

Advice to a Young Engineer

By *Ralph B. Peck, Ph.D., P.E., Hon.M.ASCE*

In March 1977, I was invited to speak to the West Point Chapter of the Society of American Military Engineers at a banquet honoring the graduates about to be commissioned in the Corps of Engineers. The text that follows is my talk, which was pointed especially to the careers the graduates would develop in the Corps. (This article has been edited from the original to fit the format of Geo-Strata.)

With your training here at the Military Academy, you have acquired an unusually broad background, as well as specialized technical skills. This background and these skills are necessary conditions for a successful career, but, as the mathematicians say, they are not sufficient conditions.

What other ingredients are needed? There are two that stand out above all others: engineering judgment, and professional and public responsibility.

Developing Engineering Judgment

The first task is to develop engineering judgment. Almost all people in the practice of engineering would agree that successful practice requires a high degree of engineering judgment, but few would agree on the meaning of the word judgment itself.

To the engineering student, judgment often appears to be an ingredient said to be necessary for the solution of engineering problems, but one that the student can acquire only later in his career by some undefined process of absorption from his experience and his colleagues. To the engineering scientist, engineering judgment may appear to be a crutch used by practicing engineers as a poor substitute for sophisticated analytical procedures. To the practicing engineer, engineering judgment may too often be an impressive name for guessing rather than for collecting hard facts and for rational thinking. These are all misconceptions.

There is actually such a thing as engineering judgment and it is indispensable to the successful practice of engineering. It is indispensable for several reasons because: some problems cannot yet be solved by mathematical analysis; those problems that can be solved by mathematical analysis can be solved correctly only if the input is reasonable; and the output of analyses even from electronic computers needs to be judged, accepted, or rejected on the basis of its reasonableness. As a working defini-



Ralph B. Peck

tion of engineering judgment, let us simply call it a good sense of proportion, and let us explore how it may be cultivated.

First, you can make every assignment count. Some of your assignments will be of a nontechnical nature. Under these circumstances, you might wonder how you can improve your judgment. But, even on a nontechnical assignment, there is always something to be learned, even if only by observing the ways in which your superior officers handle problems. In engineering, dealing with people is as important as dealing with physical laws. Some engineering officers are much more skilled in this area than others. You can observe the attitudes and techniques that seem to lead to superior or poor performance on the part of those with and under whom you work.

Second, you can teach your brain to register what your eyes see. Some engineers appear to have the ability to walk onto a job and note everything of significance; others return from an inspection trip and find they did not even notice some vital factor. One of the most effective ways to gain the ability to observe with discrimination is to keep a notebook about everything you do. The purpose is not so much to make a record as it is to develop powers of observation.

When I first began to work for Karl Terzaghi on the Chicago subway, he not only insisted that I keep a notebook, he inspected it regularly. I found very promptly that, although my eyes may have looked at a construction job and presum-

ably saw it, what I saw did not register in my brain. For example, when I went into a tunnel heading to observe how the mining and bracing were being done and then returned to the laboratory to attempt to sketch and describe what I had seen, I discovered all too often that I could not sketch certain details. I did not know how one member fit into another. I did not know how one portion of the lining was supported while another was installed beneath it. I had a general idea, but if I could not draw the details, I did not really know the procedure. I had to go back sometimes twice to see what I had already seen but had not absorbed. I can assure you that exercise of this sort will greatly sharpen your skill at noticing the significant details and remembering them. Soon, you too will be able to cast your eyes over an entire project and to pick out those features that are going well and routinely and those aspects that demand attention.

Third, you can consciously evaluate the size of things. That is, you can learn to think quantitatively. It may sound like a silly question to ask, "How big is a column load?", but if the designer of a two-story office building comes up with a column load of, say, two thousand tons, you should recognize that this is an absurdity, a load more nearly appropriate for an Empire State Building. If somebody tells you the seepage from a well point system is 400 gallons a minute, do you have a mental picture of how much water this is? Can you see it flowing in a pipe or in a ditch? Is it a small flow or a large flow in terms of dewatering jobs? If somebody tells you an earth dam is being constructed to a height of 2,000 feet, do you recognize a fallacy, because 2,000 feet is more than twice the height of any completed earth dam? The mere exercise of trying to visualize numerical quantities, dimensions, and rates, begins to give you the sense of proportion that is so valuable in sharpening your judgment, in giving you the ability to glance over someone else's work and to spot a serious error.

