

THE CHALLENGE OF CIVIL ENGINEERING

by
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(Before a Student Meeting ASCE
Worcester Polytechnic Institute)

Dr. Hooper and Fellow Students -

I use this salutation advisedly, for not so long ago, in one of those office battles that are a normal feature of every live business, one of my partners (now safe in Heaven) referred to me with a shade of deprecation, as "just a damned student". It was a fair and just characterization; I have tried all my life to be just that, and I have never had a more flattering compliment - after fifty years of the toughest sort of in-fighting in the arena, still to have retained the gleaming vision and holy curiosity of golden youth.

You will rightly surmise that I am not a disappointed man. By my standards, I have had an abundant life in civil engineering, and if I were granted reincarnation, I should, without the least hesitancy, again select this profession, for my life work. Professor Hooper has asked me to tell you how I managed to have so enjoyable a career, and incidentally to pass on to you some of the lessons I have learned from my worst mistakes.

In the first place, men who have been so fortunate as to have had our advantages, training and qualifications, are (to borrow from Scripture) veritably a chosen priesthood, and as such, have a reciprocal moral obligation, always and from the very start to stand squarely on the side of professionalism, as contrasted with unionism. The criterion of a true professional is that after acquiring experience, he have his own office or

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be a principal in a larger firm. His income will then accrue to a large extent from profit, and profit in the economic sense is the reward of the entrepreneur for assuming business risks, hazarding his personal fortune or investing his own capital. Consulting engineering is a highly competitive business, and to obtain work your charges for professional services must fall within generally accepted limits prescribed by the various pertinent manuals of the engineering societies. If you do not control your office production costs efficiently, you will lose money out of your own pocket. There are numerous other risks also involved. To mention just one, no matter how excellent your work you must expect to defend yourself constantly against litigation, which is always expensive. In short, if you are to make any real money (as engineering goes) you must be a business-man and a salesman, as well as a top-flight engineer. But above all, because you are destined to assume business risks and to "shun delights and live laborious days", you are automatically committed from the outset to the side of management.

What of the opportunities in civil engineering today? Because of the magnitude and number of the projects involved, opportunities are unquestionably greater than ever before. Civil engineering, the parent of all but military engineering, is the profession in which you will have primary responsibility for the entire job, perhaps a large hydro or steam power plant, a major bridge, a large industrial plant or a large building. Because of this broad overall knowledge of heavy construction projects, it is the civil engineer who is entrusted with the commission, and the electrical and mechanical engineers more often work under his top direction. So, from your very first day out of school, while you are still serving your internship at the very bottom of the totem-pole, and of course with a decent regard for modesty, never lose sight of the fact that you are a young professional man in training, and let "neither foes nor loving friends, nor the fools that crowd youth" batter your perspective and aspirations down to the artisan level.

I next rush in where angels fear to tread to discuss the first step in your engineering career, your education. To introduce the subject with a decent regard to my own life and

limb, I read from this editorial from a current issue of The Electrical World:

"Such Academic Nonsense
is Dangerous

'We are completely fed up with the errant, academic nonsense peddled these days by a few professors in major colleges and universities across the country, who hold up the Ph.D. in science as the passport to technical progress and downgrade the engineering profession generally and power engineering particularly.

One professor makes this comment. 'Clearly our society will continue to need people who know how to build transformer and generator stations. There is, however, no room in the faculty and student body in the physical plant of our universities to train these craftsmen.

Vocational schools, two-year junior colleges, or technical four-year schools must take over this task. These schools will also supply those indispensable craftsmen, such as glassblowers, draftsmen, electronic technicians, chemical analysts, etc.'

He feels that our major universities and institutes of technology should concentrate on broad-based education for the most gifted who will assume positions of leadership. He sums up this way: 'The Ph.D. has become the standard terminal for those who aim for leadership in the engineering profession'."

Now to go to the other end of the spectrum. When I was teaching structures at the same professor's school, Harvard, senior students would ask my boss, the late lamented Dean Albert Haertlein, whether they should not proceed to their M. S. and Ph. D. degrees. Without the least hesitation he would invariably tell them that they had finished their school days but that for all the rest of their lives they must study day and night, books and men, in the wide-world school of practical experience.

