

AN ENGINEERING STUDENT SURVIVAL GUIDE

Richard M. Felder

Hoechst Celanese Professor of Chemical Engineering

North Carolina State University

Raleigh, North Carolina 27695-7905

You say things aren't going quite the way you'd like this semester, especially in your ten o'clock class? The professor just covers the board with equations and doesn't explain anything? The textbook is dry as dust and doesn't have worked-out examples? The exam problems are nothing like the homework and class averages are in the 40's?

Well, I'm not unsympathetic--I had some classes like that in my day and complained about them just as bitterly. Unfortunately, while complaining may make you feel better, it won't do a thing for your grades. I'd like to propose several more productive ways to help yourself.

First, though, let me suggest that the real problem is not that professor who's making your life miserable. It's that over the years you've bought into a message that goes like this: *"My teachers have the truth, the wisdom, the tricks of the trade. Their job is to feed it all to me in lectures, and my job is to soak it up and then repeat it on homework and exams. If I can do that, I've learned what I need to know...and that's the only way I can learn it."*

Wrong! That approach may have worked in high school and earlier, but it begins to fail in college--and once you get into the plant or research lab, it stops working completely. On the job there are no teachers, lectures, homework, or exams. There are only problems--usually poorly defined ones--and solutions that are either acceptable or not. To make it worse, you no longer get partial credit for solutions that don't work, even if you use the correct formula. If you design ten reactors and one blows up, trust me--they won't give you a 90 and congratulate you.

And yet every day, hundreds of thousands of engineers, most no brighter than you--many not as bright--who once struggled with their own confusing instructors and texts and didn't understand entropy any better than you do, are out there doing just fine, figuring out what they need to know and solving their problems.

How do they do it? They know a few things you still haven't discovered, that's how. They learned soon after graduating not to count on someone else telling them everything they need to know to solve their problems. Then they learned how to find out for themselves what they need to know, and discovered that there is a lot of help available if they know where to go for it.

These engineers learned those things out of necessity, most of them after graduating. What I'd like to do here is give you a head start, both to help you do better in your remaining courses and to enable you to hit the ground running on your first job. Give the ideas a try. You have nothing to lose, and if they work (and I'm pretty sure that at some of them will), you win.

Figure out what you need to make course material clearer

Students have different learning styles (ways of perceiving and processing information), and tend to run into trouble in courses in which the instructor's teaching style doesn't match their learning style.¹⁻⁵ Engineering students commonly complain about the following learning and teaching style mismatches. See which complaints you might echo.

- *I need practical, real-world applications before I can understand something, but all we get in class is theory that doesn't relate to anything I know about.*
- *I need worked-out examples before I can understand mathematical theories and formulas, but all we get are a few trivial examples, or no examples at all.*
- *I want to understand how and why things work, but all we get are facts and formulas to memorize.*
- *I understand what I see--pictures, diagrams, sketches, flow charts, demonstrations--better than what I hear and read, but all we get are words and formulas.*

Identifying your problems in a course is the first step toward solving them. Once you know what's missing, you can take additional steps to fill in the gaps.

Ask your instructor for help, in or out of class

Contrary to popular rumor, most professors genuinely care about students and want them to learn. In fact, a common complaint of professors is that their students almost never ask questions except the inevitable, "Are we responsible for this on the test?"

If you don't understand a point, try asking for something that might clarify it for you. Look back at the list in the previous section for ideas about what might do it. "*Could you give an example?*" "*Could you sketch what that (device, solution, plot) might look like?*" "*Where did that equation you just wrote come from?*" "*When can't you use that formula?*" "*Could you say something about how this (theory, procedure, equation) is applied in practice?*" Even if you're afraid a question is stupid, ask it anyway. I

guarantee that others in the class are equally confused and will be grateful to you for having the nerve to speak up.

Many instructors will welcome these questions and handle them well; others won't. It won't take you too long to figure out which type you're dealing with. If you get one of the small minority of professors who are unresponsive or hostile to questions, don't push it. Go on to alternative sources. Even with the cooperative ones, don't spend too much time in class asking questions. Some lecturers get irritable if they have to deviate too much from their lesson plan. Ask them during their office hours instead. If something puzzles you and several classmates, try going as a group to the instructor. Most instructors will appreciate it- it cuts down on the number of times they have to go over the same material.

Caution, however. Even instructors who genuinely want to help, and welcome questions, will get testy if they think you are trying to get them to do your homework for you. Make it a rule never to ask your instructor for help on a problem until you have made a serious effort to solve it by yourself. When you ask, be prepared to show in detail what you tried and how far you got. Bring in your flow charts and schematics and calculations, including the ones that didn't work. The more thorough you are about what you did, the more likely you are to get the help you want.

