Integrating Information into the Engineering Design Process

Fosmire, Michael, Radcliffe, David

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PART II

Designing Information-Rich Engineering Design Experiences
CHAPTER 5

ACT ETHICALLY

Design with Integrity

Megan Sapp Nelson, Purdue University
Donna Ferullo, Purdue University
Bonnie Osif, The Pennsylvania State University

Learning Objectives

So that you can guide student design teams to identify ethical and social aspects of engineering design, upon reading this chapter you should be able to

• Define and articulate professional integrity as it applies to engineering design
• Identify and apply a code of ethics perspective of professional behavior to an engineering design team project
• Coach students in the ethical use of information throughout the design process
INTRODUCTION

Even before starting a design project, while still organizing the team, instructors frequently begin by setting expectations for student work, including introducing the concepts of ethical behavior. Among other topics, ethical behavior includes doing due diligence, presenting all of the relevant information and not just convenient facts, and respecting the work of others. Ultimately, the goal for engineers is to provide an accurate assessment of the strengths and weaknesses of their solutions, rather than misrepresenting a solution in order to win a contract. Instilling this ethos into the classroom environment from the beginning will create an appropriate focus on engineering design as a knowledge-building activity. It will also reinforce professional skills required by ABET, the accrediting body for engineering programs (student outcome 3) (ABET, 2013).

As students move through their academic career with the goal of becoming a professional engineer, a major outcome is their acculturation into the discipline. One pillar of engineering is professional integrity. The National Society of Professional Engineers (NSPE) mandates in its Code of Ethics for Engineers that engineers will “conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession” (2007, I.6). Each of these facets grows out of the idea of personal integrity as generally understood in many cultures. While these concepts are prevalent in the dominant culture, how do students learn to recognize situations that require recognition of ethical gray areas, comparing and deciding the relative priorities of competing stakeholders or specifications? The challenge of introducing professional integrity and related concepts of social responsibility, information ethics, and technical competency is to introduce them within the context of the engineering design process described.

An engineering code of ethics addresses the reality that the work of engineers and the decisions they make have serious implications for a number of people. Unlike a physician or other professional with whom members of the public interact directly, most people do not know the engineer who designed the product they use, the appliance they turn on, or the bridge they drive across. There is an implied social contract that the engineer will act ethically and with integrity. This chapter addresses concepts and techniques for introducing reflection on professional integrity in the context of the engineering design curriculum.

COMMON CHALLENGES FOR STUDENTS

Undergraduate design team members generally lack a perspective that enables them to place their work in broad context with respect to users. In fact, undergraduates have been acculturated by an educational system to believe that the work they do and the things they create in courses have no value beyond their final grade in the class. For an undergraduate design team, considering the ethical implications of the project first requires a major leap in conceptualization on the part of the students that the work they produce has long-lasting implications and impact on others.

Additionally, undergraduates in their late teens and early 20s have not yet fully developed the portions of the brain responsible for ethical reasoning. The prefrontal cortex continues to develop well into the 20s (Sowell, Thompson, Holmes, Jernigan, & Toga, 1999). This area of the brain controls higher order
logic, including ethical reasoning (Fumagalli & Priori, 2012). The implications of this physiological fact for undergraduate design teams are that

- students on the teams will have different levels of facility with ethical reasoning;
- ethical reasoning must be deliberately introduced into the pedagogy and conversation of the student design team in a facilitated way in order to assure that ethical implications are considered during the design process;
- ethical constraints that are obvious to the instructor are typically not obvious to their students.

For all of these reasons, ethical reasoning is an aspect of engineering design that can and does cause difficulties for design students.

Undergraduates deepen their appreciation of their personal integrity as they perceive themselves as an adult who controls their own behavior and responses to situations. Developing positions based on reason and evidence, weighing pros and cons, debating differences with peers, and reflecting on the ethics of decision making processes encourages students and helps them to effectively handle ethical quandaries. Education in the area of ethical reasoning assists in the development of students who are socially responsible and ethically grounded professional designers upon graduation. As we will see in the next section, engineers are expected to be both.

