Should call off the next open meeting ◯ Can't decide ◯ Should have the next open meeting

*2. Rate the following issues in terms of importance.

	Great	Much	Some	Little	No
1. Is Mr. Grant required by law to have Open Meetings on major school board decisions?	◯	◯	◯	◯	◯
2. Would Mr. Grant be breaking his election campaign promises to the community by discontinuing the Open Meetings?	◯	◯	◯	◯	◯
3. Would the community be even angrier with Mr. Grant if he stopped the Open Meetings?	◯	◯	◯	◯	◯
4. Would the change in plans prevent scientific assessment?	◯	◯	◯	◯	◯
5. If the school board is threatened, does the chairman have the legal authority to protect the Board by making decisions in closed meetings?	◯	◯	◯	◯	◯
6. Would the community regard Mr. Grant as a coward if he stopped the open meetings?	◯	◯	◯	◯	◯
7. Does Mr. Grant have another procedure in mind for ensuring that divergent views are heard?	◯	◯	◯	◯	◯
8. Does Mr. Grant have the authority to expel troublemakers from the meetings or prevent them from making long speeches?	◯	◯	◯	◯	◯
9. Are some people deliberately undermining the school board process by playing some sort of power game?	◯	◯	◯	◯	◯
10. What effect would stopping the discussion have on the community's ability to handle controversial issues in the future?	◯	◯	◯	◯	◯
11. Is the trouble coming from only a few hotheads, and is the community in general really fair-minded and democratic?	◯	◯	◯	◯	◯
12. What is the liklihood that a good decision could be made without open discussion from the community?	◯	◯	◯	◯	◯

*3. Consider the 12 issues you rated above and rank which issues are the most important.

	1	2	3	4	5	6	7	8	9	10	11	12
Most important item	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Second most important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Third most important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Fourth most important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

7. Story 4

Defining Issues Test-2 US version

Cancer

Mrs. Bennett is 62 years old, and in the last phases of colon cancer. She is in terrible pain and asks the doctor to give her more pain-killer medicine. The doctor has given her the maximum safe dose already and is reluctant to increase the dosage because it would probably hasten her death. In a clear and rational mental state, Mrs. Bennett says that she realizes this; but she wants to end her suffering even if it means ending her life. Should the doctor giver her an increased dosage?

*1. Do you favor the action of giving more medicine?

- ◯ Should give Mrs. Bennett an increased dosage to make her die.
- ◯ Can't decide
- ◯ Should not give her an increased dosage

*2. Rate the following issues in terms of imortance.

	Great	Much	Some	Little	No
1. Isn't the doctor obligated by the same laws as everybody else if giving an overdose would be the same as killing her?	◯	◯	◯	◯	◯
2. Wouldn't society be better off without so many laws about what doctors can and cannot do?	◯	◯	◯	◯	◯
3. If Mrs. Bennett dies, would the doctor be legally responsible for malpractice?	◯	◯	◯	◯	◯
4. Does the family of Mrs. Bennett agree that she should get more painkiller medicine?	◯	◯	◯	◯	◯
5. Is the painkiller medicine an active heliotropic drug?	◯	◯	◯	◯	◯
6. Does the state have the right to force continued existence of those who don't want to live?	◯	◯	◯	◯	◯
7. Is helping to end another's life ever a responsible act of cooperation?	◯	◯	◯	◯	◯
8. Would the doctor show more sympathy for Mrs. Bennett by giving the medicine or not?	◯	◯	◯	◯	◯
9. Wouldn't the doctor feel guilty from giving Mrs. Bennett so much drug that she died?	◯	◯	◯	◯	◯
10. Should only God decide when a person's life should end?	◯	◯	◯	◯	◯
11. Shouldn't society protect everyone against being killed?	◯	◯	◯	◯	◯
12. Where should society draw the line between protecting life and allowing someone to die if the person wants to?	◯	◯	◯	◯	◯

*3. Consider the 12 issues you rated above and rank which issues are the most important.

	1	2	3	4	5	6	7	8	9	10	11	12
Most important item	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Second most important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Third most important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Fourth most important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

8. Story 5

Demonstration

Defining Issues Test-2 US version

Political and economic instability in a South American country prompted the President of the United States to send troops to "police" the area. Students at many campuses in the U.S.A. have protested that the United States is using its military might for economic advantage. There is widespread suspicion that big oil multinational companies are pressuring the President to safeguard a cheap oil supply even if it means loss of life. Students at one campus took to the streets in demonstrations, tying up traffic and stopping regular business in the town. The president of the university demanded that the students stop their illegal demonstrations. Students then took over the college's administration building, completely paralyzing the college. Are the students right to demonstrate in these ways?

*1. Do you favor the action of demonstrating in this way?

- Should continue demonstrating in these ways
- Can't decide
- Should not continue demonstrating in these ways

*2. Rate the following issues in terms of importance.

	Great	Much	Some	Little	No
1. Do the students have any right to take over property that doesn't belong to them?					
2. Do the students realize that they might be arrested and fined, and even expelled from school?					
3. Are the students serious about their cause or are they doing it just for fun?					
4. If the university president is soft on students this time, will it lead to more disorder?					
5. Will the public blame all students for the actions of a few student demonstrators?					
6. Are the authorities to blame by giving in to the greed of the multinational oil companies?					
7. Why should a few people like Presidents and business leaders have more power than ordinary people?					
8. Does this student demonstration bring about more or less good in the long run to all people?					
9. Can the students justify their civil disobedience?					
10. Shouldn't the authorities be respected by students?					
11. Is taking over a building consistent with principles of justice?					
12. Isn't it everyone's duty to obey the law, whether one likes it or not?					

*3. Consider the 12 issues you rated above and rank which issues are the most important.

	1	2	3	4	5	6	7	8	9	10	11	12
Most important item												
Second most important												
Third most important												
Fourth most important												

9. Demographics

Please provide the following information about yourself:

Defining Issues Test-2 US version

***1. What is your level of education? Please mark the highest leve of formal education you are currently enrolled in or have completed:**

- ◯ Grades 7, 8 9
- ◯ Grades 10,11,12
- ◯ Vocational/Technical school (schools that do not offer a bachelor's degree)
- ◯ Junior College
- ◯ Freshman in a bachelor's degree program
- ◯ Sophomore in a bachelor's degree program
- ◯ Junior in a bachelor's degree program
- ◯ Senior in a bachelor's degree program
- ◯ Professional Degree beyond the bachelor's degree (M.D., M.B.A., D.D.S., J.D., Nursing)
- ◯ Professional degree in Divinity
- ◯ Master's in teaching or Master's in Education
- ◯ Master's degree in graduate school
- ◯ Doctoral degree Ed.D.
- ◯ Doctoral degree Ph.D.
- ◯ Other

2. Which best describes your race/ethnicity? [Check all that apply]

- ◯ African American or Black
- ◯ Asian or Pacific Islander
- ◯ Hispanic
- ◯ American Indian/ Other Native American
- ◯ Caucasian (other than Hispanic)
- ◯ Other (please specify)

***3. What is your gender?**

- ◯ Male
- ◯ Female

***4. How many brothers and sisters do you have? Put 0 if you don't have any.**

The number of brothers: ______

The number of sisters: ______

Defining Issues Test-2 US version

5. What is your age?

Enter your age in years:

***6. In terms of your political views, how would you characterize yourself?**

- Very Liberal
- Somewhat Liberal
- Neither Liberal nor Conservative
- Somewhat Conservative
- Very Conservative

***7. Are you a citizen of the U.S.A?**

- YES
- NO

***8. Is English your primary language?**

- YES
- NO

10. Test taking Environment

We would like to know something about how you completed this questionnaire. Your answers will not affect whether or not you get credit for participation but will help us understand how students take questionnaires outside of class.

1. I completed the questionnair in one sitting.

- Yes
- No

2. Music was playing while I completed the questionnaire.

- Yes
- No

3. The TV was on while I completed the questionnaire.

- Yes
- No

4. I received phone calls while completing the questionnaire

- yes-more than one
- yes-just one
- No

5. I made a phone call while completing the questionnaire.

- Yes- more than one
- Yes- just one
- No

Defining Issues Test-2 US version

6. I received emails/text messages while completing the questionnaire.

- ◯ Yes-more than one
- ◯ Yes-just one
- ◯ No

7. I responded to emails/text messages while completing the questionnaire.

- ◯ Yes--more than one
- ◯ Yes-just one
- ◯ No

8. I stopped and talked to friends while completing the questionnaire.

- ◯ Yes- more than once
- ◯ Yes- just once
- ◯ No

9. Compared to how I take surveys in the classroom I took this questionnaire:

- ◯ The same way - not different at all
- ◯ About the same way – I had a minimal amount of distractions
- ◯ Not the same way– I had distractions that made me stop and start the questionnaire.
- ◯ Not at all the same way – I completed the questionnaire when I could while doing other things.

Appendix D

The Ethical Sensitivity Scale Questionnaire (ESSQ)

Appendix D
The Ethical Sensitivity Scale Questionnaire (ESSQ)

Circle the number that most closely represents your self-evaluation of each statement with 1 being “totally disagree” and 5 being “totally agree.”

