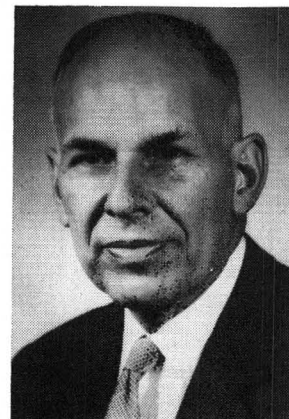


THE CHEMICAL ENGINEER IN MANAGEMENT

A. L. CONN

*American Oil Company, Whiting, Indiana
President, American Institute of Chemical
Engineers*



PRECISELY, what do we mean by management? A definition that appeals to me is "Management is the process and agency which directs and guides the operations of an organization in the realizing of established aims." Thus, when we refer to management, we are not only talking about a process or operation, but also about an agency, or group of people.

I hardly need to define a chemical engineer for you — but it is interesting that one of Webster's definitions for the verb "engineer" is "to manage," so you can see there may be a certain amount of redundancy in my title; at least in one sense, engineering implies a certain amount of management. In fact, some of my friends who are chemists define the chemical engineer as the man who is sent in to manage the chemists.

AS YOU ARE no doubt aware, the literature is full of the need for more management personnel, for it is claimed that there will soon be an acute shortage of properly trained men, due to the low birth rate in the early 30's. At the same time, the rapid expansion of our technology, bringing with it greater complexity, will increase the need for engineers in management.

In our company, there has always been a large number of technically trained people in management. And believe me, they sometimes do get into the gory details of the operation! The Chairman of the Board and the President of our parent company, Standard Oil of Indiana, are chemical engineers. In addition, two of the three presidents of the other major subsidiaries are technically trained, including a physical chemist and a geologist. And the number of technically trained people in vice presidential and general manager positions is so large that it would have taken me quite awhile to assemble the statistics.

You might think that our company has an unusually large number of technically trained people in top management; however, according to one article, "At least 80% of the top management in the petroleum and chemical companies

Arthur L. Conn is 1970 President of the American Institute of Chemical Engineers. Since 1967 he has been Director of Government Contracts for American Oil Company, Whiting, Indiana. He previously served the AIChE as Vice President in 1969 and as Director from 1966 to 1968. He has also served as Program Committee Chairman and Vice Chairman, as Technical Program Chairman for the Chicago Meeting, and as member of the Awards and Nominating Committees. At American Oil (and at Standard Oil Company of Indiana) he has held positions as Senior Consulting Engineer, Research Coordinator, Director of Process Development, Superintendent of Technical Service and various others. His major accomplishments in process development include fluid catalytic cracking and ultraforming processes and the large scale separation of boron isotopes for the Manhattan Project. He is the author of a number of publications and patents on these subjects.

in the USA received a technical or engineering education as their starting point." And, at the present time, the greatest demand for professional people in these industries is for chemical engineers. The reason for this is that your training includes an ideal combination of the theoretical and practical aspects of chemical processing, together with proper recognition of the importance of economics. Thus, it is clear that people such as yourselves, with technical training in chemical engineering, have excellent opportunities ahead of you. Before discussing these opportunities and how to make the most of them, however, I would imagine that you may have some questions that should be explored first.

At one time or another, each of you must have asked yourself one or more of the following questions: "In order to have a satisfying career and make a contribution to society, should I

Should I point toward management or let others worry about the business and community aspects? . . . At least 80 per cent of the top management in the petroleum and petrochemical industries received a technical or engineering education.

point toward management or should I stay in technical work and let others worry about the business and community aspects of the enterprise?" "How can I decide which area I am best fitted for?" "If I know that I will ultimately get into management, should I get a degree in Business Administration?" "If I don't feel I have enough knowledge to make a choice, what should I do?"