**PROFESSIONAL EXPECTATIONS OF ETHICS AND INTEGRITY**

Oakes, Leone, and Gunn (2012) stated that “in addition to technical expertise and professionalism, engineers are also expected by society and by their profession to maintain high standards of ethical conduct in their professional lives” (p. 395). Each profession has its own code of ethics that addresses its uniqueness. Within engineering, many organizations have produced codes of ethics intended to guide decision making and behaviors of professional engineers. A code of ethics for engineers is one with far reaching implications, as the results of engineering design can affect not only the bottom line of a company but actual structures, products, and the lives and safety of those who come in contact with the products of the engineers. Engineering decisions must not be made haphazardly, or be based on personal preference and self-interest. Rather, engineering decisions must be guided by a professional code of ethics, as an overarching set of principles; engineering thinking and judgment, supported by data and analysis and informed by collective knowledge; and wisdom embodied in such things as specifications, standards, codes, and regulations.

“Primarily, a code of ethics provides a framework for ethical judgment for a professional” (Fleddermann, 2012, p. 25). There are a number of codes of ethics for engineers. Most professional associations have their own codes, and this can range from a few lines to the several-page-long detailed list of the NSPE. The importance of ethics to the profession is made clear by the inclusion of codes of ethics on all major engineering society Web pages and in the Criteria for Accrediting Engineering Programs from the ABET (2013).

In general, all of the codes have a statement supporting engineering for public safety, honesty, and integrity in design. They generally agree that engineers are to put society first and design only in areas of competency, call for objectivity and truthfulness in disclosures and
Organize Your Team

dealings, and focus on the personal integrity of all engineers.

A code of ethics is a starting point, but it cannot be considered comprehensive as there are specifics and situations that cannot be addressed directly by the principles of the code. But, “a code expresses these principles in a coherent, comprehensive and accessible manner. Finally, a code defines the roles and responsibilities of professionals” (Fleddermann, 2012, p. 25). A representative list of current code of ethics websites is contained in Box 5.1.

THE CONCEPT OF PROFESSIONAL INTEGRITY

The extent to which individuals in our complex technological society can control the risks that they are exposed to is severely limited. . . . There is no practical way for each of us (even as engineers or scientists) to evaluate the degrees of safety designed into the many consumer products that we use. . . . It is thus of great importance that engineers recognize their professional responsibilities with respect to human safety, that they be properly educated to fulfill those responsibilities, and that they be given adequate authority to carry them out. (Unger, 1982, p. 12)

As discussed, integrity is a crucial aspect of the job for a professional engineer. As defined by the NSPE, honor, ethics, responsibility, and lawfulness are the most fundamental behaviors to be displayed by engineers (see Box 5.2). Only if these traits are present in conjunction with disciplinary knowledge and technical skills is a person a fully qualified engineer. Engineering has been characterized as being “essential to our health, happiness and safety” as “engineers help shape the future” (National Academy of Engineering, 2008, p. 8). In doing so, engineering as a discipline explicitly seeks to act in an ethical manner in relation to the stakeholders (and increasingly, environment) it serves.

Undergraduate engineering students may consider social responsibility either an obvious
and commonsense fundamental or a nonobvious and unduly complicating aspect of the design process—perhaps even not part of their engineering design considerations. As noted above, which view a student takes may have much to do with the state of development of his or her brain and reasoning abilities. Nevertheless, all students can be taught to consider the function of social responsibility in engineering design and its implications for their specific project.

Social responsibility includes considerations of the diverse range of individuals who may interact with the artifact they design. The most common consideration is the impact on stakeholders, whether the direct client or downstream users (see Chapter 7 for more information regarding user groups). However, social responsibility also includes considerations of environmental impact and sustainability, and legal and regulatory responsibilities (including intellectual property).

Sustainability is at essence represented by the three Ps (Jonker & Harmsen, 2012, p. 10):

- “People”, [sic] the social consequences of its actions
- “Planet”, the ecological consequences
- “Profit”, the economic profitability of companies (being the source of “Prosperity”)

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BOX 5.2

NSPE and ASCE Codes of Ethics

**National Society of Professional Engineers Code of Ethics for Engineers Fundamental Canons**

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

**American Society for Civil Engineering Code of Ethics Fundamental Canons**

1. Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
2. Engineers shall perform services only in areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession and shall act with zero-tolerance for bribery, fraud, and corruption.
7. Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision.

Within the design context, sustainability requires that the artifact honors the integrity of the stakeholders, the current environment, and the business bottom line.

Engineering is a global discipline. A product, system, or process designed in the United States may be manufactured in Southeast Asia with raw materials mined and shipped from Africa, Russia, and the Middle East and be packaged and shipped back to the United States for sale in a retail establishment. The situation of a design artifact is most likely much more global than undergraduate design students may realize (Luegenbiehl, 2010).

