

# ***Identifying Challenges to Infusing Ethics into the Development of Engineers at Texas State University***

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## **Abstract**

Over the past six years we have worked to integrate ethics education throughout the curriculum of the still-new Ingram School of Engineering. During work on an NSF funded grant, we were able to infuse ethics related modules in 13 different courses, across three colleges and at all levels of undergraduate study. Our goal in participating in the GSW ASEE meeting is to share ideas about addressing challenges that arose during this project. We also hope to learn about faculty resources others have found most helpful in allowing faculty with diverse cultural and professional backgrounds to effectively infuse ethics into technical courses.

## **1. Introduction**

Texas State University, rare among public universities in the United States, enacts an institutional commitment to ethics education by requiring all undergraduates to complete a course in philosophy with significant ethics content. Approximately 75% of students complete a course in applied ethics. Over the past six years we have worked to integrate ethics education throughout the curriculum of the still-new Ingram School of Engineering. During work on an NSF funded grant, we were able to infuse ethics related modules in 13 different courses, across three colleges and at all levels of undergraduate study. Three members of our team (Hanks, Tate, Trybula) were PIs or Senior Personnel on the NSF grant project, and the fourth member (Stern) provided advice, administrative support, and helped mentor instructors responsible for infusing modules in their courses. Each of the team members is active in engineering ethics education and in engineering professional

organizations. We bring four distinct professional perspectives –a manufacturing engineer; an electrical engineer; a philosopher with expertise in ethics in science, technology, engineering, and business; and a representative from industry who is active in ethics education. We have each been involved in curriculum development and program building, professional outreach, and research on ethics education.

## **2. Ethics Infusion at Texas State, Part 1, Background**

During the three years of our NSF-funded project (#1242087, <http://nsf-nue-nanotra.engineering.txstate.edu/home.html>), we created, deployed, and evaluated curricula for online and face-to-face course modules taught as full courses (one for lower level students, and one for advanced students) or infused into existing courses. The modules addressed ethical, health, environmental, safety, and social implications of nanotechnology, and had at the lower level also served to introduce students to nanotechnology. The courses and modules were drafted, revised, and tested under the guidance of an advisory council made up of nanotechnology experts from academia and industry. One important goal of the project was to recruit, engage, prepare, and encourage students from traditionally underrepresented groups into careers in Science and Engineering. In our third year we revised the curricula in the introductory course to better emphasize student engagement with sustainability and humanitarian issues in emerging technologies. We also introduced a course project in which students in a general education philosophy course researched, wrote, and presented case studies in engineering and technology ethics.

UT-Tyler offers both courses as full on-line courses to current students, as well as industry professionals and community leaders. At Texas State courses designated for infusion include philosophy and ethics, materials engineering, industrial safety, polymer nanocomposites, and senior design. In this project, ethics, social dimensions, environmental impacts, health, and safety are examined as interconnected. The modules are infused into existing courses, and many of these modules serve ABET student learning outcomes, such as ethics, environmental issues, knowledge of contemporary issues, and life-long learning.

During this initial phase we had very good feedback from students, and outside reviewers found the program innovative and effective. Our assessments told us that students are excited about the possibilities of nanotechnology to solve problems and promote better standards of living. Students told us that the modules have helped them understand the important ethical and social dimensions of emerging technologies, especially nanotechnology. We also uncovered some opportunities to do more, and do better.

### **3. Infusing Ethics at Texas State, Part 2, Opportunities**

Among the opportunities we identified are:

- That a successful program requires infusion across the curriculum, and this requires either
  - preparing course materials that can work across classes and disciplines, or
  - preparing distinct sets of discipline and course specific materials.
- Securing buy-in from faculty who are not part of the research project team
- Preparing tools for faculty to successfully integrate ethics
- Obtaining better measures of student outcomes.

In January 2017 the four authors participated in a workshop at the NAE about prospects for engineering ethics education. We learned two important things about our local context that present further opportunities.