Perhaps I can be of some assistance to you in answering these questions by giving some observations from my own experience. Whether or not one should point toward management or stay in technical work obviously depends on his interests and abilities. If you were a big man on campus — enjoyed managing the swim team or leading the group in the test on the distillation column or found yourself suggesting new goals for your fraternity and ended up as president, the chances are that you have management talent. On the other hand, if you were fascinated by the amount of knowledge you could acquire at college in addition to your regular courses, liked to burn the midnight oil, and enjoyed working out original problems for their own sake, perhaps you should point toward technical work. But these clues should not be taken too seriously. You may have talents along both lines and have had time to concentrate only on one. In any event, it isn't really necessary to make a decision now, so if you feel you don't have enough knowledge to make a choice, don't worry. Almost every large company will start an engineer in a technical position where he will have a chance to learn the business, and sooner or later you will encounter situations that will give you a chance to decide whether or not you have the interest and inclination to manage, or in a rapidly growing company, you may find yourself managing even before you have decided whether or not you want to do so. Conversely, in a well-established, highly technically oriented company, you may find more demand for technical specialization.

As far as I am concerned, either management or technical work can provide an interesting challenge and an opportunity for a real contribution. Many companies have recognized this and have established a dual ladder of promotion — one along administrative lines and the other

along scientific and engineering lines; however, we must recognize that the administrative ladder can lead to the presidency, whereas the top of the technical ladder is usually a staff position, such as senior consulting engineer, scientific adviser or the like. Nevertheless, the differences between management and technical work are not so great or clearcut as may seem at first, and a man may readily change from one to the other. An engineer in management cannot afford to get too far behind in his knowledge of the technical aspects of the work or he will soon find himself making decisions about things that he does not fully understand. Sooner or later, this can trip him up badly. On the other hand, the engineer in technical work, particularly in a senior capacity, may find that his greater technical knowledge puts him in the position of a de facto manager because he knows best what should be done and his suggestions will be followed. In some cases, this may actually call for greater skill in human relations to be able to "call the shots" and still not undermine the authority of the man who is really in charge.

IF YOU HAVE ALREADY made up your mind that you would like to point toward management, I should caution you that just as there are wide variations in abilities and interests among yourselves as students, so there are wide variations in the character of industrial organizations, in the complexity of their operation and in the type of management they require. You may find it a lot easier to make a contribution and earn rapid promotions in the tumbled-down XYZ company than in the prosperous ABC company. Also, just as your interests and abilities will change with the years, so do the needs and the outlook of industrial organizations change. So when you try to pinpoint what you want to be doing ten to twenty years from now, your situation is like that of a man shooting at a moving target with a rifle having a sight needing constant readjustment.

Perhaps that makes it sound a little tougher than it really is. But let's consider first the differences in character of industrial organizations. Let's compare a company that makes cosmetics, toiletries, and related items such as Avon Products, Gillette, or Helene Curtis, with the ABC

company. I won't say which is the ABC company, but I am sure you can guess! The cosmetics company makes a wide variety of products but few of them require complex technical operations. What is more important, the volume of material handled is relatively small and the markup on each item is so large that there is relatively little incentive to try to optimize the engineering steps employed in each operation. Contrast this with an oil company like American, which obtains crude from about 16,000 different wells, sends various crude mixtures to 9 different refineries, and distributes products from these refineries through pipelines, water transportation, and trucks to over 31,000 retail outlets. The volume of material handled is extremely large and the profit per unit volume relatively small, so that there is a tremendous incentive to optimize the entire operation as well as each and every part. Incidentally, ten cents per gallon is the cost of gasoline leaving the refinery; the additional 20-25¢ is almost half taxes, the rest including transportation and dealer service costs.

In the case of the cosmetics company, learning how to manage the business takes relatively little technical knowledge, whereas for the oil company it may take a number of years to become sufficiently familiar with the technical operations to be able to handle a management job. A man working toward management of the first company might do well to take a Master's Degree in Business Administration as soon as he has finished his chemical engineering degree, for he may soon move out of technical work into other

Should one ever refuse a promotion?