Development of a situational awareness that fully anticipates the impact of a design project is a part of developing a sustainable artifact. “Sustainability can be approached from many different perspectives, varying from North to South throughout the world, and from governmental regulations to market considerations” (Jonker & Harmsen, 2012, p. 2).

An important part of designing for sustainability is learning from all invested parties and creating the best possible solution to meet their needs and expectations. In the context of a student design team, many different perspectives can be facilitated by encouraging all voices on the team, including those with non-majority backgrounds, to contribute. Students of diverse and international backgrounds bring different insights and assets to the design process. Often these participants in the design must be encouraged to share their strengths in group interactions. Majority students in a design team frequently have a difficult time recognizing the value in the variety of experiences on the team, as they rush to a design solution that frequently arises out of the input of the most assertive team members. Eliciting valuable experience and input from non-majority team members is similar to eliciting design constraints (discussed in Chapter 7).

**COMPETENCY**

A major facet of engineering ethics is simply to acknowledge what you don’t know, when you don’t know it. Most codes of engineering ethics require that engineers not perform work or give advice beyond the limits of their technical knowledge and competence. Competent engineers honestly assess their own ability to complete a project well and on time. By extension, engineers will

- refuse to sign documents that they do not understand;
- identify projects that are not up to relevant codes or standards as well as refuse to sign documents for those projects;
- seek out experts to complete work that they feel is outside their personal competency.

Students are working to achieve competency in engineering and engineering design, while also attempting to develop an internal gauge for what skills they possess. Tools such as skills assessments, completed by the individual or team, provide insight into the skills in which students and their teammates appear strongest and weakest. Skills inventories and assessments can be utilized throughout the design process with a variety of outcomes. A baseline can be established early in the semester using a skills assessment. With the addition of a post-assessment, changes in perceived skills can be measured.

Building recognition of personal competence can be woven throughout the design process. As part of early team-building exercises, students can develop individual so-called elevator pitches that describe their areas of special
knowledge, skills, and competence. Teams can then create a team consulting brochure intended to give the stakeholders an understanding of the expertise represented.

Student teams can be prompted to develop procedures for the distribution of tasks based on either strengths (for quick turnaround on a deliverable) or weaknesses (to build competency across the entire team). They can also work together to identify competency gaps across the team and invite an expert to fill in that weakness. Students should be encouraged to identify alternative solutions that may reduce the need for a weaker skill and to determine the difference in resources (time, money, effort, physical materials) required by both strengths-based and competency-building task distribution.

Instructors should take the opportunity to help students grapple with the concept that an engineer cannot be excellent at all aspects of engineering. As such, students should be prepared to network with other experts upon their graduation to build up their informal ties in preparation for future project needs. By building this capacity for networking throughout the undergraduate engineering curriculum, students are investing in lifelong learning habits that will enable them to identify, articulate, and track their expanding professional competencies. Most students will not make this mental connection between their own skills inventory and networking unless an instructor invests time in introducing them to that concept.

**OBJECTIVITY**

Objectivity is the active pursuit of presenting the complete context of design decisions and constraints in a manner that is absent of bias, prejudice, and emotional influence. There are a number of concepts underpinning this definition, as listed below.

- Engineers choose to be objective. Action must be taken to increase objectivity; it does not naturally occur. Engineers, along with everyone else in human society, are prone to prejudices and biases, often unknown to themselves. In order to be truly objective, an individual must choose to set aside his or her own personal inclinations.
- Objectivity has as its goal the removal of the engineer’s personal prejudices and biases from an engineering decision. Therefore, engineers seek to present the full context of how decisions are made in order to allow stakeholders to develop their own opinions.
- Objectivity is an external discipline, as opposed to an internal state. Engineers will of course have opinions of their own about specific aspects of a deliverable. Objectivity ensures that the stakeholder has the full information necessary to make decisions without exposure to prejudice.
- Objectivity is a mitigating technique for separating the engineer as an individual from the product he or she has created.

In the engineering design classroom, objectivity can be practiced in a number of ways. While case studies are frequently used to discuss issues of objectivity as well as other ethical canons, students learn best through active engagement and practice.