First, most of the institutions present had curricular and administrative structures that make course change or course addition difficult. We have an advantage of General Education requirement that can be met with an Ethics course, and a home department (philosophy) interested and qualified to provide a technology and engineering focused version of that course.

We serve a different student population than other participating institutions, a student population that will likely be familiar to many in the GSW. Texas State serves a higher percentage of first generation university students, and a more ethnically and socio-economically diverse student population. This means that some of our excellent students find themselves in need of additional course work, beyond what might be found at other schools. Subsequent examination of engineering curricula at other universities confirmed a general lack of developmental courses in which an early introduction to ethical dimensions of engineering and technology would be possible. We have the opportunity to develop, test, and share, a new approach to engineering ethics education that would be appropriate for a broad range of institutions and serve many students.

Additional opportunities at Texas State originate in the university's rapid transition from a regional teaching institution into an emerging research university. i) The university has several living learning communities intended to support the success of STEM students, especially those from underrepresented groups, and foster undergraduate interest in research. ii) The rapid growth of the research enterprise at Texas State has gone hand-in-hand with the growth of graduate education, both in number of students and number and quality of programs. Because the emphasis on research is fairly recent, and still developing, we have opportunities to integrate an emphasis on ethics throughout new programs, and through RCR education for all students.

### **4. Infusing Ethics at Texas State, Part 3, What comes Next**

Next Steps:

- Upgrade existing course modules

- Work more closely with non-project faculty to create teaching and research communities, and to learn from their experiences
- Refine a proposal currently in development for the 2018 NSF Creating a Culture of Ethical Stem Program.
- Integrate knowledge gained into new curricular initiatives, including program development and graduate education, especially RCR.
- Leverage work in lateral infusion of ethics into discipline specific engineering courses to transform STEM education, and eventually influence the research and ethical culture across campus.
- Share what we learn with local and regional professional organizations
- Develop new forms of outreach for professionals
- Prepare presentations and publications for professional practitioners and academic audiences.

Team members think there is a significant opportunity to present our concepts and processes as more appropriate for addressing the needs of the students from underrepresented groups. This group of students requires a different realm of interaction since many lack scientific/engineering role models in their chosen fields or in their communities. In our role at Texas State, faculty and staff become the role models and guide the development of these students, and our ethics focused team can be part of that effort. Additionally, because of the structure of our curriculum, class sizes, and the length of our proposed project (five years in the next phase) we have the opportunity to run control groups as we develop and integrate new materials.

This project will investigate whether a focus on “engaging the instructor” is a viable path for cultivating an ethical culture of STEM education and practice, with a special emphasis on whether this approach will be a good way to reach students from under-served populations. Specifically, this project will investigate:

- 1) whether engaging the instructor is a viable path to greater ethical

and cultural awareness and knowledge,

- 2) whether engaging the instructor contributes to a change in organizational culture around ethics, and
- 3) whether engaging the instructor contributes to increased student awareness and knowledge of ethics.

The project will focus on three, linked, initiatives that directly impact the professional formation of engineers:

1. Reinforce and foster ethical and cultural sensitivity, knowledge, and skills in engineering faculty, in order to
2. Support and further an institutional culture with ethics as foundational component, that will provide a basis for
3. Nurturing ethical sensitivity, knowledge, and skills in future engineers.

Some of what we anticipate as outcomes:

- We will be able to compare students who complete courses with additional STEM ethics emphasis with those who complete sections without special emphasis.
- We can compare results in courses taught by project personnel and those taught by non-project faculty.
- We will have evidence about whether student and faculty knowledge and awareness changes.
- We will have evidence about what faculty resources are most helpful in allowing faculty with diverse cultural and professional backgrounds to effectively infuse ethics into technical courses.
- We will have some evidence of whether this approach, engaging the instructors, is a good way to reach students from underrepresented groups.