If you don't get adverse criticism, does this mean you are doing your job well?

parts of the organization. In the case of the oil company, he might do better to gain a broader technical background, say a Master's or Doctor's degree in chemical engineering, so that he will be in a better position to understand and handle the complexities of the operation. In this case, he might best wait to work for his Master's degree in Business Administration after he had been in the industry for a number of years. This would have several advantages; at that time he would have worked with the company long enough to be sure that he prefers a management job and has the necessary attributes. He would learn the most up-to-date management theories and practice and believe me, they do change! —

and he would have an opportunity to put the theory to direct use. Furthermore, if his superiors have noticed his management talents, he might well be sent by the company to an advanced management school. So you see, the type of industry you plan to enter can have an important effect on how you prepare for it.

Let us now suppose that you have started to work for a company. How can you develop your aptitudes to make the most of your opportunities? Some of you undoubtedly have read some of the large volume of articles and textbooks that have appeared on management. Rather than summarize what you can find there, I would like to mention a few of the commonly accepted "truths" or "cliches" that hold in many situations but can sometimes lead you astray. In doing so, I will take the position of the devil's advocate, and give you some of my observations which show that you can't always go by the book. These are based on situations I have observed in my own company as well as in a number of other companies with which I have had business and professional contacts. I am sure that they apply equally well in government agencies and colleges, for after all, what I am really talking about is working with people — and this is much the same regardless of the specific situation. And believe me, there are many times that the reality can be quite different from the ideal situations that one either hears or reads about.

You have all been advised at one time or another that "If you make sure that you do your present job well, the future will take care of itself." There is a lot of truth in this statement;

by far the most important step you can take toward future advancement is to make sure that you do the job at hand. But is this enough? Certainly, your immediate superior, who is most familiar with your work, is supposed to see that you are properly rewarded. But you can't always count on its working out this way. Supposing for one reason or another he is unable to promote his promising men. He may be working on too small a budget, or he may not get along well with the head of the department, or the department head may have the same problems with his superior, or the company itself may not be doing well. Look at your job as part of a much broader picture. Try to evaluate your boss's

situation as well as your own; try to evaluate the future of the department and the entire company in which you are located. I have sometimes been flabbergasted by the audacity of some young men who have very quickly decided that a particular company was not moving rapidly enough for them, and make a change to improve their opportunities. Some of these men have ultimately landed in top jobs. So, if you are sure you are in a blind alley, do something about it. You may find it necessary to change divisions, departments, or even companies in order to assure yourself of the best possible future. But don't arrive at a conclusion too hastily. On more than one occasion, I have seen a man leave a department or a company and take what appeared to be a much better job, only to find it go sour, while the situation he left suddenly became much brighter — for the man who succeeded him.

You may find it a lot easier to make a contribution to the tumbled-down XYZ company than to the prosperous ABC company.

WHAT SHOULD YOU DO if offered a promotion? I am sure that many would say "Never refuse a promotion — it may be your only chance." Yet I know personally of a number of situations in which promising young men refused promotions that would have taken them away from the work that they liked best, and yet did not suffer. In one case, the man later received numerous promotions in his area of interest, and is now a vice president of a large chemical company. Another man was also very successful and is manager of an important department. So don't feel you have to jump at the first opportunity if it is not in an area to your liking. Study the situation and find out the long-range opportunities in your chosen area, and remember — you will do the best job in the work you enjoy most.

How many times have we heard "Don't be a griper — people will only be annoyed." This may apply to little things, but in cases where the good of the company is involved, the opposite is often true. A man who is sufficiently interested to take the trouble to call to the management's attention a situation that is hurting the company will almost always get a hearing. If the complaint is well considered and is accompanied by constructive suggestions on how to improve the situation, the man will most likely be better off for having

aired his views. And you all know how it is in voluntary organizations — the man who does the griping often gets added responsibility. This can just as often be true in a work situation.

