Ethics and the Senior Design Project: A Guide

All Senior Design Projects require the completion of a written section addressing the ethical significance of the project. This brief guide is meant to help you and your team to complete the ethics section.

There are three sections to the guide, each meant to help you reflect on the ethical significance of the project. The sections are:

- The ethical justification for the project: Why are you doing what you are doing?
- Ethics, your project, and what it means to be a good engineer: What does your project teach you about the character of an engineer?
- Ethical pitfalls in the project itself: What are the specific engineering ethics challenges regarding safety and risk raised by the project itself?

Throughout your project, it is highly encouraged that you approach the ethics section as a team: Talk with your teammates about the ethics resources that you read; talk with them about the key ethical points that you see at stake in the project.

Also, there is an excellent model for the ethics section of the Senior Design Project available on the website of the Markkula Center for Applied Ethics. This ethics section of an actual Senior Design project was written by Kelli Oura, Lauren Reinnholdt, and Danielle Locklear, all 2011 engineering grads of Santa Clara University. Their essay can be found at: http://www.scu.edu/ethics/practicing/focusareas/environmental_ethics/design_analysis.html

Section I: Senior Design and the Ethical Justification of the Project

What is the fundamental moral reason that you are doing the project in the first place? This may seem like an obvious question. But there is usually in fact a great deal that goes into answering it.

For instance, an increasing number of SCU engineering students do Senior Design projects connected to communities in the developing world. Perhaps, for instance, a team is interested in developing a solar-powered incubator for use in hospitals in sub-Saharan Africa.

What is the moral purpose of such a project? We might think obviously: It's to help sick newborns in a part of the world with inadequate medical care. But it's important to reflect more specifically on that thought in terms of specific ethical categories. So, for instance, we can ask a hard but important question: Why should a sick newborn anywhere receive adequate medical care? Of course, we all think they should. But we're looking here for the ethical justification for why they should. And, to find that, we need to turn to concepts or ideas like: All human beings have inalienable dignity and, on the basis of that dignity, are worthy of having adequate medical care. Or, similarly, that all human beings have fundamental human rights, one of which is a right to basic health care. Then we might consider the fact that such newborns in sub-Saharan Africa don't have all kinds of medical care that we in Santa Clara and elsewhere in the United States take for granted. So should we have such medical care but they shouldn't? Or how do we explain what bothers us about the inequity of different degrees of such care? Here we might turn to the concept of justice as equality or, in other words, to the very intuitive concept that every human being should be treated equally unless there is a sufficient reason to treat them unequally.

Or Senior Design projects may involve work in areas of energy and the environment. Teams working on these projects might consider such ethical approaches as using a utilitarian calculus to sum benefits over harms in how we treat the environment. Or they might ask if the earth has intrinsic value or, similarly, if animals have rights.

Many teams will no doubt be working on Senior Design projects that don't have the more apparent ethical significance of, say, many civil engineering projects undertaken in the developing world. For instance, a team could be developing a new video game. In such a project, a team might consider the role that such games in general play for human well-being: Are games good for people and, if so, why? A team working on such a project might also reflect on the specific nature of the game they are designing: What kind of characters does the game presume? What do those characters in the game actually do? What are the choices faced by the characters in

the game? How do things like this – characters, choices – affect how we might think more generally about what it means to lead a good life?

There are also, of course, Senior Design projects that may not have an immediate application or relevance to the broader public. For instance, a team may be developing a new kind of circuit, period. The team, rightfully, has confined itself to the development of this circuit and not to larger issues of application. In such a case, the team might reflect on why the development of such a circuit is a good thing: Why is scientific advancement valued at all? The team might also reflect on how such a circuit could be used for future human well-being. What are some applications to which the circuit could be applied?

For this first section of the paper, it is imperative to do two things:

- Talk among your team about what you each identify as the key ethical justification(s) for what you are doing; and
- Review some key documents pertinent to engineering ethics that can provide you with more specific ethical language and concepts to help you articulate and clarify your own intuitions about the ethical significance of the project. It's not important that you read a lot of documents. Pick a few and burrow down into them. Even within those documents, find the sections that speak most to what you are doing and reflect more deeply on those sections.

These documents include: The Framework for Thinking Ethically from the Markkula Center for Applied Ethics. This document is available at:

- http://www.scu.edu/ethics/practicing/decision/framework.html

The Framework is a very user-friendly document that includes helpful information about ethical theory and an entire decision-making model; your team might use that decision-making model as the way that you think through the entire issue of the ethical significance of your project.