1. In conflict situations, I am able to identify other persons’ feelings. 1 2 3 4 5
2. I am able to express my different feelings to other people. 1 2 3 4 5
3. I notice if someone working with me is offended by me. 1 2 3 4 5
4. I am able to express to other people if I am offended or hurt because of them. 1 2 3 4 5

5. I am able to cooperate with people who do not share my opinions on what is right and what is wrong. 1 2 3 4 5
6. I tolerate different ethical views in my surroundings. 1 2 3 4 5
7. I think it is good that my closest friends think in different ways. 1 2 3 4 5
8. I also get along with people who do not agree with me. 1 2 3 4 5

9. I am concerned about the well being of my partners. 1 2 3 4 5
10. I take care of the well being of others and try to improve it. 1 2 3 4 5
11. In conflict situations, I do my best to take actions that aim at maintaining good personal relationships. 1 2 3 4 5
12. I try to have good contact with all the people I am working with. 1 2 3 4 5

13. I take other peoples’ points of view into account before making any important decisions in my life. 1 2 3 4 5
14. I try to consider another person’s position when I face a conflict situation. 1 2 3 4 5
15. When I am working on ethical problems, I consider the impact of my decisions on other people. 1 2 3 4 5
16. I try to consider other peoples’ needs, even in situations concerning my own benefits. 1 2 3 4 5

17. I recognize my own bias when I take a stand on ethical issues. 1 2 3 4 5
18. I realize that I am tied to certain prejudices when I assess ethical issues. 1 2 3 4 5
19. I try to control my own prejudices when making ethical evaluations. 1 2 3 4 5
20. When I am resolving ethical problems, I try to take a position evolving out of my own social status. 1 2 3 4 5

21. I contemplate on the consequences of my actions when making ethical decisions. 1 2 3 4 5
22. I ponder on different alternatives when aiming at the best possible solution to an ethically problematic situation. 1 2 3 4 5
23. I am able to create many alternative ways to act when I face ethical problems in my life. 1 2 3 4 5
24. I believe there are several right solutions to ethical problems. 1 2 3 4 5

25. I notice that there are ethical issues involved in human interaction. 1 2 3 4 5
26. I see a lot of ethical problems around me. 1 2 3 4 5
27. I am aware of the ethical issues I face at school. 1 2 3 4 5
28. I am better than other people in recognizing new and current ethical problems. 1 2 3 4 5

Appendix E

Statistical Reports for ESSQ and DIT-2

Appendix E

Statistical Reports for ESSQ and DIT-2

Excel report for Statistical significance of ESSQ Pre-test and Post-test

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	3.486264	3.802198
Variance	0.327708	0.105998
Observations	13	13
Hypothesized Mean Difference	0	
df	19	
t Stat	-1.7297	
P(T<=t) one-tail	0.049948	
t Critical one-tail	1.729133	
P(T<=t) two-tail	0.099897	
t Critical two-tail	2.093024	

Excel report for Statistical significance of DIT-2 Mean N2 Pre-test and Post-test 2014

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	34.08154	47.15417
Variance	203.9566	146.5042
Observations	13	12
Hypothesized Mean Difference	0	
df	23	
t Stat	-2.47502	
P(T<=t) one-tail	0.010562	
t Critical one-tail	1.713872	
P(T<=t) two-tail	0.021124	
t Critical two-tail	2.068658	

Appendix F

Permissions to Publish Copyrighted Material

Research Article

Finnish Teachers' Ethical Sensitivity

Elina Kuusisto,[1] Kirsi Tirri,[1] and Inkeri Rissanen[2]

[1]Department of Teacher Education, University of Helsinki, P.O. Box 9, 00014 Helsinki, Finland
[2] Faculty of Theology, University of Helsinki, P.O. Box 33, 00014 Helsinki, Finland

Correspondence should be addressed to Elina Kuusisto, elina.kuusisto@helsinki.fi

Received 23 February 2012; Revised 12 June 2012; Accepted 14 June 2012

Academic Editor: Elizabeth Campbell

The study examined the ethical sensitivity of Finnish teachers ($N = 864$) using a 28-item Ethical Sensitivity Scale Questionnaire (ESSQ). The psychometric qualities of this instrument were analyzed, as were the differences in self-reported ethical sensitivity between practicing and student teachers and teachers of different subjects. The results showed that the psychometric qualities of the ESSQ were satisfactory and enabled the use of an explorative factor analysis. All Finnish teachers rated their level of ethical sensitivity as high, which indicates that they had internalized the ethical professionalism of teaching. However, practicing teachers' assessments were higher than student teachers'. Moreover, science as a subject was associated with lower self-ratings of ethical sensitivity.

Troesch Note: The ESSQ is referenced in Chapters Three and Four in this dissertation and is reprinted in Appendix D.

Subject: RE: Permission to include copy of DIT-2 in dissertation
From: ethicalstudy <ethicalstudy@bamaed.ua.edu>
Date: 5/26/2015 12:08 PM
To: Valorie Troesch <vtroesch@mtu.edu>

Yes, ofcourse. Just include the proper citation in the Methods section (i.e. materials subsection).

Thank you,
Meghan

Center for the Study of Ethical Development
307 Carmichael Hall
BOX 870231
The University of Alabama
Tuscaloosa, AL 35487
www.ethicaldevelopment.ua.edu

From: Valorie Troesch [vtroesch@mtu.edu]
Sent: Monday, May 25, 2015 9:13 AM
To: ethicalstudy
Subject: Permission to include copy of DIT-2 in dissertation

Hello,
I used the DIT-2 for part of my dissertation research pertaining to engineering education (as a pre and post test in an Ethics course I taught fall semester 2014). I used the Center at U Alabama for processing and analysis of the DIT-2. I would like to include the DIT-2 as an appendix to my dissertation. May I have your permission to do so? I am finishing the dissertation now and plan to defend this summer.
Thank you.
Valorie Troesch
PhD Candidate
Humanities Department
Michigan Tech University

Troesch Note: The DIT-2 is referenced throughout this dissertation but is specifically discussed in Chapters Three and Four and is reprinted in Appendix C.

Appendix G
Extracts of Qualitative Data Results

- Significant statements
- Formulated meanings
- Six Themes from Round One Coding
- Example of Round Two Essay coding for markers of understanding

Significant Statements: Research Paper Essays: What is it to be an ethical engineer?: Understanding of professional and ethical responsibility (numbers refer to essay number and line number within essay. Example 1.1 = essay number 1, line one)

1. Ethics is a complicated subject 1.1
2. Aristotle states that “a man who possesses character of excellence does the ‘right’ thing, at the ‘right’ time and in the ‘right’ way” 1.4-5
3. The problem with trying to create this definition [of “right”] is that every situation a person encounters with ethics is entirely different based on the conditions of the situation and their own personal beliefs 1.7-8
4. With engineering, this question is even more difficult to answer 1.9
5. more than your own personal beliefs 1.10
6. the ethical decision will have constraints to fit the decision into several different societies that each defines the problem differently. 1.10-12
7. interview a practicing engineer whom I could get some serious answers from 1.14
8. a few of the answers opened my eyes to a new way of viewing ethics that I have never thought of before 1.18-19
9. I feel I really learned something new from in this interview 1.19-20
10. resulting answer was not at all what I expected 1.22
11. “Has making an ethical decision ever held you back in your career,” 1.21
12. Rather than a simple yes or no with an explanation, I received a story that would teach me a lesson that I have never considered before in my life. 1.22-23
13. There were no laws pertaining to this situation, the decision was made in the name of safety for the human population 1.30-31
14. perfect example of this fundamental cannon in practice, as the company gave up a huge market advantage to offer safety to public 1.33-34
15. My take away from this answer was that the ethical decision is more important than having a market advantage over other companies even when there is no alternative reasoning to help your competition 1.35-36
16. a decision of this caliber does not lie solely on the shoulders of the engineer; other people need to be brought into the situation to make a fully informed ethical decision 1.38-39
17. I again was offered a learning experience 1.41
18. “Do ethical decisions always lead to the greatest good for the greatest number of people?” 1.43
19. that is not the answer that I was expecting 1.44
20. I asked for an elaboration on that answer 1.45
21. This was an answer that I grappled with understanding for a while 1.48
22. The question at hand is still very difficult to make a decision on 1.52
23. The take away from this question was a lot more difficult for me to understand; as there is not exactly a clear cut answer in this situation on what is right. 1.61-62
24. I believe that the best way to handle questions like this is to look at the entire situation 1.66
25. “Do you believe that ethics questions are all situational?” 1.70
26. This is a question that I began thinking about after one of the class readings 1.70
27. I also wanted to hear the answer from a practicing engineer 1.77
28. I believe that being able to see the whole picture in a situation is the most important part of being an ethical engineer, as the only way to make the ethical decision is to be fully informed of the situation at hand. 1.83-85
29. added to my understanding of what it is to be an ethical engineer 1.86
30. most helpful to me as I seek to define and understand what it is to be an ethical engineer, and why it is important. 1.87-88
31. the information that they know gives them a level of responsibility to the public that many other professions do not have 1.89-90