I naturally incline to the viewpoint of Dean Haertlein. In my opinion the universities have been badgered into catering too much to the missile and nuclear industries with the result that the pendulum has now swung too far in the direction of pure science to the practical elimination of the traditional courses in basic practical engineering design. I am a great advocate of advanced applied mathematics. Get all of this you possibly can, but I still feel that after four years at college a graduate should be able to start earning his living by being able to design a railroad plate-girder, or to participate intelligently in the design of wind-bracing for a sky-scraper, or the design of an arch dam. I have interviewed candidates for research fellowships who were so befuddled with computer technology and system analysis that they could not state in simple intelligible English what research they proposed to conduct.

This brings us to still further controversial ground: the use of digital and analog computers in engineering. In this connection I always think of Sir Winston Churchill awaiting his turn to speak at the MIT convocation in Boston Garden some years back. The previous speaker in a moment of exuberance had stated that computers now could almost think. Sir Winson swallowed hard and said that when that day arrived he hoped to have departed to his eternal rest. Only a few days ago I saw a pertinent caricature in the New Yorker, done in gloomy India ink, showing a beetle-browed scientist with heavy black beard, horn-rimmed spectacles, and a Wellington pipe, frowning at the console of a mammoth computer. The sole decoration in the room was a framed motto in heavy black letters: "To err is unlikely; to forgive is unnecessary." Now in all seriousness, the two lessons are plain. No machine can ever think for us; and while such devices should by all means be used where there is iterative numerical labor, their abuse, if unrestrained, can become an obsession. They then breed a tendency to consign to pedestrian oblivion any study that does not involve the computer and system analysis. One of my bosses, the famous Robert Moses, has the following pertinent comment concerning his selection of the location for the Long Island Bridge:

"I would be less than frank if I said my own conclusions rest solely on population, industry and

travel figures, computers, origin and destination surveys, graphs, extensions of lines, and other accepted stereotypes, especially in locating a crossing where it must serve for centuries.

No machine can take the place of the shrewd, prescient and clairvoyant practitioner. Machines do not measure the imponderables, the freaks of human nature, accidents, hell, high water and the King's enemies, time, chance and luck."

By far the greater number of problems confronting the more mature engineer are not iterative. Each one is more likely to be tailor-made and different from its predecessor. For many of these real problems, the time required to program the work would be greater than is available for the entire assignment. Furthermore, no engineer past his early youth would think of doing his own programming, anymore than he would of typing his own letters. So do not become too proficient at this sort of thing or you will never have a chance to do anything else.

I come at last to the most important thing I have to say to you, i.e., how to "stand the gaff". No less a figure than the great Benjamin Fairless, who rose after college from a civil engineering draftsman to Chairman of United States Steel, once wrote that he was certain that several promotions he richly deserved were given to others of lesser merit. Such experiences are the common lot of all of us. How then are we to build up our spiritual reserves to take such injustices in stride, to keep our eyes on the goal we have set and to attain the state of mind of Yeat's Irish Airman:

"Nor law, nor duty bade me fight,
Nor public men, nor cheering crowds.
A lonely impulse of delight
Drove to this tumult in the clouds."

I read recently a very interesting little book by Lord Wavell. It is called, "Generals and Generalship." It describes the training of British generals, and more than any other quality it emphasizes robustness. The general mustn't go to pieces when things are going against him. When the outlook is

black, he has to fight harder than ever. When Lord Wavell was Colonel of a Field Artillery Regiment in a mountain district in India, the authorities would send out new field artillery pieces to be tested. The first step was to take these artillery pieces to the top of the highest cliff in the region and push them abruptly over the edge. If they were still able to fire at all after hitting the ground, the guns were given further and more refined tests. Robustness was what counted, and if your experience is to be anything like mine, you're going to be pushed over that cliff a great number of times, and you must come up fighting harder than ever.

The Iron Duke of Wellington said that the battle of Waterloo was won on the playing fields of Eton. While you are still at college by all means go in for sports of the rough-and-tumble variety, football, baseball, basket-ball and the like. Don't foul, don't flinch, but hit the line hard. You may be advised not to waste your time upon such plebian sports; but to learn instead the finesse of golf and bridge, which will later give you social entree to business success. You may be told to "cultivate the type of people who can get you somewhere." Like old Cyrano, "I mark the manner of these canine courtesies", I hate to see the gilt of an honorable idealism rubbed off at too early an age. My old baseball coach often "bawled me out" in front of my teammates. "You have all the physical attributes of a hitter, but because you go up there with the heart of a chicken, you strike out everytime!" I did not conquer my yellow streak in time to become a great athlete, but with the voice of that old Holy Cross second-baseman continually ringing in my ears, I just had to win out. You simply do not get this essential rough treatment in uppercrust pastimes like golf and bridge.

