# CHAPTER 17 Introduction to Engineering Design

# 17.6 TWO GROUND RULES FOR DESIGN

There are two important ground rules for design, the use of a design notebook and effective teamwork.

## 17.6.1 Ground Rule 1: Use a Design Notebook

When you are working on a design project and you want to write something down, the design notebook is the place to do it. There is no need for notepads, reams of paper, or sticky notes. The place to record your thoughts is in a permanently bound volume with numbered pages, a cardboard cover, and a label on the front cover identifying its contents. Every college bookstore has them, though they may be called laboratory notebooks.

As a starting engineer, now is the best time to start a career-long habit. Just how important the design notebook is can be explained in the case of Dr. Gordon Gould.1

*On November 9, 1957, a Saturday night just given to Sunday, Gould was unable to sleep. He was 37 years old and a graduate student at Columbia University. For the rest of the . . . weekend, without sleep, Gould wrote down descriptions of his idea, sketched its components, projected its future uses.*

*On Wednesday morning he hustled two blocks to the neighborhood candy store and had the proprietor, a notary, witness and date his notebook. The pages described a way of amplifying light and of using the resulting beam to cut and heat substances and measure distance. . . . Gould dubbed the process light amplification by stimulated emission of radiation, or laser.*

It took the next 30 years to win the patents for his ideas because other scientists had filed for a similar invention, although after Gould. Gould eventually won his patents and received many millions in royalties because he had made a witnessed, clear, and contemporaneous record of his invention.

The lesson is that patents and other matters frequently are settled in court for hundreds of millions of dollars by referring to a notebook that clearly details concepts and results of experiments. You must maintain that notebook in a fashion that will expedite your claim to future inventions and patents.

Another more immediate benefit of using a design notebook is that you will know that everything related to the project is in one place. Finding that key scrap of paper in a pile of books and papers on your desk after working for months on the project can be a rather time-consuming endeavor.

**Here are some of the most important guidelines for keeping a design notebook:**

1. **Date and number every page.**
2. **Never tear out a page.**
3. **Leave no blank pages between used pages. Draw a slash through any such blank pages.**
4. **Include all your data, descriptions, sketches, calculations, notes, and so forth.**
5. **Put an index on the first page.**
6. **Write everything in real time—that is, do not copy over from scraps of paper in the interests of neatness.**
7. **Write in ink.**
8. **Do not use whiteout; cross out instead.**
9. **Paste in computer output, charts, graphs, and photographs.**
10. **Write as though you know someone else will read it.**
11. **Document team meetings by recording the date, results of discussions, and assigned tasks.**

## 17.6.2 Ground Rule 2: Team Effectively

Working in teams on a design project is both a joy and a challenge. Although there is a sense of security in knowing that others will be venturing into the unknown alongside you, the unpredictability of human interactions can be as perplexing as the design itself. To reduce the risk of ineffective teaming, rules of conduct wiljl be presented in this section. These are well-accepted best practices based on observations of effective teams.

There are several advantages to attacking a design project in teams. First, design requires a wide range of skills and areas of knowledge. No one person is experienced enough to pursue every unfamiliar design challenge in isolation. Teaming provides an opportunity to expand the talents and life experiences that will be brought to bear on the design problem. Second, if done right, teaming serves to keep personal biases in check. Third, more people should mean that more will get accomplished in a shorter period of time, although it is puzzling to often see team members standing by politely as one team member does all the work (especially during manufacturing). When best practices are followed, a team will be greater than the sum of its parts.

For design projects done during the freshman and sophomore years, three people are the ideal team size. Teams of two may not experience all the typical dynamics and so may not learn as much about teaming. With teams of four, it may be too easy for one team member to hide. Design teams at this level usually are not assigned a team leader by the instructor. Leadership typically emerges within the team. If a team leader is assigned, the role is not to be the boss, but rather to organize and facilitate participation by all team members.

Here are some teaming best practices:

* Assign clear roles and work assignments. A few things are best done as a team, such as brainstorming and evaluation of concepts. Most of the time it will pay off if everyone has his or her own assigned responsibilities and tasks to which he or she will be held accountable by the team. These tasks should be assigned or updated at the end of each and every team meeting.
* Foster good communication between team members. An atmosphere of trust and respect should be maintained in which team members feel free to express their ideas without retribution. That trust extends to allowing for civilized disagreement, delicately done so as not to suppress ideas or discourage participation. Everyone should participate in the discussions. Sometimes this means reaching out with sensitivity to the shy members of the team. If you succeed, you will have a team operating on all cylinders.
* Share leadership responsibilities. If there is a designated team leader, that person should empower the other team members with significant leadership responsibilities. This will give those students a strong sense of ownership in the project. At the same time, team members have to be willing to step forward to assume leadership roles.
* Make team decisions by consensus. Teams make decisions in one of three ways: (1) the team leader makes the decision, (2) discussions continue until everyone agrees (as in a trial by jury), or (3) after discussions are exhausted, the team takes a vote. Those who disagree with the outcome of the vote are then asked if they can put their opinions aside and move forward in the best interests of the team. In a college- level design project, the only ways to go are (2) and (3), which are both examples of decision making by consensus.