

GRADUATION

*The Beginning of Your Education**

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MOST OF YOU participating in this conclave will be graduating and going into industry in a few months, and I felt that this was a good time to attempt to describe the world you are about to enter. After discussions with many friends and acquaintances in different segments of the U.S. chemical and petroleum industries, I uncovered a consistent industrial point of view which was somewhat of a surprise. It is evident that:

- *The United States is in a war!*
- *We don't realize it.*
- *We are losing!*

The natural response to this is, what war? One reason we don't recognize the situation is because this war is camouflaged. By war, I mean an aggressive foreign policy for nationalistic goals. In the past, wars were fought for territory. Today the war is for international markets, and all indicators show that the U.S. is losing. We can see evidence of this in the trade imbalance, the national debt, and the personal debt. Even more ominous is the fact that more and more of the U.S. resources, such as real estate, industrial companies, and stocks and bonds are owned by foreigners. If this trend continues, historians will look back and describe a country which hid in the bunkers with their missiles, totally unaware that the enemy was already behind the lines. The net result will be a loss of territory by a technique that is quite different from anything that man has previously experienced.

This war has many casualties. All one has to do is travel through the Monongahela Valley and see the unemployed steel workers and the deserted, run-down steel mill towns. Or drive down the streets of Detroit with its graffiti-covered buildings and unemployed auto workers standing on street corners. Or check out Manhattan, where white collar middle

managers have been forced into early retirement. All of these victims are psychologically wounded and many turn to alcoholism, gambling, violence, and suicide. The statistics also show that abrupt changes in employment reduce the life expectancy of individuals.

But how does all this affect you? The fact is that as graduating chemical engineers, you will be the front line troops in this technological war. When we look at the gamut of industrial activities covering basic research, applied research, development, manufacturing, technical marketing, and marketing, it is apparent that we are still winning at the two extremes. Our basic research is very strong, and this places us in the forefront scientifically. At the other extreme, our marketing techniques have become an art as expressed in advertising, and here again, we rank among the best in the world. However, we are losing the battle in the central regions of applied research, development, manufacturing, and technical marketing. These are areas dominated by engineers and, consequently, we are losing the war on the engineering front.

The military is completely impotent in this war. Similarly, management and government can optimize our ability to respond, but the final load will fall on



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the shoulders of our engineers. We must become better at turning our scientific advantage into a technical and industrial advantage. We must become better at manufacturing quality goods at low cost. We must become better at technical marketing where we can respond to the technical needs of our industrial customers both here and overseas. The outcome of this war will have more impact on your career than any other external factor.

The papers are filled with the impact of this war on the steel industry, the auto industry, and the high-tech computer industry, but the chemical industry is also in the heat of the battle. Twenty-five years ago, when I entered the chemical industry, the U.S. market and most of the international markets were dominated by American companies. Industry was experiencing steady growth. Competition existed, but just enough to keep everyone on their toes, and companies had the luxury of trying a few new things and making some mistakes.

Today, all of the major chemical industries are international. Not only is our share of the foreign market down, but we are also experiencing a strong invasion of the U.S. chemicals market. The Arabs and other countries with low-cost fuel stocks are invading the commodity market. Japanese and Europeans, with backgrounds in high technology, are invading the specialty chemicals market. The U.S. chemical industry (our territory) is being bought out by foreign companies, particularly the Germans and Japanese. The industry is in a period of low growth and very stiff competition. To survive, companies have to provide high-quality products at a competitive price with extensive technical service and development for their customers. Because of the instabilities in oil prices and the value of the U.S. dollar, it is very difficult to plan and there are renewed pressures for short-term profits.

Engineering has always involved a lifetime of continuing education, but the world situation today calls for even greater effort in this area. I feel you will learn more in the next four years than you did in the past four years. Unlike your previous education, most of your continuing education will not take place in a formal classroom setting. Many "A" students who are very good at learning in a formal educational system will have difficulty adjusting to self education through work experience and interacting with individuals in

the work place. I have been able to identify six areas, which I feel will dominate your continuing education.

Assimilating the Industrial Culture

The first thing you will have to learn is the culture of the company and the industry you join. All institutions have specific cultures and it is impossible to be effective without working within that culture. Unfortunately, the culture is something that everyone in the institution is aware of, but no one ever explicitly states or formulates. It has to be assimilated by interactions with the people in that culture. It has always been difficult for students to learn the culture of industry, but it is even more difficult today because the culture of many companies is changing in response to the war for international markets.

Defining Problems

Up to this point in your education, the emphasis has been on solving problems that have been explicitly presented to you. In industry, you will discover that the biggest problem is determining the nature of the problem. Compared to defining the real problem, the solution is often trivial.