Another key document, especially for those working in the developing world, is the Universal Declaration of Human Rights. This document is available at:

- http://www.un.org/en/documents/udhr/

The Universal Declaration provides a justification and list of key human rights understood to apply to all human beings, wherever they live and of whatever economic or social status.

Of course, a whole set of other key documents relevant to the first part of the ethics section of the Senior Design project (and indeed to the whole ethics section of the project) are the Codes of Ethics for all of the different societies of professional engineers (civil, mechanical, electrical, computer, etc). Your team should closely read the Code for your relevant field and ask yourselves which part(s) of the code especially pertain to the ethical justification for the project (and which parts may help your team understand the latter two parts of the ethics section of the project). These codes can be found at the following:

Bioengineering:

http://associationdatabase.com/aws/BMES/asset_manager/get_file/19110/2004_approved__code_of_ethics.pdf

Mechanical Engineering:

http://sections.asme.org/colorado/ethics.html

Electrical Engineering:

http://www.ieee.org/about/corporate/governance/p7-8.html

Software Engineering:

http://www.computer.org/cms/Computer.org/Publications/code-of-ethics.pdf

Civil Engineering:

http://www.asce.org/Leadership-and-Management/Ethics/Code-of-Ethics/

Section II: Senior Design Project and the Virtues of a Good Engineer

You will no doubt have noticed that the codes of ethics of different engineering societies are largely negative in character. That is, they say many things that you shouldn't do. This approach to ethics is very important and corresponds to what is often considered the first ethical obligation: Do no harm. But if we only think of ethics as a set of rules for what we shouldn't do, then we leave out such crucial ethical matters as the use of good judgment and the importance of motivation. What is called virtue ethics has traditionally been the field where such broader concerns have been addressed. An article, "The Good Engineer: Giving Virtue Its Due in Engineering Ethics" by Charles Harris, provides an excellent overview of virtue ethics applied to the field of engineering. Indeed, this section of this guide is drawing on the article, which is available at:

http://site.iugaza.edu.ps/kshaath/files/2010/10/Good-engineer2.pdf

For purposes of the Senior Design project, we can frame the challenge of this section as asking the question: What are the technical and professional habits required by your project?

So, for instance, you should talk with your team about the specific technical challenges of your project and, correspondingly, the specific habits of thinking that your project requires.

And, in more specifically ethical terms, you should also discuss with your team how work on your project affected the way that each of you – and your team as a whole – thought about the way that the following habits can and should play a role in the work of

any engineer. These habits are taken largely from the Harris article (link provided above); I'd highly encourage you to read at least the last six pages of the article, where he discusses these habits. The habits are:

- Techno-social sensitivity: in other words, how has your work on the project been informed and/or been changed by a critical awareness of the way technology affects society and the way social forces in turn affect the evolution of technology?
- Respect for nature: in other words, how has your work on the project been informed by and/or been changed by the way that you feel, perceive, understand, and put a value on the natural world?
- Commitment to the public good: in other words, how has your work on the project been informed by and/or been changed by the awareness of the connection of your project to a good beyond something purely private – i.e., a larger public good?
- Teamwork: in other words, how has your work on the project been informed by and/or been changed by your understanding of what are the key habits for making a team work best together?
- Courage: in other words, how has your work on the project been informed by and/or been changed by your understanding of the role of courage in the project, either, for instance, in how you dealt with your team or in how you pursued an idea that others thought wasn't very promising?

Section III: Senior Design Project and Safety, Risk, the Public, and Informed Consent

In this section of the guide, there are four key, related ethical topics: safety, risk, the public, and fulfillment of the principle of informed consent. Each one raises potentially important questions about your project. And all of these topics are closely interrelated. We'll review each topic in turn. But you should think of taking each topic and considering it in light of your project. As always, talk about these topics as a team!

Safety and Ethics

Obviously, one of the first ethical concerns in assessing any engineering project is safety. But how we define safety can make a big difference in what we identify as issues of safety. So, for instance, consider this definition of safety drawn from Introduction to Engineering Ethics (2nd edition) by Mike Martin and Roland Schinzinger (I'll be drawing on this book throughout this third section of the guide):

- A thing is safe if, were its risks fully known, those risks would be judged acceptable by reasonable persons in light of settled value principles

Then apply this definition to your project.

- What are the risks?
- What would it mean to make those risks "fully known" to those who may be exposed in some way to your engineering project? In other words, the key is not risks fully known to a member of your team but risks fully known to those who do not have technical knowledge but who may either be in a position to benefit from your project or are exposed to your project, whether they are in a position to benefit from it or not.