Early in the design process, while gathering design constraints from stakeholders, students can begin to examine their own biases and prejudices through reflective exercises such as journaling. Identifying preconceived notions or preexisting biases will help students to mitigate their impact on the design product.
After the design constraints have been gathered and specifications developed, students have the opportunity to systematically check their implicit assumptions by presenting a document for the approval of the stakeholders that details the constraints found during specification development and how the design specifications mitigate those constraints. This allows the teams to check their own understanding of the design context, while confirming that the stakeholders feel that the ultimate deliverable will meet the constraints. It also allows the students to present information in an objective way, neither pushing the stakeholder to accept the specifications as written, nor influencing the stakeholders’ decision.

The development of documentation also provides an opportunity for practicing objectivity. Requiring students to include critical assessments of the resources they are using to assist in the conceptual design, detailed design, and fabrication stages of the project not only creates an extensive paper trail for why decisions were made throughout the project, but also allows students to practice evaluating what sources of information should be shared with the stakeholders.

**TRUTHFULNESS**

Another important aspect of information ethics that is required of both professional engineers and engineering design students is truthfulness. Truthfulness is the avoidance of deceit, whether through commission or omission of communicating relevant information. In engineering, truthfulness is paired with objectivity to create a situation in which full disclosure is made to a stakeholder or in another business relationship. Honesty is particularly key to the decision-making process; in the absence of a truthful disclosure, major flaws in a design product or process are not identifiable because the full context has been hidden or altered. Stakeholders rely on engineers to provide truthful information.

A major component of this, providing full access to all relevant and pertinent information, is similar to objectivity. For undergraduate students, the ability to identify relevant and pertinent information is a skill that needs to be introduced. While students may have written term papers previously in their academic career, they commonly have not yet realized that the same information retrieval, synthesis, and citation skills are relevant to their engineering projects. Requiring citation of all sources of information used to create documentation goes a long way toward improving the quality of undergraduate project documentation, while simultaneously helping the students remember the importance of truthfulness. (See Chapters 6 and 13 for more information on communicating via documentation.)

Attribution and acknowledgment are an equally important part of being a truthful engineer. Acknowledging the work that someone else has done to create the artifact is both ethical and courteous. Work that has been taken without attribution is plagiarized. Plagiarism could end an engineering career in academia and may hurt the professional reputation of an engineer for many years.

Attribution and acknowledgment are connected with the competence of the engineer. No one engineer has the expertise to complete a large project by him- or herself, and many small projects are also team based. Recognition of the expertise of everyone who participated elevates the perceived competence of the resulting product because the competence of the team is broader and deeper than that of one individual alone.
Generally, students understand the concept of truthfulness through the lens of their own cultural background. Raising awareness of truthfulness during the process of an engineering design class simply requires that accountability be built into the system. One way is to require students to cite the resources that they are using to develop the design product. Sources of information are not uniformly of high quality. This exercise allows the instructor to help students understand that the credibility of the sources they have chosen reflects on their credibility as a competent engineer.

Students may also keep design notebooks. If so, the design notebooks should be graded in such a way that the contribution of individual members of the team are placed within the context of decisions the whole team is making. In that way students are able to identify who contributed what to the team and also to understand their role within the work of the group, thereby identifying growing competencies for themselves. A related opportunity comes in the form of individual portfolios of work, which some schools are now requiring for their undergraduate students. Helping the students to identify specific areas of expertise within a project and then truthfully place their work within the larger scope of the team’s design process will assist students to identify their own competencies, which will ultimately impress employers.

**CONFIDENTIALITY**

While objective and truthful disclosure is valued for engineers, in addition information can be very valuable and therefore must be controlled in the timing and breadth of the disclosure. Many engineers are asked to sign confidentiality or nondisclosure agreements to work on a particular project. These agreements limit whom can be told details about the project, or even whether the project exists. A nondisclosure agreement generally contains language specifying what information is within the scope of the agreement, permissible ways for the information to be used, and how or when the agreement will end.

Engineers agree to be truthful and honorable by seeking to abide by codes of ethics. As such, if an engineer has signed a nondisclosure agreement, he or she is bound by the terms of that document. Therefore, each document signed needs to be carefully read and understood, questions should be asked if any part of the document is difficult to understand or abide by, and the document should be examined for requirements that raise professional and personal ethical questions that would make it difficult for the engineer to abide by the agreement. These red flag issues should be discussed.

To assist undergraduates in their future career, discussing the contents of a nondisclosure agreement within the context of a design assignment is appropriate. In some cases in which corporations are the clients for a project-based learning class, the students may have a legally binding nondisclosure agreement that they must sign before beginning the project. Breaking down a real or sample agreement, encourages students to identify the governing terms of a nondisclosure agreement, identify potential terms that would be likely sources of noncompliance, and discuss what they are agreeing to abide by.