32. my ethical viewpoint when I started this course, what it has become by the end of the course, and the transformative process 2.2
33. learning process and how my opinions changed over the course of this class 2.6
34. I never had given too much thought on either my personal values or how these values aligned with any professional engineering codes of conduct 2.17
35. I'd like to believe I had a pretty good moral compass, but it wasn't especially calibrated. 2.19
36. I had a misaligned idea of how working in the automotive industry would be as far as where the responsibility for ethically challenging decisions was placed 2.20
37. course readings, there were several that I either strongly agreed with or strongly disagreed with 2.26
38. made me think of certain aspects of ethics I had not considered in the past
39. there is still the recurring question of how to weigh this against profitability, safety, and durability, to which there is no immediately apparent answer in my opinion. 2.109-110
40. Another related question is, when government regulations cover something, is the engineer responsible for its design absolved of the ethical burden, and is that burden shifted on to the lawmakers? 2.126-127
41. The interview was a good learning experience for me.2.132
42. There was a lot of information for me to take away from this interview 2.137
43. Some helpful information was the advice to figure out where you stand on a given ethical issue before you're actually faced with it. Things may not especially be easy but then at least you already know your preferred outcome, all that's left is getting it to happen 2.137-140
44. information that was surprising to me 2.141
45. Some information that was a new way of thinking about was that you can go to your supervisor or other management staff for help resolving an ethical issue. You're never on your own completely to make a decision on anything, at least in the automotive industry (and especially when you're just starting out). This was never a consideration for me in the past. 2.145-148
46. asked about an ethical decision that was not clearly right and wrong 2.153
47. I also learned that the most difficult decisions that have to be made in the automotive industry generally is when a problem is found late in the development cycle that will cost a lot of money to fix, whereas it could cause a lot of warranty repairs and negative customer opinion if it is let go 2.156
48. if there was advice Joe would offer to someone just entering the field of automotive engineering 2.170
49. This advice is very useful to me, as I hadn't ever really thought about ethics in this way 2.175
50. However, I now know some introspection is needed before I start working in the automotive industry 2.176
51. issue I had always for whatever reason assumed that I would be all alone to make my decision; the revelation that that's never the case especially in the automotive industry was a bit of a paradigm shift 2.180
52. This is another important piece of information for me because 2.185
53. In retrospect, this seems obvious, but it just wasn't something I'd considered in the past.2.189
54. Obviously this is an extreme example, but it illustrates the difficulty of an engineer's position. 2.199
55. A good ethical compass will help with making the required decisions, but that doesn't mean they're all easy 2.203
56. Often engineers have conflicting ethical obligations, 2.216
57. I now understand more the difficulties associated with reaching a decision due to the multiple factors that go into a design: 2.214
58. Ethics are going to have to be considered in the future more than ever as vehicles' systems become more and more sophisticated, approaching the theorized future of a self-driving car 2.218

59. When the car becomes able to make a decision in place of the driver, there's a lot riding on that decision 2.220
60. In my journey this semester to discover what ethical engineering means 3.3
61. I am always learning and this paper is more of a clarification of what I have recently learned and what I already know, so that I am internally consistent with my beliefs 3.5-6 (horizon)
62. This is our strongest asset as engineers; the ability to filter out noise and focus on the substantive portions of a problem. However this is also our blind spot, as it makes it much easier to forget the whole picture. Therefore, as I see it, ethical engineering is designed, and ethics in general for everybody, is to draw us out of our narrow interests and remind us of the whole. Without ethics we would be very remiss in our duty to others and to ourselves 3.15-19
63. It is an interesting case of situation ethics in which an engineer could have lied about the machine specifications to save the workers, but in doing so would have been dishonest to his management, who he is bound by ethics to be honest and forthright with (speeding up the hot dog machine) 3.64-65
64. We never found out and to my everlasting shame instead of reporting the missing ammo, I panicked about losing track of them and doctored the numbers to make them match. That is a mistake I never should have committed and is indefensible 3.93
65. my moral fiber is more resilient than when I was 18 and fresh out of high school 3.99
66. Because we have specialized knowledge we need to hold ourselves up to higher standards and owe it to ourselves and others to use our knowledge and abilities towards a greater good 3.111-114
67. and I have since learned that admitting failure, although hard, and a large blow to my ego, is necessary for preventing greater tragedy. 3/105
68. What is meant by 'ethical?' What does this mean? What role do ethics play in the everyday encounters of an engineer? 4.2
69. brings more questions than answers. 4.1
70. collaborated with fellow students 4.5
71. to broaden my knowledge resource 4.7
72. by choosing to interview someone who I knew more personally I was able to receive more unfiltered feedback without fear of portraying himself as a bad person. This was very successful as our interview evolved into a conversation shortly after beginning as the topic began to intrigue us 4.10
73. As expected I found that he does not consider what is ethical on a typical day 4.13
74. The critical decisions made by an engineer are often the ones that go unnoticed. 4.19
75. Through our discussion I realized that there is no correct answer to this dilemma and each engineer must make decisions on a daily basis that may affect someone negatively 4.45
76. What is right and what is wrong? Each individual has their own distinction between the two 4.47-48
77. In many cases including my interviewee the decision must be shared among a group 4.49
78. I feel that Wade Robinson did a fantastic job of explaining not only how ethics can unknowingly be intertwined in decision making relevant to engineers but also expresses why engineers must not intentionally cause harm 4.58
79. There are also circumstances where there isn't a set right or ethical code to follow (bombs). 4.72
80. . In an informal sense, it is a way of conducting yourself in a professional manner while trying to do your best to not mess up 4.80
81. we will seek to understand how an engineer can conduct themselves ethically to properly address these expectations. 5.8
82. In many cases an ethical chemical engineer will be of greater value in the workplace than their counterparts 5.87

83. Engineers of all sorts will have to take the interest of various parties into account when choosing their actions. The ethical engineer will keep these interests in mind and choose to act in a manner that minimizes injustice 5.109-111
84. Too often in today's society do we forget to take some time for introspection. 6.1
85. Taking the time to reflect on what is important to me, what I find moral, or how I prioritize things in my life is a critical aspect in how I will respond ethically in future conflicts and situations in my life and career 6.4-6
86. I have taken that time to think for myself, discovered ideas regarding ethics in today's world, and worked to understand how they will affect me in being an ethical engineer.6.6-7
87. an ethical engineer, let alone ethics, cannot be defined in one word, sentence, or even an entire essay 6.10
88. Ethics may mean something to different to each person 6.11
89. At the beginning of the semester, I may have simply defined ethics as "what is right or wrong". I now have a more complex understanding that ethics encompasses more than that; it is values, decisions, desires, and what drives an individual to do what they do 6.12-13
90. an ethical engineer makes designs and decisions that improve the public good, who understands their limits, and trusts their intuition 6.15
91. hope I can learn to be content and make an ethical call when needed 6.20
92. professional engineer I interviewed stressed the importance of being a good listener 6.22
93. work for a company whose passions align with mine. 6.25
94. . I value the ethical decision to integrate consumer values and opinions into the design of the product and not let price solely drive the design process 6.26-27
95. most people, engineers specifically, are inherently good people 6.28
96. ethical engineers have a desire to improve the world, not destroy it 6.29
97. situations can skew people's values and cause them to act differently than they ideally would.6.31
98. Engineers don't just decide to be careless or to be unethical with no reason. 6.33
99. I was surprised at her minimal understanding of what ethics means in the workplace.6.35
100. she struggled to give good examples or even understand the difficult questions 6.36
101. I believe she simply did not have an education in recognizing ethics 6.37
102. education can help an individual identify and choose to be an ethical employee 6.39
103. Understanding first that ethics differ across the world, with ages, or even between genders is a step to then understand how and in what ways they differ 6.40-41
104. learned through self-reflection and experience 6.42
105. I recognize that my ethics may change through experiences and years of working in industry 6.44
106. Each experience in a design process or a day at work may open my mind further and expand my understanding of ethics 6.45.
107. experiences as a student has recently improved my understanding of ethics.6.47
108. I was completely shocked at how little I knew about the ethics of our own nation's past, including the ethics of those developing the engineering and scientific world 6.50
109. Scientists were driven by finding answers, not by protecting human health. 6.52
110. . I wondered how I could have not learned about this sooner! 6.54-55
111. question of how I will continue to educate myself further once I'm in the position of an engineer developing products used by humans 6.55
112. believe one of the best ways for an engineer to understand ethics is to communicate and teach others 6.57
113. helping to develop the understanding of ethics in my coworkers someday, I'll better understand my own view on ethics 6.57-58
114. discussion of ethics is "needed to raise awareness, determine our common values and find new strategies to safeguard these values to the maximum possible" 6.60
115. An ethical engineer would understand the ethics of his or her coworkers, 6.64