Another blade of Damacus steel stands ready for your grasp all the days of your life and its potency has best been certified by that great physician and humanist Sir William Osler:

"Science is organized knowledge and knowledge is of things we see. Now the things that are seen are temporal; of the things that are unseen science knows nothing, and has at present no way of knowing anything.

The man of science is in a sad quandary today. He cannot but feel that the emotional side of

which faith leans makes for all that is bright and joyous in life. Fed on the dry husks of facts, the human heart has a hidden want which science cannot supply; as a steady diet it is too strong and meaty, and hinders rather than promotes harmonious mental metabolism.

To keep his mind sweet, the modern scientific man should be saturated with the Bible and Plato, with Homer, Shakespeare and Milton; to see life through their eyes may enable him to strike a balance between the rational and the emotional, which is the most serious difficulty of the intellectual life."

The engineers who really stand out in the profession, men like the late Boris Bakhmeteff of Columbia, or Abel Wolman of John Hopkins, have a spellbinding felicity and facility of expression that bespeak life-long love for, and intimacy with the classic world literature. Of course we read the classics principally for delight, not for material advancement; but as you progress in civil engineering you will be called upon more and more to serve as an expert witness in litigation. When you stand on your own resources at the mercy of the opposing lawyer in cross-examination, you will find this facility of expression no handicap.

In conclusion gentlemen, I wish you the best of good luck. May you too have the good fortune always to remain students in spirit for all your days, and in your inevitable hours of trial and testing, may you lift up your hearts to the great lines of Rupert Brooke, written when, homesick in a strange land, he draws renewed courage from the memories of his college days at Cambridge:

"Say do the elm-clumps greatly stand
Still guardians of that holy land?
The chestnuts shade in reverend dream,
The yet unacademic stream?
Is dawn a secret, shy and cold
Anadyomere, silver-gold?
And sunset still a golden sea
From Haslingfield to Madingley?"

And after, ere the night is born,
 Do hares come out about the corn?
 Oh, is the water sweet and cool,
 Gentle and brown, above the pool?
 And laughs the immortal river still
 Under the mill, under the mill?
 Say is there Beauty yet to Find?
 And Certainty, and Quiet kind?
 Deep meadows yet, for to forget
 The lies, and truths and pain? - Oh! yet
 Stands the church clock at ten to three?
 And is there honey still for tea?'

Do not be too surprised if your ultimate destination is not what you had earlier planned. Recall Cromwell's famous statement that nobody appears to go quite so far as he who does not quite know where he is going. Remember too the wisdom of Ecclesiastes: "I returned and I saw under the sun that the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding nor yet favor to men of skill; but time and chance happeneth to them all."

By modern Madison Avenue standards, our old friend Cyrano de Bergerac with the long nose would have been an abysmal failure; but not even the Admiral at Trafalgar had so glorious a death:

"Hopeless you say
 But a man does not fight merely to win!
 Yes, all my laurels you have driven away
 And all my roses; yet in spite of you,
 There is one crown I bear away with me,
 And tonight, when I enter before God,
 My salute shall sweep all the stars away
 From the blue threshold! One thing without stain,
 Unspotted from the world, in spite of doom
 Mine Own!

And that is _____

my white plume _____"

ERRATA

Getzler, Z., "The Virtual Differential Settlement Method,"
Vol. 53, No. 2, April, 1966, pp. 199-218.

1. page 200, line 23, missing "in", should be: "stress distribution in soil"
2. page 204, line 9, missing "see Fig. 1,"
3. page 207, formula (20), should be: $R_B^0 a - R_A^0 b = 0$,

$$4. \text{ page 209, line 6, should be: } \sigma = \frac{R_B^0}{b^2} = \frac{R_A^0}{a^2}$$

5. page 209, line 9, should be: "settlements for $\nu = 1$ will be equal."

6. page 210, left formula, line 3 from the bottom, should be:

$$\frac{\beta E_c J_c^{\Sigma}}{3} \left(\nu \delta e + \frac{b}{a} \right) \text{ or } \dots$$

7. page 213, line 10, should be: "the plan and a section with"
8. page 217, Notation Nos. 7 & 8, should be: J_c and J_c^{Σ} (capital letters).