**INTELLECTUAL PROPERTY**

As members of a design team, the students are creating something original, perhaps for the first time in their career. As such, they are working as engineers with a vested interest in intellectual property. To act as honorable and
BOX 5.3
Definitions of Intellectual Property Terms

Copyright—Federal law that protects creative works that are unique in some manner and that have been expressed in a tangible form. Copyright protects a whole cadre of works such as books, journals, music, computer programs, and images. Ideas are not protected under copyright law. It is the expression of the idea that generates the protection. Procedures, processes, systems, and methods are not copyrightable. (See patents). Copyright limits the amount of time the copyright holder can retain the rights to the work.

Trademark—A distinctive name, slogan, symbol, or design that identifies and distinguishes the product or service from other brands. Example: Nike as the name as well as the swoosh mark. Trademarks protect a trade or a service.

Trade secret/trade dress—Similar to trademark. Trade secret protects vital processes or components of a product. Trade dress protects the overall appearance of a design. Example: Coca Cola’s recipe is a trade secret. The distinctive red and white packaging is trade dress.

Patent—Legal document claiming ownership of a unique function (utility patent), hybridization (plant patent), or aesthetic (design patent). A utility patent can be classified as a machine, a process, a composition, an article of manufacture, composition of matter, or any new and useful improvement to an invention.

Prior art—Preexisting information describing a process, product, procedure, system, or method for the patent process.

Right of publicity—The control of the commercial use of an individual’s name, image, and likeness that can continue even after death.

responsible engineering designers, students need both to acknowledge the influence that preexisting artifacts have had on their product, as well as to identify the work for which individual students are responsible. Acknowledging the work of others creates transparency and exemplifies the honesty of the engineer doing the work. Similarly, by identifying those portions of the work that the engineering student created, the student is taking responsibility for the quality and completion of the work.

Intellectual property is a highly visible, strongly codified aspect of legal and ethical behavior associated with design and is made up of a number of legal frameworks that protect the work that has been done. For most enterprises, it is a financial imperative to protect intellectual property; frequently it is the core asset owned by a company. The world of intellectual property revolves around the common theme of protecting intellectual output, which can be manifested in many forms and in many ways. The existence of a nondisclosure/confidentiality agreement generally signals a belief that the project that is being completed is a potential source of disclosure of existing intellectual property and development of new intellectual property. This document seeks to protect intellectual property.

Intellectual property is a possession similar to real property such as homes and cars in that there are laws that protect and sometimes dictate its ownership. Intellectual property violations are identifiable via design documents and the final product, while simultaneously enforceable in courts of law.

The area of intellectual property law consists of copyright, trademark, trade secret/trade dress, patents, and right of publicity. Each of
these areas has its own unique protections (see Box 5.3).

To assist students to develop their knowledge of intellectual property and how it works in context, it is recommended that consideration of each intellectual property concept be intentionally included appropriately into the design cycle. Many of these are directly or indirectly utilized by students in the process as it is. Design artifacts and notebooks, manifestations of the engineering design decisions made, are the physical proof of reasoned ethical decision making.

**COPYRIGHT**

Copyright comes into play during the specification and conceptual design phases of the design cycle. Students will be accessing a number of information resources, nearly all of which will be governed by copyright or an alternative intellectual property agreement such as open source or Creative Commons licensing (see Box 5.4). Copyrighted works are protected even if they are freely accessible or given away, whether print, electronic, or digital media.

In the educational setting, engineers have the option of fair use at their disposal which allows specific uses of copyrighted information. Whether fair use applies is determined partially by whether the information is used in an educational setting, how much of the work is copied, how unique the original work is (fiction is protected more heavily than factually based work), and the financial impact on the market for the original work. Each of these factors has implication for engineering design.