How many times have you heard someone say "As long as they don't give me adverse criticism, I know what I am doing my job well." This may often be true — but I have seen situations where a supervisor sees so many things wrong with what a man is doing that he doesn't know where to begin or how to give him constructive comments. So he says nothing. Other supervisors have become so imbued with the idea of "getting along" with their men, that they haven't developed the ability to give adverse criticism or they may give it to you coated with so much sugar that you don't understand that anything was really wrong. I once had a boss like that — and believe me it was much worse working for him and finding out my mistakes indirectly than working for the type who was difficult to satisfy but told me straight from the shoulder what I had done wrong. So be sure that from time to time you take a good, hard look at your own work; don't assume that lack of criticism necessarily means that your performance is good.

"If you are doing a good job, it isn't necessary to point out your accomplishments to your boss — he has been through the mill and understands the problems you have had to handle." This is something we often tell ourselves — and it has appeal for several reasons. Most engineers are modest individuals and would prefer not to boast about their accomplishments. And — let's face it — most people who go into engineering are not born salesmen. So we usually assume that the boss will know about our accomplishments without our telling him. After all, if we don't tell him, he will hear it from someone else; certainly it is the boss' job to know what is going on in his shop. But, stop for a moment and try to put yourselves in the boss' position. He is being pushed by his superiors for results. He may have been promoted from another area and may not fully understand enough of the details of your job to realize what you have accomplished. In any event, one of the most common errors that I have seen is for an engineer to assume that the boss knows and understands everything that is going on. Frequently, this is not the case. So unless you use one means or another to make sure that he knows the problems you have faced and how you have solved them,

he may not realize how good a job you have done. Diligence is not enough. You have to sell yourself.

THE BOOKS ON MANAGEMENT all say that "authority should be delegated commensurate with responsibility." This is often claimed to be a self-evident truth — after all how can one take full responsibility for the success of a project if he isn't given the authority to carry out all aspects of the job? Everyone agrees to this as a matter of principle — yet I have rarely seen it carried out in practice. Managers are often loath to delegate authority — for many reasons. They may be setting a precedent in one area that they may not want to apply in parallel situations elsewhere; or they may not have full confidence that the man will handle this authority properly. In any event, you will often find yourself in a position where you have to get something done and can't really tell anyone else that he *has* to do this or that for you.

Well, it isn't really as bad as it sounds. If you plan a logical program, discuss it with knowledgeable people and enlist their aid, you will be surprised how, in most cases, they will go along with you and help you get the job done. And so, more often than not, many of us find ourselves doing things for which we have no authority other than the knowledge that this is the best way it can be done and the persuasiveness to get it done that way. So, don't be afraid to move on a project even if you don't have all the authority you feel you need.

If you are given a promotion to replace a man who is going to be working somewhere else, your first reaction will undoubtedly be to discuss the job with your predecessor and find out just how he handled it so that you will cause the least disruption when you take over. This can well be worthwhile, but it should not be a substitute for making your own evaluation of the situation. You may have some knowledge or talent to bring to the job that the other man did not have. You may analyze the situation and conclude that the job can be carried out much better using a different approach. Your boss may not have been completely satisfied with your predecessor and for one reason or another, may not have told you. So don't make the mistake of falling into the same rut; it may be that you were chosen for the job because you were expected to change the situation.

Everyone knows that authority should be commensurate with responsibility . . . but this is rarely carried out in practice . . . the griper often gets added responsibility.

LET US ASSUME you have now made the first step and are now in a supervisory or "management" position. It won't be long before you are wondering how to advance yourself further. Even if you are 100% satisfied, your wife will be wanting a larger house, the kids will be getting close to college age, or something will be impelling you to greater achievement, so you will read books and magazines on management to find out how to get ahead faster. You will undoubtedly find statements such as "concentrate on understanding, judging and dealing with people — this is the most important requirement of an executive." No doubt this is an important requirement. Any person in management soon realizes that everything he accomplishes has to be done through people. Furthermore, it is particularly important for engineers, who are used to dealing with inanimate objects, to acquire the ability to work well with people. But is this the *most* important requirement of a manager? I don't think so.