Fourth, you should of course read. You should read the technical literature and such journals as ASCE's *Civil Engineering*, *The Military Engineer*, and *Engineering News-Record*. But, you should not only read the articles, you should also read the ads. In the advertisements you often find the latest information about the kinds and capabilities of equipment, new records in foundation depths, or totally new construction concepts.

Finally, you should study precedents, the folklore of engineering. You could hardly do better than to start with the work of the Army Engineers. Indeed, I am sure you already have studied many of the accomplishments of Corps of Engineers officers. You know about Colonel Goethals of the Panama Canal, but are you aware of the extremely close relationship between the Corps of Engineers and the development of my specialty of soil mechanics? It is a fascinating story—one that might make an appropriate subject for a banquet address in itself.



The Attributes That Really Count

So in these ways, by these simple procedures that you can carry out day by day during the early part of your career, you can cultivate this elusive thing called engineering judgment. If you achieve it in full measure, you will be able to decide quickly whether those working under your command have made sound engineering decisions or have not. The value of this knowledge is obvious.

The second attribute you will need is a sense of professional and public responsibility. In even the recent past, the decision to build public works, such as the civil works constructed by the Corps of Engineers, was based almost strictly on the benefit-cost ratio, with little regard for ecology or the environment. There was little public participation in the choosing or the design of the projects. The decision to proceed with a particular project was determined largely by the political skill and prestige of those members of Congress whose constituents would be beneficiaries of the project. Surely this was an inadequate, unbalanced procedure.

Today we have moved too far in the other direction. There is much public participation in all projects, mostly by highly vocal and organized objectors. Needed projects that would produce energy or provide flood control without serious detrimental side effects are delayed or killed entirely for trivial reasons.

I hope that your careers as Engineer Officers will coincide with a time of moderation, and of trade-offs, when both the basic economics of projects and their effect on the environment will receive reasoned, balanced consideration. If this situation is to come about, however, you as engineers must participate as members of the public. You must be the ones, in an unbiased fashion, to give the facts to the public. If you do not, the public will have no basis for reasonable choices.

Each of us is only one person, and no one of us can expect to change the course of history. Yet each of us has a part with a meaning in his own day and age. Our per-

sonal, individual attitudes toward engineering and toward society have a potential impact on our country's future. However small that impact, each of us should try to make it for good.

Sage Advice From Karl Terzaghi

Karl Terzaghi had this in mind when he gave his students at Harvard a set of rules for what he called the game of engineering. The rules are full of wisdom:

1. Engineering is a noble sport which calls for good sportsmanship. Occasional blundering is part of the game. Let it be your ambition to be the first one to discover and announce your blunders. If somebody else gets ahead of you, take it with a smile and thank him for his interest. Once you begin to feel tempted to deny your blunders in the face of reasonable evidence, you have ceased to be a good sport. You are already a crank or a grouch.
2. The worst habit you can possibly acquire is to become uncritical towards your own concepts and at the same time skeptical towards those of others. Once you arrive at that state, you are in the grip of senility, regardless of your age.

3. When you commit one of your ideas to print, emphasize every controversial aspect of your thesis which you can perceive. Thus, you win the respect of your readers and are kept aware of the possibilities for further improvement. A departure from this rule is the safest way to wreck your reputation and to paralyze your mental activities.
4. Very few people are either so dumb or so dishonest that you could not learn anything from them.

Engineering is indeed a noble sport, and the legacy of good engineers is a better physical world for those who follow them. You are well started on a career that can leave such a legacy and, as you pursue that career, I give you my very best wishes. ○

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Ralph B. Peck, Ph.D., P.E., Hon. M.ASCE, is Professor Emeritus of Civil Engineering at the University of Illinois at Urbana-Champaign. He can be reached by fax at 505.323.7760

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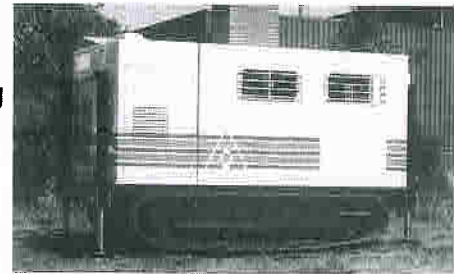


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