While students are attending a university, much of the information that they are using is governed by the educational exception to copyright, meaning that the expectation of paying revenues for use of the work is significantly lower than if they are professional engineers who are using information for commercial use. Using a small percentage of a given work (a sentence, a paragraph) is considered to be considerably fairer than using entire chapters or whole works without permission. Many e-book providers limit the amount that can be downloaded from any one work for this reason. Generally in engineering, the information used is factually based, which means that the usage terms may be more lenient. The possible negative financial implications from the use of a copyrighted work are particularly relevant to digital media. If artwork or images are used in the creation of a deliverable but copyright is not honored, artists will lose money for work

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**BOX 5.4**

**Open Source and Creative Commons Licensing Websites**

Explore these websites for more information on open source and Creative Commons licensing:

- [http://creativecommons.org/about](http://creativecommons.org/about)
- [http://orbison.exp.sis.pitt.edu:8080/webdav/Miscellaneous/understanding-common-open-source-licenses.pdf](http://orbison.exp.sis.pitt.edu:8080/webdav/Miscellaneous/understanding-common-open-source-licenses.pdf)
- [http://opensource.org/licenses](http://opensource.org/licenses)
- [http://www.gnu.org/licenses/license-list.html](http://www.gnu.org/licenses/license-list.html)
that they distributed for the purpose of making money.

As future engineers, it is important for students to recognize that the work that has been distributed, whether via the Web or in print, has economic value. As creators of information, the honorable as well as legally required course of action is to comply with copyright when appropriate. If an exception such as fair use does not apply, then it is the responsibility of the user of the copyrighted work to seek permission from the copyright holder. A copyright infringement of a work transpires when the use made of the work is outside of the exceptions such as fair use and/or permission was not granted.

**PATENTS**

Patents are generally accessed during the specification and conceptual design phases, although they may also be used during detailed design. Patents protect the intellectual property rights of an inventor or patent holder and ensure that the patent holder has time to commercialize the invention before competition can produce the product as well. As part of the process of determining prior art, students should be looking for patents that currently exist. As part of a truthful, objective, and comprehensive background search, patents should be included. If the project is one that is novel enough to be commercialized, the failure to conduct a prior art search may lead to the product’s failure due to patent infringement. It also casts doubt on the credibility of the engineering team who designed the product.

If a patent search is assigned, students should be encouraged to consult with a local librarian. The dictionary of terminology used to describe patents is quite different from the everyday terminology that society uses to describe those items. What is known as a “generally spherical object with floppy filaments to promote sure capture” in the patent database is known as the Koosh ball in general society.

Librarians can help to increase the success of beginner patent searchers by providing coaching on the selection of terminology for keyword searching and classification searching (which enables the searcher to find a number of related examples at once as opposed to an individual patent). The entire U.S. Patent Database back to its inception in 1790 is available via the uspto.gov website.

**SUMMARY**

Engineering students must have a well-developed sense of professional integrity. This will manifest itself in their student group work and professional lives through evidence of the consideration of the safety, health, and welfare of others, through the development of competency and the restriction of work only to those areas of competency, and through a robust understanding of information ethics. Student design projects present a high-impact teachable moment—an opportunity for students to practice ethical reasoning and develop both a stronger sense of self and responsibility to stakeholders. Beginning the discussion of ethics and setting expectations for individual and
team ethical behavior, including ethical use of information, at the outset of a project when teams are formed, provides a foundation that will serve students well not only in their course work but also in their careers after graduation.

**SELECTED EXERCISES**

**Exercise 5.1**

Using engineering controversies as a conversation starter for a class discussion, followed by an individual reflection activity, can provide a baseline at the beginning of the semester to understand the relative ethical reasoning abilities of the students in a class. The same topics can be used to start required blog or wiki conversations. Some possible topics include the following:

- MIT/Aaron Schwartz case of downloading scholarly articles illegally
- Algo Centre Mall roof collapse
- URS Corporation and the Minneapolis I-35 W bridge collapse
- Sinking of the Titanic
- Bhopal chemical disaster
- Chernobyl nuclear power disaster
- Fukushima nuclear power disaster
- Charles de Gaulle Airport roof collapse
- Banqiao Dam disaster
- Niger Delta contamination

For more information on potential questions to pose and ideas for other case studies, see the Online Ethics Center website, http://www.onlineethics.org.

**Exercise 5.2**

A service learning class is partnered with a nongovernmental organization in a Sub-Saharan African country. The students will be partnered with the NGO (nongovernmental organization) staff, who will be the primary interface on the ground between the stakeholder community and the class. The students are tasked with designing a water filter using locally available, sustainable, and renewable sources. A first activity that would enhance objectivity is having them list the assumptions they have about the community, the environment, the stakeholders, and the long-distance communication process. The instructor may require the students to submit their responses and reply back privately while correcting major potential biases and prejudices. The instructor may also initiate a group discussion on the most prevalent assumptions in the class regarding these aspects of the design constraints. Either way, identifying these assumptions early will help the class to avoid the pitfalls of prejudice and bias from the start of the project.

**REFERENCES**