116. I understand that if I am ever in the situation where I do not agree with my coworkers ethics and cannot find a meeting point, I feel comfortable with leaving the company 6.65-67
117. As the field of engineering evolves, corresponding ethics for an engineer will need to as well 6.69
118. Oortmerssen, “our values direct the development of technology, but at the same time technology has an effect on our values 6.71
119. The impact of age of technology makes it easier to be anonymous and unethical in an online setting 6.73
120. but no regulation is absolutely error proof.6.76
121. “families are driving our cars”. 6.78
122. as technology and science develop, I will need to personally be aware my ethics will need to drive my decisions even more 6.83
123. This enforces my opinion that ethics is much more than facts and much more than emotions.6.89
124. Ethics is a confusing mixture of both, with the recipe for one individual’s ethics different than another 6.90
125. In the following years, as I aspire to be an ethical engineer, I will need to ask myself many question 6.91
126. . I’ll be challenged with the task of self-accountability to uphold and maintain my standards of ethics, even in a profit driven society 6.92
127. . I’ll need to be aware of what I’m uncertain about. I’ll need to make a decision on my personal boundaries of what will drive my choices: my values or profit? 6.93
128. I’ll grow to understand that ethics won’t just impact decisions I’ll make at work; ethics will be in my everyday life 6.95
129. I understand the ethics I practice in my life outside of my career will influence my set of ethics in my career, and vice versa 6.96
130. I’ll need to establish for myself how far my responsibility as an engineer goes. 6.97
131. consider how I will interact with international colleagues 6.99
132. understanding how ethics differ in different countries will become incredibly crucial. How will I determine which countries set of ethics overrule the others? 6.100
133. may replace a human worker? 6.102
134. I will ask all of these questions, but may not have definite answers 6.103
135. Rules are black and white, but ethics in real life have infinite gray line 6.103
136. Ethics is not completely definable, but it is unique to the individual.6.104
137. sometimes the quest for profits may collide with ethical value 7.4
138. is entirely up to the engineers as individuals to maintain and uphold ethical values.7.5
139. right off the bat he was bridging the gap between engineering ethics and personal ethics as an individual. 7.9
140. valued honesty, integrity, and openness and fairness just as much in his work, as he does in his personal life 7.10
141. first step to practicing ethical engineering is to possess a strong ethical code, whether it be the NSPE Code, religious, or whatever. 7.12
142. Once ethical values are maintained, they easily fall into place as an engineer 7.14
143. It seems in personal situations, ethics becomes a subconscious process 7.15
144. but it seems to be that ethical behavior becomes a core value of the individual engineer 7.17
145. Seems to be similar to any other repetitive process, and once an engineer possesses and practices ethical behavior, it becomes a subconscious and automatic process. The second step to becoming an ethical engineer seems to be the same way to get to Carnegie Hall…practice! 7.17-19
146. What do they mean when they say “public 7.22

147. , it got me pondering about what it means to affect people as engineers in different regions, and to serve the “public”, and public shouldn’t be divided by borders: state, country, or otherwise.7.26
148. engineers shouldn’t stop at regional or national borders, or race, or gender, etc. when talking about how ethical issues will affect the public. Engineers need to keep in mind everything, not just a close-minded view of what affects them locally, when making ethical decisions 7.30
149. the interview about the differences between engineering in government and how it differs from private companies, because government agencies don’t have profits to worry about, 7.36
150. public regards engineers as experts in a profession, and this responsibility needs to be taken seriously to continue on the quest to being an ethical engineer 7.42
151. , they need to place themselves in an environment that allows them to be ethical, and not compromise their ethical code 7.50
152. Completely avoiding unethical behavior seems to be an impossible task 7.52
153. An important part of being an ethical engineer may be to take a class on ethics, and determine what it means to be ethical 7.59
154. a big part of it seems to come from the values you were taught growing up.7.60
155. , “Sometimes ethical behavior is compared to ‘Things I Learned in Kindergarten’ (Share things, play fair, don’t hit people, put things back where you found them, etc). If you learned these values early in life and have attempted to live by them, then you have a solid foundation for the ethical challenges in the workplace.” 7.61-64
156. So it turns out that both government and privately employed engineers have to worry about the pressures of corporations pushing profits or budget constraints interfering with ethical decision-making. 7.66
157. it goes back to the fact that there needs to be ethical engineers in place to prevent unethical activity, and if it happens to happen, there needs to be a way to report and correct the activity 7.70
158. it is crucially important that engineers remain loyal to their ethical codes, and if placed in a situation that would force them to compromise their ethics, that they find another opportunity 7.73
159. to find a place that allows them to stick to their values 7.75
160. Ethical engineers need to keep everyone in mind when making ethical decisions, not just local people of a certain race, religion, or gender 7.83
161. Engineers are regarded as experts in their fields, and need to take that responsibility seriously 7.85
162. . While engineers may not always be consciously thinking about ethics, those decisions affect people, the environment, health, and so much more, and engineers having a strong foundation of ethical values will allow mankind to thrive 7.85
163. In order for ethical engineering to take place, three things are necessary. First, the engineer must be aware that many, if not all, engineering products are designed with Ethical Expectations. Next, the engineer needs to be aware of who The Public is and how The Public will be affected by the Ethical Expectations. Finally, the engineer must be equipped with a Moral Motivation that helps them to determine and execute a correct course of action to take when encountering Ethical Expectations that will negatively affect The Public. 8.1-6
164. it is quite tempting to come to the conclusion that ethics and engineering do not go hand in hand. The classic argument that “guns don’t kill people, people kill people” comes quickly to mind as a way to avoid taking on the undesired responsibility for the safety and well-being 8.8-11
165. many products are designed in a way that has an Ethical Expectation for the consumer, whether the engineers and customers realize it or not 8.12
166. Does “public” mean an engineer’s nation,” 8.31

167. I would also argue that, due to the great amount of specialization that can be seen in all technical fields, almost everyone who is affected by the technology will not have a grasp on the full implication of the technology. Therefore, it is safe to assume that anyone who comes in contact with a product is "innocent" and their ignorance should be taken into account when designing a product. 8.35-38
168. This seems a little overwhelming for any engineer who is unable to foresee events in the distant future. 8.45-46
169. engineer is responsible for the products they make and should be on the lookout for products that will clearly have a negative impact on the welfare of The Public 8.50
170. particularly meaningful when considered in the context of the role that German engineers played in enhancing the efficiency of the Holocaust 8.51
171. , the success or failure of a technology may depend on the regulations imposed on the technology by the government 8.54 (discusses examples where government regulation would be essential – head transplants, AI, self-driving vehicles)
172. I believe that after the engineer gives recommendations to The Public for how his/her technology should be used, the engineer should continue to work on the usability and safety of the technology, blissfully secure in the knowledge that the government will make the ultimate decision on whether the technology should be used and what precautions should be taken to ensure that The Public is best served by the technology in question 8.61-65
173. If an engineer sees that the technology has a negative impact on The Public, it is necessary for the engineer to have the will to solve the issue 8.67
174. The engineer can be motivated internally or externally to take action.8.68
175. if a group is led by a strong leader who emphasizes ethical behavior, the group will be more likely to act ethically (externally) 8.71
176. I would work to behave in a way that would not disappoint a person that I respect. 8.74
177. having a strong governing body that is able to punish wrongdoers in such a way that it would hurt more to cheat and get caught than it would to lose 8.76 (citing article)
178. money as an incentive not to cheat, so it will have the greatest effect on those who value money most. Yet if the financial incentive outweighs the risks and possible fines, then the "strong stand" of the FIA or any other governing body will mean nothing. 8.83-85
179. it is more important to have an internal Moral Motivation. 8.87
180. Internal Moral Motivation is something that is strongly affected by what you believe in. 8.89
181. He said that his belief in moral absolutes as revealed in the Bible was helpful to him in ethical situations. 8.89
182. is important for engineers to have some sense that there are right and wrong solutions to an ethical situation.8.92
183. (Comparative Ethics article): rigorous examinations do not seem to be the deciding factor for ethical soundness.8.99
184. why French engineers are ethically sound is that they believe they can use mathematics to create the perfect state 8.100
185. If an engineer has an internal Moral Motivation, s/he will follow this ideal or system of beliefs since that is genuinely what the engineer will want to do. 8.104
186. but internal motivations are stronger and more likely to consistently lead to ethically sound decisions.
187. Controversy exists about what constitutes an ethical engineer 9.1
188. Many people, including engineers themselves, first think of personal values and decisions made in the discipline that comprise of ethical engineers, and I am no exception.
189. At the core of morality, being able to distinguish the best choice or deriving an alternative one with regard to ethical virtues and standards is considered ethical itself, which is sufficient for many engineers in the profession 9.14-16
190. this is a very narrow-minded approach towards engineering morality, and it does not consider the long-term impact of the decisions they make; hence, most engineers do not

fundamentally understand how far their responsibilities go for the goods/services they provide. 9.16-19