- What would count as explaining the safety issues of your project in a way that "reasonable persons" could understand? Assuming that "reasonable" in this case does not mean a lot of highly technical details, how would you go about explaining the safety issues in terms that are nevertheless reasonable?
- And, last, do you need to pay close attention the "settled value principles" of those for whom you are doing the project or for those who are exposed to any risks related to the project? For instance, affluent people living near a new bridge in a subdivision in San Jose will likely readily understand any risks associated with such a bridge. However, very poor, tribal people using a hospital in Africa who may be likely users of a new incubator may not at all have as ready a sense of the specific nature of risks involved in the project. Do you need to take into account such cultural concerns in explaining the safety risks?

Risk and Ethics

Safety is all about risk. But what, after all, is risk? And what are the risks involved in your project? Here's how Martin and Schinzinger define risk:

- A risk is deemed acceptable when those affected are generally not or no longer apprehensive about the risk

But apprehensiveness depends on how a risk is perceived. And this depends on several key factors that Martin and Schinzinger note, including:

- Is a risk accepted voluntarily or not? We are more apprehensive about risks assumed involuntarily than voluntarily.

- Do we have any measure of control over the risk – through a governmental agency that represents us, a civic group, an adequate degree of knowledge, etc?
- What is the likelihood of the risk being realized?
- What is the nature and magnitude of the kind of risk at stake? Is it massive?
- What is the proximity of the risk in question? Do we know someone who is more nearly involved? Can we imagine a person who is situated near to the source of the risk?

The Public and Ethics

Most codes of ethics for engineers contain a phrase something like, “engineers shall hold paramount the health, safety, and welfare of the public.” But who is the “public” anyway? Professor Michael Davis of the Illinois Institute of Technology in the article “Thinking Like an Engineer: The Place of a Code of Ethics in the Practice of a Profession,” has said that each engineering project has a specific public. Thus the public is not everyone. Rather, we might think of it as those who stand to benefit from the project you are undertaking and those who have been in any way exposed to the risks involved in your project. To borrow Professor Davis’ language: The “public” in any engineering project are all those whose lack of information, or lack of technical knowledge, or lack of time for deliberation renders them vulnerable to the powers that an engineer wields.

- How would you identify the “public” in your engineering project?
- Who or what population, specifically, are you trying to help?

- Who or what population is being exposed to risk from the project that you are doing?

Principle of Informed Consent

Martin and Schinzinger note that the principle of informed consent requires that people should be able to consent to being exposed to significant risk. Hence the principle requires that such people should be given appropriate information (that's the "informed" part) and should be given the opportunity to consent or not to exposing themselves and their families to the potential risk of the project (that's the "consent" part). In seeking such consent, there shall be no force, fraud, or deception.

There are also important considerations to take into account about how information is presented to people and about how we understand what consent means to them.

For instance, information about an engineering project should not be shared as a huge data dump that no person can really comprehend. Rather, only pertinent information should be provided and in a clear way. Also, the information should be presented in a way consistent with the cultural expectations of those receiving it. Moreover, the persons receiving the information should be ready to receive it ("ready" in terms of their education level, their worldview, their core values, etc.). And the persons receiving such information should either be capable themselves of exercising consent (or denying same) to a proposed action or such persons should be capably represented by an association that is charged with exercising consent (or denying same) on their behalf. Such associations might be political entities like a City Council or legislature or church groups or neighborhood associations.

So the team should consider the following questions:

- How, if at all, does the principle of informed consent apply to your project?
- If it does apply, then what are the challenges in terms of how information might be presented to those exposed to the risk of the project?
- What are the challenges in being sure that consent is secured from those being exposed to these risks?

Conclusion

This guide has proposed a three-part process for doing the ethics section of your Senior Design Project. The first part invites you to consider the fundamental ethical justification for what you are doing. The second part invites you to consider how doing the project has affected what you think it means to be a good engineer. And the third part invites you to consider the ethical dimension of the fundamental categories of safety and risk in your project. Addressing each of these sections in one paper could make for an excellent ethics section of the Senior Design Project. Again, it will be crucial for your team to talk among itself about these ethical matters. And it's also crucial not to think that you have to read a great deal to complete this section of the overall project. Stick with a few key sources – perhaps a code of ethics from the relevant engineering society, perhaps the "Framework for Thinking Ethically" from the Ethics Center – and then stick with a few key points that strike you most strongly. St. Ignatius of Loyola said that it's not how much we learn but how deeply we grasp a thing that is most important. And that's true of engineering ethics along with other modes of knowledge.