Actually read your course text

Some texts that cover theoretical material try to explain its importance, describing real-world behavior that the theory explains and problems it can be used to solve. Students often ignore those parts of the book and just search through the examples for clues about how to solve the homework problems. It may be, though, that parts you skip contain points that would make both the theory and its applications clear to you. Look for them. It may also help to glance ahead in the book when something confuses you to see how it will be applied later.

Look for other references

If you need real-world examples and applications to make abstract concepts clear and you have a theory-oriented instructor and text, you'll probably have trouble with the class. If the lectures and course text are mainly collections of facts and formulas and you need meanings and connections for material to make sense, you may have equal difficulty. In either case, find other references on the same subject--other textbooks, handbooks, even encyclopedias--and look over their explanations of the points that confuse you. If you want worked-out examples in a subject for which a Schaum's Outline exists, get the Outline and use it. Even if you can't find a reference with

exactly the type of coverage that works best for you, just reading about the same topic in two different places usually clarifies the ideas.

Work with others

When you work alone and get stuck on something, you may be tempted to give up; when you're working in a group, someone usually can find a way over the hurdle so the work can proceed. Group work also exposes you to alternative ways to solve problems that may be more effective or efficient than your way. Moreover, students routinely teach one another in group work--and as any professor will tell you, teaching something is probably the most effective way to learn it.

A wealth of educational research supports the effectiveness of collaborative learning. Students who consistently work together on problems in study groups and, when permitted, homework groups, get higher grades, retain what they learn longer, enjoy classes more, and gain more self-confidence than students who only work individually and competitively.⁶ Industry is well aware of the power of collaborative work: virtually all engineering projects are done by teams.

However, simply getting together with some friends to go over problems is not enough to get the full benefit of the team approach. Here are some ideas for making collaborative learning effective.

- *Work in groups of three or four.* When you work in pairs, you don't get a sufficient variety of approaches and ideas and there is no good mechanism for conflict resolution. When you work in groups of five or more, some group members tend to be left out of the active problem-solving process.
- *Outline problem solutions by yourself first.* Often the hardest part of a problem is figuring out how to get started. If all problems are tackled together by the entire group, one of the quicker students may initiate every solution. If that one isn't you, you may think you'll know how to begin solving similar problems in the future--on the exam, for instance--but you probably won't. An effective way to work on a set of problems is to outline the solution to every problem yourself, without doing detailed calculations; then work out the complete solutions in the group.
- *Make sure everyone understands every solution.* Students in a group will often go along with a solution without really understanding it. For group work to be fully effective, every group member should be able to explain in detail every solution obtained in a work session. Having the group members (particularly

the weaker ones) go through these explanations before ending the session is a good way to make sure that the session has achieved its objectives.

When all else fails, consult experts

Sometimes you'll encounter a problem that neither you nor your group partners can figure out, even after reading the text and checking out other references. When practicing engineers run into such problems (as they all do occasionally), they consult experts. You also have experts available to you--the trick is to find out who they are and to use them wisely. Your course instructor is an obvious candidate, but that option doesn't always work out. Other potential consultants include the graduate teaching assistant(s) for the course, professors other than your instructor--especially those who sometimes teach the same course, graduate students, undergraduates who have previously taken the course, and bright classmates.

If you're fortunate enough to find people willing to help you, don't abuse their generosity by running to them with every problem. They have their own work to do, and spending hours every week helping you will get old to them very quickly. Go to them only occasionally, and only after you've tried everything else recommended here. If you need help in a course on a regular basis, arrange for a tutor. Your college or department may have a program that will find one for you, or you may need to find and pay one independently. If you seek tutoring, do it early enough to get meaningful help. Waiting until two days before the final exam will probably get you nowhere.

Summary

When you go to work as an engineer, you won't have lectures to provide information on how to solve your assigned problems, but will be pretty much on your own. It is to your advantage to start functioning that way while you're still in school. Figure out what you need to make course material clearer--practical applications of theories and formulas, for example, or worked-out examples of computational procedures--and try to get it. Ask your course instructor, in or out of class. Look for helpful material in your course text, in other texts on the same subject, and in references like handbooks and encyclopedias. Study for tests and (if permitted) work on homework in groups, following the guidelines given in this paper for making group work effective. When all else fails, occasionally consult experts or arrange for tutoring in courses in which you regularly need help. These practices will improve your performance in college courses and in your professional career. More importantly, they will enable you to keep learning effectively for the rest of your life.