191. strengthened my understanding of the importance of challenging the complex regions of ethics, as morality is not just a simple black-and-white choice.9.21
192. provided a foundation for me to begin questioning my own ethical habits. 9.23
193. Many engineering problems do not have one solution or series of solutions to them (which is the primary difference between university class problems and industry tasks 9.31
194. separation of ethics and intentionality 9.31. unintentional harm while in use or after use 9.35
195. Harms that are upstream or downstream" Robison says during the engineering design process, "are a part of the design solution. 9.36
196. Surprisingly, many of the values I labeled as core ethical engineer virtues were reiterated by him, such as honesty and integrity 9.46
197. , respect was also brought up, which directly correlates with credibility, and, furthermore, accountability 9.47
198. Individuality also correlates to an ethical engineer 9.51
199. . Another interesting aspect involves flooding one's personal life with virtues from the ethical engineering life. 9.59 upholding these particular virtues at home assist the engineer in solidifying them as a part of oneself
200. Expectedly, I received no indication that he would purposefully consider the long-term effects of his engineering and design decisions, nor the predictions of harm associated with the misuse of any engineered product/service.9.63-65 (re:interview)
201. Therefore, I have concluded that many "ethical" engineers do not actively consider the impacts their engineering and design choices have on the world, especially for long periods of time, and I further assume that these decisions have been mediated through technology, especially for engineered products. 9.67-69
202. my philosophical approach to determining "what is it to be an ethical engineer." 9.71
203. I will briefly be analyzing the ethical aspects that many engineers do not consider; an emphasis will be placed on technology, since I believe technology is the primary mediation technique for engineers. 9.71-73
204. these technological design implications can potentially drastically alter the method in which people experience the world, which, in my opinion, can be considered a form of control that the engineers have over the general public 9.82
205. Is the procedure of improving technology a benefit to society 9.91
206. , both of these concepts should, at the very least, come to mind when planning to design and release a product to the public, as well as the fact that technology is not a neutral tool.9.85
207. analyzing the problems with engineering ethics and implementing solutions are two very drastic problems 9.97
208. many issues and concerns revolving around engineering ethical fissures are contextual, generalized ideas do not provide much reconstruction 9.98
209. engineers should attempt to think, and possibly philosophize, about all the impacts the potential products they are designing have on the world 9.106
210. Many of my previously believed ethical values still support my ethical foundation, such as honesty, integrity, reliability, accountability, perseverance, and capability 9.109
211. these virtues provide only one level of engineering morality to me, and I am just beginning to delve into the further categories 9.112-114
212. independence is an extremely important trait for providing an unbiased judgment on ethical concerns, and, as such, needs to be practiced to the same extreme that honesty should be 9.115
213. many moral issues are contextual, so generalized solutions cannot be formulated that will properly apply to most situations; 9.117

214. the ethical engineer must remain vigilant and critically apply themselves to solving any moral conflict that arises 9. 118
215. that technical artifacts are much more than just neutral tools 9.124
216. many “ethical” engineers are very narrow-minded in their morals, and the true ethical engineer will need to draw upon multiple disciplines to properly succeed at their engineering work 9.124-126
217. that ethical engineering takes on a dynamic form and followers will need to perform constant, consistent investigations in the field 9.127
218. Studying ethics, while perhaps not the most exciting subject, is necessary in engineering. 10-2
219. . Engineers collectively wield great power, and therefore are continually confronted with ethical decisions.10.3
220. Bunge – compares science and technology. All technology has inherent ethical properties 10.15
221. Technology not only has ethical properties, but at times it actively makes moral decisions 10.16 (ICDs as example)
222. Ethics for engineering is also important because engineering affects people. 10.25
223. the public is global; it does not stop at country border.10.26
224. their actions can have widespread effects. 10.33
225. What does it mean to be an ethical engineer? This is by far a harder question to answer 10.34
226. The drawback of ethical codes is they are generally just rules; Rules cannot cover all situations, and so engineers are still forced to make decisions with little outside guidance. 10.36-38
227. they need to be informed enough to know if there are better options not yet under consideration 10.42
228. they must be competent and objective enough to know whether they can execute their chosen decision 10.43
229. The way to choose what is an ethical decision is the hardest question to answer. 10.47
230. Nearly always there is trade-off 10.47
231. What is best is very subjective, and so the best option is different for each individual 10.48
232. The engineer must make the decision based on his personal values 10.49
233. The evaluation of what is right and what isn’t is ultimately up to the engineer, and by extension, his employer. 10.50
234. Interview examples – company that aims for sustainability even if some things operate at a loss 10.57
235. Also mechanization of manufacturing – what happens to people it replaces 10.63…
236. , engineers must care about ethics because of what engineering is 10.70
237. Because of their skills, position, the things they work on, they have power over others. 10.70
238. , it the end, it is up to the engineer to choose the best decision, based on his personal values.10.75
239. code of ethics can help, but it is ultimately a subjective decision of right and wrong 10.76
240. Engineers are among some of the most trusted professionals in today's work force 11.1
241. when the public takes advantage of the work of an engineer, they believe that it will live up to the standards that are set by the public themselves or by what's advertised 11.2
242. An ethical engineer makes the decision to perform to the best of their abilities even with these temptations (cutting corners, eg) 11.11
243. An ethical engineer does not serve themselves 1.13
244. we hold so much responsibility is because we are the ones who hold all the knowledge of our projects. 11.21

245. I am also being paid to take the time to deliberate over the ethical issues that come with my projects.11.24
246. When working on a project, I must always be aware of ethics 11.25
247. I must constantly be thinking of how the public will handle my product 11.27
248. My knowledge of engineering allows me to consider different options and solutions. 11.34
249. Knowing which risks are the most important to eliminate is the hardest thing for an ethical engineer to do 11.61
250. It is up to me to decide which are the most dangerous to the public. This decision is not always just quantitative (such as number of deaths) but is often qualitative too 11.63
251. There is a thin line between eliminating what I think is a risk to the public and creating a paternalistic environment 11.74
252. With the pressure from the company I work for, it will not always be easy to carry out the most ethically ideal project. 11.84
253. At a certain point, however, I may have to draw the line where my company does not meet the ethical standards that I have put for myself. When this happens, it may be time to either compromise my beliefs or move on. This can be extremely difficult because of how intimidating and difficult it can be to try and find another job. However, after my interview with___, , I feel much more comfortable with making the decision to leave a company 11. 89 (relays interviewee experience of quitting job over ethical issue & consequences for new job – hired because of his ethics) 11.94-103
254. This story showed me that people value ethical decisions. Because of this, I am less afraid of quitting for a reason having to do with ethics 11.102
255. With the power I will have, I must take care of those who do not have the knowledge from an engineering degree or the time to figure out the risks themselves. 11.105
256. Engineering is much less clear cut than most people make it out to be. 11.109
257. When designing products that people use every day, engineering, necessarily, becomes value-laden 11.110
258. It has turned out to be one of the most ambiguous, complicated and debatable answers to a question I've been asked to explain 12.2
259. hard for many engineers and technicians to answer as well due to the fact that most of us have been programed to think quantitatively through lots of our studies and research 12.4
260. Ethics isn't so cut-and-dry like solving a math problem, it has a lot more gray area compared to the calculus classes most struggle through 12.5-6
261. Through my semester of research focused on thinking more qualitatively than usual 12.7
262. stumbled upon many interesting points of view concerning ethics including viewpoints from other parts of the world and treating technology as an ethical element 12.8
263. learned a decent amount about myself and my own ideas on what it should mean to be an ethical engineer. 12.9-10
264. businessdictionary.com– "The basic concepts and fundamental principles of decent human conduct. It includes study of universal values such as the essential equality of all men and women, human or natural rights, obedience to the law of the land, concern for health and safety and the natural environment." However if I could change it, I would add the two words "perception of" to make it say – "The <u>perception of</u> basic concepts and fundamental principles…" 12.11-17
265. One of the most important ideas that I have taken away from my studies is that these principles of human conduct concerning what is right and what is wrong has everything to do with someone's point of view and beliefs. 12.18
266. views on what is morally right can be brought about by religious beliefs, political stances, scientific knowledge or even daily observations and will highly influence an engineer's decision on how to proceed with a give task 12.20 (example building mall in forest)
267. engineer's meaning of ethics also can be induced by what part of the world they grew up in and how they were taught about ethics. 12.28 (cites interview and Downey). France: they believe that one should not have to study ethics, but should be ready to accept the tough

choices they will be faced with and keeping the interests of the nation and world ahead of personal/corporate gain

268. risk versus reward. “This is something that most engineers will be faced with at some point in their careers,”12.44 – interview and Hylton

269. There seems to be a lot of gray area in the world around us, and ethics is not excluded 12.57

270. When asking “what does it mean to be an ethical engineer,” one must research and weigh the effects for them working for a specific company where the product or job they are asked to complete could have ethical problems down the road. For example, if an engineer is offered a job working for Lockheed Martin and they will be working in their missiles and guided weapons department, that person must look inside and decide for themselves if they want to develop new weapons that kill people every day (bad and good people), because that is what Lockheed Martin needs in order to be able to make a profit. There is a risk versus reward element here as well due to the fact that if you will be rewarded with a nice paycheck to provide your family with, but might risk your own emotional wellbeing. A perfect example of this is the Manhattan Project during World War II when physicist J. Robert Oppenheimer and a team of US Army engineers conceived the first atomic weapons to use on the Japanese in order to end the war. 12.63-73

271. “Engineers should know that the product they design could end up injuring or killing people or being used in a manner to harm someone or something,” Dr. Middlebrook stated. “This applies to almost any product.” And if you really think about it, it makes sense 12.74 (people using cellphones in cars). sometimes things go wrong even when you are ethically in the right state of mind, with your product’s main function not intended to cause harm 12.80

272. one might ask if technology that the engineer develops can be ethical. Isn’t a bomb’s main purpose to destroy buildings and harm people? 12.82

273. Although I’ve read several papers this semester that talk about how technology itself can be ethical, I have denied this opinion from the start. I believe that it is the developer and the user of the technology who have to be held accountable for the actions that the technology takes …. For the Manhattan project, the engineers and physicists took it upon themselves to unveil nuclear weapons knowing that the world could never be the same, and that these weapons could be used for strategic political gain. In order for something to be ethical, I believe it must be able to think ethically itself. 12.85-92 Uncertain what this means