Learning Through Mistakes

To be creative and innovative, you will have to be able to adjust to failing and learning from your mistakes. This is a difficult transition for many serious students who have achieved high grade point averages. They are not used to traveling over uncharted territory. But the great chemical engineers are those who weren't afraid of failure if they felt it would eventually bring success with a unique innovation.

Communicating

You will have to learn how to communicate and realize that the communication of the solution of a problem is in many cases more important than the actual function of solving the problem. Communication becomes paramount. During my eight years in industry, I did not see one engineer fail because of incompetence on the technical plane. However, I did see many very bright engineers lose their jobs because they could not communicate.

Travelling Over Unfamiliar Areas

You will have to learn to enter many areas which are now foreign to you. Some of these areas will be technical areas such as electronics, biotechnology, materials, etc. However, many other areas, such as business accounting, management, psychology, communications, etc., will be totally unrelated to your technical background. You'll have to use a combination of formal and self-education to make the transition into these new areas. Successful engineers indicate that after a few months of self-education, they can move into any new area, interact with experts in the area, and make contributions to the area.

Decision Making

You will have to learn to make decisions with a limited amount of information. It will often be necessary to make a decision on the basis of knowledge sufficient for action but insufficient to satisfy the intellect. This is quite different from solving problems on an examination where you have all the required information.

THE GOOD NEWS

Up to this point, my presentation has been rather pessimistic and you may feel overwhelmed by the challenges that you are going to face. There is a positive side to the picture, however. For one thing, the United States is the best-equipped nation to survive this war because we know the terrain and we essentially started the war. When the movement of the industrial revolution came together with the movement for individual freedom in the United States, the result was a system which other countries would emulate. Our main opponents in this war are not the countries who have different systems of government, such as the Russians, but the countries who have copied our system.

There is another very optimistic aspect concerning this war. All previous wars were zero sum wars. If one country gained territory, someone had to lose territory. But this war is different and everyone could win to some degree. If the United States continues to lead in science and engineering, this engine could drag the rest of the world to a higher standard of living.

Finally, a chemical engineering education is the best preparation for survival and success. As Carl Gerstacker said when he was CEO of Dow Chemical: "A chemical engineering education is the best education for whatever you want to do in life, and particularly if you do not know what you want to do." In

many ways, the chemical engineering degree is the liberal arts degree of the technological age. The reasons for this are very basic to the chemical engineering curriculum. You have learned fundamentals that have broad applicability. You have been taught to think and solve technical problems and the same techniques can be used in all areas of human endeavor, and should be, since the aim of a true chemical engineering education is to teach people to continue to learn. Your professors have given you the basic training required to win this war, but some skills can only be learned in the heat of battle. □

ChE letters

THE PLEASURES OF USING MODELL AND REID

Dear Editor:

I have enclosed an item for inclusion in your "Letters" section. I am suggesting that an explanatory note be added in Chapter 8 of Modell and Reid. Note that I have already corresponded with Bob Reid about this and he has agreed with my suggestion.

I would appreciate your publishing this in a forthcoming issue.

Comment on

Thermodynamics and Its Applications

Among the pleasures of using *Thermodynamics and Its Applications* by Modell and Reid (1983) is the precise, logical way with which the subject is developed and the corresponding traceability of any given result to first principles. For the discerning reader, operations are explained in sufficient detail to avoid having to puzzle over results and having to reconstitute missing steps. I have found one instance, however, where an additional note of explanation might be helpful.

The book bases its development on fundamental equations and shows early on the important role played by the Legendre transform in providing a link among the various fundamental forms. Coupling these forms to specific state equations (the Peng-Robinson is the equation of choice in the book) is done in terms of departure functions, both for pure fluids (Chapter 7) and for mixtures (Chapter 8).

Understandably, the analysis begins in both cases with the Helmholtz energy. Differentiating the pure-fluid expression (Eq. 7-81) with respect to temperature yields the entropy departure function, but not without an interesting aside that the authors perceptively highlight in a footnote. The operation in question (expressed intensively) is

$$\begin{aligned} \frac{\partial}{\partial T} [A(T, V) - A^0(T, V^0)]_V \\ = \frac{\partial}{\partial T} \left[- \int_{\infty}^V \left(P - \frac{RT}{V} \right) dV + RT \ln \frac{V}{V^0} \right] \quad (1) \end{aligned}$$

and its well known result follows:

$$S(T, V) - S^0(T, V^0) = \frac{\partial}{\partial T} \left[\int_{\infty}^V \left(P - \frac{RT}{V} \right) dV \right] - R \ln \frac{V}{V^0} \quad (2)$$