I have seen managers who did not give too much thought to their people — who did not really try to understand them, and who were not too good at judging them, but who through boldness, initiative and good judgment were able to reach the top. *They got results.* And I have seen men who spent so much of their time concerning themselves about their people — that they did not give enough attention to the economic factors such as promoting a new process, cutting costs, or changing systems for doing business. I don't mean to say that learning to work well with people is not important. It *is*. Nevertheless, your primary responsibility is rarely people oriented. The major function of a corporation is to make a profit and you are expected to get a certain job done at minimum cost or to meet a specific time schedule or the like. And you will not get the next promotion if you are the perfect boss, as far as your men are concerned, but don't help meet the primary objectives as well as someone else.

Another concept that has been promoted strongly by "experts" in management is "make sure that you develop a successor." One management consultant pointed out at a recent meet-

ing that "you can do your present job so well that you become indispensable and can't be promoted." Therefore, he concludes "you should first train a subordinate to do your present job so that you will have someone to take over when the right opportunity presents itself to you." Another expert writing in the Harvard Business Review says "It should be made very clear to the bosses that they will be rated on their success in developing successors." There is no doubt that learning to delegate is an important asset, and that training the men under you can greatly ease your own load and enable the group to get more done. Nevertheless, in some cases, this puts the cart before the horse. In order to win a promotion, you have to demonstrate to your superiors that you can handle a more responsible job. Whether or not you get promoted may be totally unrelated to whether or not you have trained a successor. Your superior may already have someone else in mind as your replacement. In any event, I would suggest that you consider the advice given me many years ago by the vice president for research and development of one of our competitors — "Learn your job well; learn all the aspects of your boss's job; then and *only* then train your successor."

WHAT DOES THIS all add up to? In summary I would say that you don't have to decide now whether or not you should work toward a management position; furthermore, there is much satisfaction to be gained from a predominantly technical career. But if you are sure you are interested in management, and want to work in a large company, it may still be best to take an advanced technical degree rather than one in business administration. Once in industry, or even in government or education, and you decide to head for management, a chemical engineer should recognize that he will be entering an entirely new area loaded with intangibles where his training and background in logical thinking can sometimes lead him astray. There are no completely accepted theories of management that can be studied and learned like a course in distillation or heat transfer. But don't get me wrong. I certainly believe it is wise to learn all you can about good management practices and to apply them in your job wherever possible. At the same time, however, observe carefully how your organization operates, see how these practices are being applied, and above all, make your own evaluations. Remember, that

dealing with people is not always subject to logical analysis; even in engineering decisions the "people" or "political" aspects may prove to be more important than the technical phases. Nevertheless as I mentioned earlier, getting the job done is the most important thing. There are many successful managers who don't follow all the rules, but have the boldness, initiative, and drive to get results.

PROCESS CONTROL: L. B. Koppel

L. B. Koppel (Continued from page 171)

minute process (see reference 1, page 456). When the slower sampling rate was introduced, the value of α was left unchanged; apparently $\alpha = 0.3$ was a blanket recommendation of the computer vendor. But, with the new sampling rate and this value of smoothing constant, the equivalent filter time constant became 8 minutes, much too large for the 10 minute process. In effect, an additional process lag had been unintentionally introduced into the loop, inevitably degrading the performance, and apparently discrediting the use of slower sampling rates. When the value of α was changed to 0.9 to maintain approximately a 1 minute filter time constant, closed loop performance became practically equivalent to that in the original loop with faster sampling, as expected.

Upon reflection, I concluded that I had previously been far too defensive in my attitudes toward teaching graduate-level process control. Very practical technological contributions should result from such teaching. Care must be taken to ensure reasonably complete treatment of theoretical as well as practical ramifications since one could not always predict the sorts of difficulties to be encountered in application. Thus, at a minimum, digital filter theory must be included in a course which discusses sampling frequencies. More importantly, it became clear that recent advances in control theory would not be widely applied to processes until there were more practicing engineers adequately trained in the theory. Some of the theoretical misunderstandings and evasive recommendations which currently exist are illustrated by the discussion on sampling rates in a recent industrial textbook.¹⁵ Typical is the following: "For best results with easy processes, the sampling interval should be as short as practicable."

The subject of sampling rates is clearly not the only potentially practical contribution of con-