274. , I personally have found that ethics is a very ambiguous subject that will challenge the best thinkers and I know now that it is not something to take lightly when one enters the work force 12.93

275. when I say think, I don’t mean just quantitatively, but qualitatively as well! Think about how the quality of life will be with your product in it. Will it be a presence of good in the world, or something that is made to harm? How will affect the quality of your life? Will the financial reward be worth the risk of a clear conscience? 12.97

276. if an engineer can honestly look inside and have a clear moral sense and understanding of what they are working towards, then they can be considered ethical, no matter what background or point of view they have 12.100

277. Every day, members of modern society put their health, finances, and wellbeing in the hands of diverse professionals. It is necessary to trust doctors, accountants, and engineers to use their specialized knowledge to protect these items of immense personal value 13.1

278. This is not to cheapen the ethical duty that engineers have, but rather to put it in the proper light. Engineers are responsible, like other professionals, to protect the interests of those whose “innocence” means they are not able to protect themselves 13.21

279. engineers have this sweeping duty to act ethically 13.24

280. A Spartan-minded person would respond by saying that an ethical engineer would perfectly protect the public by completely avoiding mistakes. The human experience teaches that this cannot be. 13.25

281. The solving of an ethical problem, like a physical engineering problem, requires some theory as well as some empirical experience and gut feeling. It is this mix of theoretical moral behavior and acquired know-how, applied in an honest manner that makes an ethical engineer 13.31
282. Producing engineering codes of ethics is helpful, but not a sure way to produce ethical engineers 13.36
283. One issue with the effectiveness of codes of ethics in influencing engineering decisions emerges quickly in a discussion with the average practicing engineer. Either the engineer does not reference published codes of ethics or does not realize they exist. Dr. King falls into the latter group. This does not mean that the average engineer neglects to examine the ethical element of their work, but just that he or she generally does not do so with a published code of ethics in hand 13.36
284. issue with engineering codes of ethics is that they differ slightly between the different societies that issue them 13.42
285. Engineering codes of ethics differ more significantly between the cultures from which they are issued 13.53 (with examples). Also discusses cultural Downey 13.60
286. . These values, not a code of ethics, guide engineers as they operate in their respective cultures. 13.82
287. In reality, all engineers are guided – knowingly or not – by their values 13.83
288. When asked if he applied particular values to ethical decision in an engineering context, Dr. King said no. He does not have clearly defined values which he methodically applies to engineering ethics questions 13.83. However, it was clear when talking to him that Dr. King operates with a particular mindset that automatically keeps him within the realm of ethical engineering 13.86 (with examples)
289. This habit did not result from an ethical deliberation, but rather from experience which teaches that a good reputation in research can be maintained by producing concrete results. 13.100
290. Ultimately, it seems that all engineers are guided by their values since values can quickly guide decisions 13.107
291. . Codes of ethics are and other such tools are too cumbersome for the fast paced world of engineering decisions. 13.108
292. alZahir and Kombo cite some authors who suggest that codes of ethics are more a method to enhance the respectability of the engineering profession than to adjust the behavior of engineers 13.110
293. “making an honest effort” means developing good values and intentionally applying them, or reaching a state where they are applied naturally. For older engineers, this comes through learning from experience. For younger engineers, it is necessary to consult with veteran engineers to gain from their experience 13.111
294. Being an ethical engineer means making on honest effort to protect the innocent public through applying well developed values to questions of ethics 13.117
295. Young engineers do well to enlist the help of those more experienced when faced with decisions that have real consequences in a fast paced world 13,124

Formulated meanings of significant statements: Understanding of professional and ethical responsibility (numbers refer to statement numbers in "significant statements")

1. Ethics is complicated 1, 23, 69, 87, 89, 258 (quote)
    a. Every situation is different 3, 63
    b. Every person has a unique set of personal beliefs and values 3, 76, 88, 136, 231, 265-266
        i. Growing up values learned 154-155
    c. It's more than one's own personal beliefs 5,
    d. Constraints of cultural and societal differences too 6, 103, 267
    e. Even harder for engineering 4
        i. Conflicting obligations: understanding of ambiguity in problems and solutions: 54, 56, 115 (understanding co-workers), 117, 123-124, 193 (compares this to case studies), trade-offs 230, 274
        ii. Multiple factors and parties to consider in design 57, 83, 160
        iii. They possess specialized knowledge and this gives them a unique level of responsibility to public – what that means 31, 66, 150, 161, 219, 237, 238, 244
            1. Public" and extent of engineer's responsibility 40 (government, also 149), 166, 190 (most engineers don't understand how far it extends)
            2. Beyond borders 147-148 (good quote about reflecting on this), 160, 223
            3. Public as "innocent" and special duty (good argument here 167-170), 255, 278
        iv. Critical decisions go unnoticed 74
        v. "intertwined" nature 78, 95 (inherently good), 139 (personal and professional values are not inseparable 139, 140, 199 quote)
        vi. Decisions are qualitative, not just quantitative 250, 275
        vii. Ethics is part of the job 245-250
        viii. Understanding of why people might screw up 97, 98, 96
        ix. Science versus ethics 109; engineering as ethically neutral 164, way we are taught 259-260
        x. Technology issues to consider 203-209, 215, technology makes moral decisions 221
        xi. Worry about how I will do 111, 125, 126, 127
        xii. Importance of education on ethics (self and others) 102, 111, 112, 113, 153, 218
        xiii. How to help ensure ethical behavior
            1. Work for a good company 151, 159 have good people in place 157, remain vigilant 214, draw on multiple disciplines 216, enlist experienced engineers 293-5
        xiv. Ultimately up to engineers and employers 233 (examples from interview 234-235)
    f. No simple "yes" or "no" 12, 89, 135
    g. Cannot avoid unethical behavior absolutely 152, 280
2. Why it's important for engineers 58 (technology), 59, 122, 117, 138 (up to them)
3. Questions about ethics I've never thought about; change during semester
    a. Opened my eyes to new way of thinking about ethics 8, 12, 32, 33, 38, 49, 108 (how little I knew), 110
    b. Added to my (also self) understanding 29, 35, 52, 191, 192 (foundation to question my own ethical habits)
    c. Most helpful to me 30
    d. Never thought about it before (personal or professional ethics and values) 34, 53

   e. Insight about ethics for the profession in practice 36, 43, 73, 89 (personal change)
4. Value of interview
   a. Learned something new 9, 41, 42, 49
   b. A source to consult 7, 48
   c. Stories from experience that taught me lessons 12
   d. Surprising 44
   e. Gained strength from it 116, 252-254,
5. Rules
   a. Decisions are above what rules say –13
   b. Limited usefulness of rules 55, 79, 120, 135, 226, 239, 282-292 (use quote)
6. Ethics versus profit (& public interest versus company & profit; self-interest): risk vs. reward
   a. Ethical decision is more important than profit or market advantage 14, 15, 47, 93, 94
   b. Tough to resolve – lots of ambiguity and conflicting priorities 39, 63, 96 (improve world, not destroy it), 137
   c. Self-interest 64, 67
   d. Same considerations apply to government work 156
   e. Lockheed Martin & weapons considerations 170
7. I'm not alone in making ethical decisions
   a. Important lesson – a learning experience, didn't know this before 16, 17, 45 (good quote), 51 (paradigm shift), 77
8. Ethics as utility 18-23
   a. Not answer he expected and hard to understand, no clear-cut answer
9. Need to consider whole situation – very broad and broader than we think 24, 28 (most important part)
   a. 62 – really good quote – ability to focus is strong point and blind spot
10. Expressions of personal reflection and thinking about what they are reading and hearing
   a. Compare reading and interview 25-26
   b. Readings – critique – agree and disagree 37
   c. Value of course 60 (my journey), 61, 70 (collaboration), 71, 89 (beginning and end of course)
   d. I realized 75, 91 (aspiration)
   e. Good definition (trying not to mess up) 80, also 89. Another one 281
   f. Reflections on what they learned about ethics and engineering workplace (through interviews or their own experiences) 99, 100, 101, 102, 104-105 (importance of reflection and experience – fusion of horizons)
   g. External vs internal moral motivation – discussion and reflection is good 174-186
   h. Need to consider long-term impact & most engineers don't understand how far their responsibilities extend 189-190
   i. I have concluded that many "ethical" engineers do not actively consider the impacts their engineering and design choices have on the world, especially for long periods of time, and I further assume that these decisions have been mediated through technology, especially for engineered products 200-201
   j. Learned a decent amount about myself 263 and worldview (262), added "perception of" to definition of ethics = example of reflection 264
11. Values and Introspection 114
   a. Think about where I stand ahead of time – similar to quote in my dissertation 43, 85, 86
   b. Need for introspection 50, 84, 125-134 (good quote on self-reflection and ambiguity)
   c. Sort of a "being in the world" with ethics – prereflective: 142, 143, 145 (good quote), 144 (ethics as core value), 293-94
   d. Role of personal values 232
   e. Reflect on discover of and thinking about own biases – examples

f. New ways of being in the world? New ways of envisioning selves as ethical engineers. Examples – transformational experiences – expressions of how this class experience will change the way they think they will behave – pause and observe selves in act of maturing. Movement need not be a complete shift – how they encounter themselves considering the view of the Other – acknowledgement that there might be another horizon (Soloway) – new wisdom about selves
g. Engagement with texts – mindfulness (observing mind in its processes) learning as if it is a new experience – see last para of Soloway. Embodiment. “Learning was lived through to new orientations of what it means to be in the world”

Six Themes from Round One Coding

1. Unprepared – fear of being left alone and fear of losing job
    a. Leaving job 3.77, 6.65, 11.84 (did I use this already?)
    b. Be willing to admit failure 3.100, 7.71

2. Ethics is complicated and asking questions about what this means: Public, human aspects, socially situated, technology
    a. Public – compare to other professionals & innocence 13.17
    b. Market and competition: risk vs. reward 12.44
    c. Situational 1-78 and a trade-off 10.47, 11.61 (risk)
    d. Ambiguity
        i. In industry, problems are seldom clearcut but ambiguous 2.152, 165 (cite Goldman)
        ii. Looking for absolutes 8.91 Bible and mathematics
        iii. Good quote (use this!) on ambiguity 11.104
        iv. Qualitative 11.63, 12.97
3. Technology as a separate issue
        i. Argues against Bunge – we're doing good things 2-29 struggling with personal choice vs. imposing choice as ethics 2-41 – it's the mental struggle that is important here. Weighing things as a choice. 2-108
        ii. Whose responsibility? Government – thinking about the question! 2-119
        iii. Critique of interviewee – didn't consider impacts of technology 9.63
        iv. Personal decision and how to make sense of that: 12.66
        v. Quote on developer and engineer responsibility for technology 12.85

4. Values and reflection – greater self-awareness and value of that
    a. Think about this in advance 2.136
    b. General value of reflection quote 6.1-9
    c. Experience will help and will change ethics 6.42
    d. Growing up values 7.59
    e. Flooding one's personal life with values 9.59
    f. Self-learning – independence 9.114
    g. Self-reflection use quote 12.3
    h. Depends on values 12.18
    i. Good summary of where students are at: 12.95
    j. How they work in practice 13.84

5. Experience
    a. Becomes a subconscious process (practice!) 7.15
    b. Getting this experience from older engineers 13.107-115, 122

6. Other – this class (and education) a good way to find out about these things, experience
    a. Value of interview 2.131, 1.16, 7.9
    b. Voice of experience – value of: 2.169 – advice
    c. Importance for engineers to study ethics see 6; 10.2 &.25
    d. New way of thinking about ethics section #3 from significant statements

Example of Round Two Coding of Essay

Introduction

The purpose of this paper is to examine my ethical viewpoint when I started this course, what it has become by the end of the course, and the transformative process. I started knowing only some basic things about engineering ethics, and at the end of the course I had completed the course readings and conducted an interview with a practicing engineer in the automotive engineering field. My learning process and how my opinions changed over the course of this class will be covered. Also contained in this paper will be information I've gained from the interview I conducted as part of the research for this paper.

Since this paper concerns my personal ethical development, a brief introduction is in order. I am a mechanical engineering major in my final semester. I have fairly recently accepted a full-time position with Ford Motor Company in Product Development starting January 26th 2015. I've also been on Michigan Tech's Formula SAE team for five semesters and worked part-time during the school year and over the summer during the majority of my college career. This past summer, I had an internship with Ford, which was my first and only experience with the automotive industry so far.

vtroesch
Foregrounded horizon

Ethical Viewpoint at Start of Semester

At the beginning of the semester, I had a very general idea of what would be considered ethical behavior and what wouldn't. However, I never had given too much thought on either my personal values or how these values aligned with any professional engineering codes of conduct. In general, I'd like to believe I had a pretty good moral compass, but it wasn't especially calibrated. Additionally, I see now in retrospect that I had a misaligned idea of how working in the automotive industry would be as far as where the responsibility for ethically challenging decisions was placed. Thanks to the interview I conducted, I realized I held some misconceptions about the day-to-day realities of working as an engineer in the automotive industry.

vtroesch
Foregrounded horizon, openness to challenge biases, new understanding

Literature Inputs

As I read through the course readings, there were several that I either strongly agreed with or strongly disagreed with, and made me think of certain aspects of ethics I had not considered in the past. I will avoid summarizing the readings as I assume readers of this paper will be familiar with the contents of the referenced works.

vtroesch
Challenging biases, dialog

Bunge [1] argues that technology is sometimes considered to be ethically neutral even though that is not the case in his opinion. Focusing only on this point of his paper, I disagree with his assertion that technology is never ethically neutral. There are a lot of instances that I would argue that technology can be ethically neutral. For example, the Internet can be used to spread a wealth of knowledg e all over the globe, but by the same token can be used to steal information, extort people, and so on. Whether or not a technology can be used for good or bad is not a consideration that engineers are ethically required to consider simply because nearly anything could be used to cause harm. Additionally, the five maxims Bunge lays out are in my opinion outdated and archaic. We no longer view ourselves as separate from nature, and are increasingly taking steps to minimize and reverse damage we've caused the environment in the past. We continually strive to understand and utilize the laws of nature, certainly, but I would argue this is free of the negative connotations that Bunge seems to imply.

vtroesch
An example of dialog with text against foregrounded horizon and new understanding emerging (even if it isn't what the author of the text "intends")

Varshney [2] argues that sociotechnical problems such as obesity, information overload, and climate change are issues that must now be considered by engineers. He goes on to argue that engineers have an ethical obligation to solve the issues that improved technology has brought about. I agree with this assertion to a point, and that point is only insofar as it affects society as a whole. Climate change, for example, is definitely something that needs to be slowed and eliminated. Obesity, on the other hand, involves an individual's personal choices. I believe that it is never an engineer's ethical obligation to force decisions to be made by individuals; in fact, I believe that doing so would be unethical. There are many food options available, as well as many options for exercise available to individuals. Technological progress has certainly enabled a more sedentary and higher-calorie lifestyle but it is still the responsibility of the individual to make lifestyle choices that they feel are appropriate.

Climate change, on the other hand, cannot very well be left to individuals as enough people would simply continue using fossil fuels at an increasing rate that anything other than an enforced method would be required to reverse its effects. Is it ethical to force a change in individual behavior in this case? I feel it's a bit of a gray area, but since it's in the interest of the common good including the health of the planet's biome, I think the tradeoff is worth it personally.

Hylton [3] examines the motorsports industry, where obtaining a competitive advantage is highly desirable and there may be opportunities to do so unethically. His paper is particularly relevant to me as I will be going into the automotive industry which, while not as fast-paced, has some similar traits. For just over half of my career at MTU I've been a member of the Formula SAE team.

Hylton states that since motorsports is such a large industry with a lot of money on the line frequently, there is a great temptation to cheat. Additionally, motorsports increases the propensity to try to cheat since only one team wins out of many, as opposed to traditional sports such as basketball or football where half the players will win as only two teams are involved. Based on my experience on the FSAE team, there are also large discrepancies in funding school teams receive. For example, Tech's FSAE team has a budget of approximately $15,000 per year, whereas the teams that consistently win have budgets of hundreds of thousands of dollars, and some teams have a smaller budget than ours even.

The motivation to use any method possible to gain an advantage, even unethical methods, is definitely present.

Hylton uses the John Force example as a technically legal but questionable decision. I feel that losing when you could otherwise win for personal gain is always unethical. The students Hylton interviewed agree with my viewpoint until the example is the university's race car, with the program director developing an 'engine problem' in the last lap, allowing the university to take first rather than second. The students felt that was ethically fine. I disagree and would say that is still ethically objectionable. First off, the program director gained from it still, not in a racing capacity but added credibility to the program he was tasked with heading, enhancing the appearance of his own competence. Additionally, letting a team win just because they're new to the sport could be unethical as it gives them false hope and doesn't give them as much of a drive to learn from their mistakes and improve in the future, which is what student racing programs are ultimately all about. This scenario, however, doesn't particularly apply to the automotive industry.

Robinson [4] argues that engineers already use their skills and knowledge to make ethical judgments in the design process whether or not they are conscious of it. One way that ethics could negatively enter designs is in the form of error-provocative designs, the most extreme example being two

vtroesch
Same thing – dialog with a text and a new understanding emerges for the student – engaged his/her biases and now there is a new way of thinking. Doesn't have to align with author of text.

vtroesch
Dialog and new understanding

vtroesch
Dialog and using personal experience to examine issue

vtroesch
Same thing. This paper has a lot of these kinds of dialogs with texts.

identical switches on the control panel of a nuclear power plant, one whose function must be used daily and the other whose function would result in a meltdown. I disagree with his assertion; certainly it would be possible for an engineer to do such a thing, but it would be immediately obvious that it was both a poor design and intentionally misleading. Most engineers are not 'evil geniuses' as postulated by Robinson, so for our consideration of ethics this is a useless point. I do not currently nor would I ever seek to intentionally cause harm through a design.

> **vtroesch**
> dialog

The more relevant concern is unintentional harm. Robinson states that the intent to cause harm need not be present to hold someone ethically responsible for the harm they have caused. I would agree with this statement; in fact, to me, that is an important part of being an engineer. Engineers are supposed to put their specialized training and knowledge to use to fully understand all the risks of failure a system has, the likelihood of such outcomes, and the severity of the damage possible from each of those failures. 'Accidents' are something engineers are ethically obligated to avoid to the best of their abilities, especially when the potential for damage is large. Engineers should be held responsible for being careless in their designs even if they had no negative intentions. A tangent point to this is also that engineers should only operate in their areas of knowledge and competence; for example, me being a mechanical engineer, I should refrain from making any engineering decisions in the areas covered by electrical or chemical engineers.

> **vtroesch**
> dialog

Robinson also argues that any solutions reached by engineers should also factor in the 'big picture' effect of the item, and minimize any harm caused upstream or downstream. For example, using a switch that contains mercury in a toaster is obviously not the best design decision possible. For me, this is definitely an important ethical consideration to keep in mind as I start at Ford, which makes a wide range of vehicles that many people the world over will use day to day, and even a small change in per-unit factors can become a very large change. For example, using recycled materials where possible, even in a small part, could result in a large amount of raw materials being saved. However, there is still the recurring question of how to weigh this against profitability, safety, and durability, to which there is no immediately apparent answer in my opinion.

> **vtroesch**
> Another example. This student is really going over various texts and analyzing them. Hopefully, the texts gave the student things to consider against his/her foregrounded horizon – seems to have done that – with a new understanding that emerges – changed from the original position but not identical to the author's.

Millar [5] argues that whenever technologies make decisions, they should be characterized as moral proxies acting on someone's behalf. He also claims that technology is no longer morally neutral as soon as it embeds moral norms, for example seatbelt alarms in automobiles. To me this is also an important topic that will become increasingly important as vehicle technologies become more advanced and self-driving cars become a technical possibility. Already in current vehicles there are factors such as child safety locks, tire pressure monitors, seat belt alarms, collision avoidance systems, and automatically deploying airbags to attempt to mitigate risk of injury or loss of life in a certain scenario. However, each of these features carries with it a pre-determined decision. What if someone needs to get out of the car quickly, but the child safety lock is engaged? What if the airbags deploying severely injures a passenger? These technologies contain embedded moral values, for better or worse. Most people would agree that wearing a seatbelt is a good thing to do, but is it truly ethical to remove the individual choice of each driver? This issue in particular is larger than simply the automotive industry since most states have laws requiring the use of seatbelts. Airbags and tire pressure monitors are also required by federal legislation. However, as emerging technologies add to the variety of systems capable of acting as moral proxies, government legislation will lag their implementation, leaving them an open question. Another related question is, when government regulations cover something, is the engineer responsible for its design absolved of the ethical burden, and is that burden shifted on to the lawmakers? Or is the ethical burden shared between engineer and

> **vtroesch**
> Good example.

> **vtroesch**
> Follow up on above – takes a text, has a dialog, and emerges with a new understanding.

government, with the engineer being responsible for its proper implementation? In my opinion the latter interpretation is most correct.

Learning from Experienced Industry Member Interview Summary

The interview was a good learning experience for me. I chose to interview Joe xxxxx, who just recently (mid-October) got promoted to Manager of Transmission and Driveline for all SRT products. Prior to this he was the Chief Engineer for axles in heavy duty trucks and miscellaneous other products. He has been working with Chrysler for nearly 20 years. I am acquainted with him through his daughter.

vtroesch
Admission of understanding.

There was a lot of information for me to take away from this interview. Some helpful information was the advice to figure out where you stand on a given ethical issue before you're actually faced with it. Things may not especially be easy but then at least you already know your preferred outcome, all that's left is getting it to happen.

vtroesch
Dialog. New understanding admission.

Some information that was surprising to me was that someone would steal from the company they work at as an engineer. I would have thought that the amount of money engineers are paid would be sufficient compensation; it seems like hourly workers or lower-paid employees would be more likely to have sticky fingers.

vtroesch
Foregrounded horizon, openness, dialog, new understanding.

Some information that was a new way of thinking about was that you can go to your supervisor or other management staff for help resolving an ethical issue. You're never on your own completely to make a decision on anything, at least in the automotive industry (and especially when you're just starting out). This was never a consideration for me in the past.

vtroesch
Foregrounded horizon, openness, dialog, new understanding.

Interview In-Depth Analysis

In this section, I will go over the questions that I felt offered me some insights. Not all of the 23 questions asked gave me useful information, but many did and I will reflect on those here.

The first question asked about an ethical decision that was not clearly right and wrong. I learned that in the automotive industry, it is unlikely to encounter a situation that is so extreme there is a clear- cut answer. This makes sense to me because there are a lot of procedures you must follow in the industry, and these are continually evolving and increasing in number. I also learned that the most difficult decisions that have to be made in the automotive industry generally is when a problem is found late in the development cycle that will cost a lot of money to fix, whereas it could cause a lot of warranty repairs and negative customer opinion if it is let go. Obviously safety concerns don't fall under this as they are always paramount. This makes sense to me, even from an unethical viewpoint: it's still a popular pastime for politicians to crucify automakers for small mistakes. Just look at GM's ignition switch recall fiasco from this summer. From an ethical viewpoint, obviously making your products as safe as is reasonably possible is very important and cost shouldn't be too much of a determining factor. However, combating this is the fact that you could always make a vehicle safer if you throw more money at it, using stronger materials that absorb more energy , put in a five-point racing harness plus head strap and require the driver to wear a helmet at all times, and so on. However you wouldn't sell many of these vehicles; behaving ethically is of little use if you're out of business. Therefore balance is required. Determining the degree of balance exactly is why automakers hire engineers.

vtroesch
Example of foregrounded horizon, openness, dialog, new understanding.

Question seven, which asked if there was advice Joe would offer to someone just entering the field of automotive engineering, was of particular

vtroesch
Great example of the whole process.

interest to me since I'm about to enter the automotive industry whereas he has 25+ years of industry experience, both with Chrysler and other companies. He said to make sure that one understands their beliefs about right and wrong, respect other people's health and safety, and make sure to live what you believe. You should do these things both to help your career and to help you live with yourself. This advice is very useful to me, as I hadn't ever really thought about ethics in this way. However, I now know some introspection is needed before I start working in the automotive industry, at least some of which I've hopefully captured in this paper.

Question eight, which asked to whom an ethical objection would be brought to, he said that his supervisor or management would be brought in as necessary. Imagining an issue prior to the issue I had always for whatever reason assumed that I would be all alone to make my decision; the revelation that that's never the case especially in the automotive industry was a bit of a paradigm shift in any imagined future scenarios I would be involved in.

Question sixteen concerns leading by example and encouraging others to make ethical decisions. Joe said that it wasn't uncommon especially when younger engineers were involved. This is another important piece of information for me because I will very soon be a young engineer in the automotive industry. That's another angle I hadn't considered in the past- I won't be thrown into the thick of a project all on my own and be expected to fend for myself; there will be a lot of other engineers around with many years of experience whose experiences and advice I can utilize to develop professionally and personally. In retrospect, this seems obvious, but it just wasn't something I'd considered in the past.

Question eighteen concerns the balance of sustainability and profitability. Joe's answer makes sense in that he said there needs to be a balance between the level of sustainability and customer demand. It's a good goal to have to improve sustainability, but on the other hand it won't do anyone much good if you make a perfectly sustainable vehicle that is far out of a price range that any customers are interested in. This also ties in with safety- Safety is the utmost concern, but there still needs to be compromises. An extremely safe vehicle could be designed and produced, but if it cost $25 million per unit, it would do hardly anyone any good: The average (or even above-average) consumer would be unable to afford it, the company would sell very few, and very few people would have the advantage of the safety measures offered. Obviously this is an extreme example, but it illustrates the difficulty of an engineer's position. Things like profitability, safety, reliability/durability, and sustainability are often partially exclusive and work against at least one other factor. It becomes a continual balancing act that is further complicated by customer demands and government regulations. A good ethical compass will help with making the required decisions, but that doesn't mean they're all easy.

vtroesch
Foregrounded horizon, dialog, new understanding (balance).

Ethical Viewpoint at End of Semester and Conclusion

At the end of the semester, I have given thought to what is right and wrong so I will be prepared to handle any ethically grey decisions I may encounter through my work. Additionally, I will review Ford's codes of conduct when they become available to me and use them to further guide the decision-making process when necessary. Also I am a lot less nervous about starting full-time as I know I won't be expected to make big ethical decisions all by my own; I will have guidelines, coworkers, and my supervisor/management to get help with the decision. This may seem obvious but it had simply never occurred to me prior to conducting the interview.

vtroesch
New understanding

Also, I now understand more the difficulties associated with reaching a decision due to the multiple factors that go into a design: Safety, profitability, sustainability, durability, federal regulations, and so on, and how they must be

balanced with one another. Often engineers have conflicting ethical obligations, such that compromises must be made that result in the least harm possible.

The automotive industry is an increasingly interesting field to be going into. Ethics are going to have to be considered in the future more than ever as vehicles' systems become more and more sophisticated, approaching the theorized future of a self-driving car. When the car becomes able to make a decision in place of the driver, there's a lot riding on that decision. The decision could be deciding who dies if a system is forced to choose, for example, between careening into a pedestrian or getting T-boned by a dump truck. Even in the absence of these considerations, a lot of people operate automobiles daily and there is a lot of potential for personal injury or fatalities, so there is always the question of ways to improve safety.