
Observations & Opinions

The Practicality Gap*¹

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The topic, "The Interface Between Management Science and Managers," sounds as if it should make a certain amount of sense, and yet sometimes I worry. If I referred to "The Interface Between Physics and the Motorist," "The Interface Between Aeronautical Science and the Airline Pilot," or "The Interface Between Nuclear Science and the Reactor Owner," you would say, "Well, it seems to me that there is such a gap in these cases, that we almost need a whole new profession to fill it." Well, that's the point of my letter.

However, there is a problem in the communication between management scientists and managers as these groups are presently constituted. (In my definition, management scientists include all who give themselves this name.) The evidence for this lack of communication exists on both sides. First of all, if we look at managers' descriptions of management science applications in their firms, we find quite a difference between the way we would describe the job and the way they do. It seems as if in the past ten years, management science has not done much to discard the "efficiency expert" image that has always plagued the field. On the other hand, management scientists have contributed to the lack of communication because of their frequent ignorance of the actual problems of management. It is rare in a gathering of management scientists that I hear them speak with intimate knowledge of what actual managers do or what actually bothers the manager, or why it is that the top managers get paid so much more than the top management scientists. Managers are often put off by what are to them ridiculous assumptions made in our journals. It is interesting to bring a copy of *Management Science* to a manager and have him comment upon it. I recommend it to you if you think you are being very relevant to the problems of management.

The reasons for this lack of communication are many, and again they lie on both sides. One of the main ones is that managers do not usually have what we would call a formal approach to management. They are generally ignorant of the

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philosophy of mathematics, of the idea that there are formal logical procedures for carrying out operations that are important to them.

I am reminded of a story that a friend told about the time that he dated a plumber's daughter. The plumber was sitting at home one night when my friend came to pick up his daughter, and the plumber decided to give him a little intelligence test to see if he was worthy of his daughter's company. The plumber asked, "Suppose you have to figure out how long to cut a pipe to make it fit across a diagonal of a square room, how long would you make it?" My friend started out with the square root of the sum of the squares and so forth, but the plumber interrupted and said, "Forget all that. You just make it 41% larger than the sides." Then he added, "This will work every time."

Well, the plumber was right, of course. He had developed a rule of thumb that always fitted the applications that he faced. My friend had a much more general way of looking at the same problem—one that would give him exactly the same result in the same situation, but would also extend to more general situations. But the beauty of this more general approach was entirely lost on the man who has solved the problem by his 41% rule.

There are specific areas, many of them, in which this lack of formal knowledge on the part of managers affects us. One of the major ones is their limited ability to treat uncertainty by using probability. Murray Geisler has commented on the inability of our race to handle probability problems with ease, and I agree with him. I sometimes think of the radioactivity analogy: just as there are phenomena in the world that our bodies cannot sense, there may be calculations that our minds cannot readily perform.

We might spend some time worrying about how managers got this way or how management education became so cut off from formal procedures. Some have suggested that the case method is responsible, that it focuses people on trying to learn by example rather than from a basic logical structure. Regardless of why the deficiency exists, there are important implications of the lack of formal approach. One is that management generally has difficulty in seeing the possibilities of change that result from our formal procedures. The difficulty can lie in one of two areas: managers can take either a too-old-fashioned point of view of what can be accomplished with logic plus computers, or a much too blue-sky approach in view of what is feasible at this stage of technology. Managers have the same difficulty in understanding the nature of a difficult management science problem that a layman would have in trying to understand why color television is relatively easy for the electrical engineer, but a typewriter that translates from voice to the printed word is difficult. Some of the problems that seem most difficult to the layman are, in fact, rather easy, and *vice versa*.

One reason for the gap, therefore, lies on the management side, but the other, of course, lies on the side of the management scientist. The failing here is that management scientists so often emphasize particular models in applications rather than the general idea of rationality or formal logic in their approach to problems. The resulting confusion of managers is often the confusion of the general with the specific, as when they describe our field as the field of linear

programming and management science. One reason for the confusion that is always striking to me is the fact that management scientists have traditionally been concerned with what we would describe as middle-management problems, the repetitive problems of inventory, congestion, scheduling, and so forth. The view of these problems from the executive suite is quite different from the view that we have. They see these as problems that they can hire somebody to solve and problems that do not affect in a serious way whether the business will continue to exist at a very profitable level. We, in a sense, have been carrying our efforts to the wrong people or to people, let us say, who represent only the beginning in terms of solving the problems of management. So, to get around this difficulty, I think we are going to have to raise our sights to look at the problems that top management faces and to develop not techniques or tools but methods of thought, ideas, and concepts that are appropriate to this level of problem.

The seeds of solution do exist; there is a pressure for solution that will be generated in many ways. First of all, the growth of computers has created the ability to process large amounts of data using a formal logic. In fact, it is rather amazing to talk to people in the operating world about the growth of computers. Very great strides have taken place that are perhaps not so well noticed when you look day to day at this process. Another pressure for the growth of the field that I am going to be describing is organizational growth—most organizations in our society seem to be growing rapidly. This growth causes a decline in the one-man show, the situation where one person can make decisions unilaterally. The manager now needs to convince committees and boards of directors. Procedures in documentation that could be bypassed previously must now be made much more explicit.

In spite of all this pressure, we need a strategic solution to the problems. Short courses and professional meetings are stop-gap measures; they can oil the squeaky wheel. Like putting cork in a noisy differential, they stop the symptom but not the problem.

We need, rather, a basic change in the way our society looks at the application of science to management. It seems to me that the necessary step in developing this solution is the creation of a new language for the description of problems, one that is realistic enough to describe the actual problems of management in management terms and yet precise enough to form the basis of formal models. I think that this new language, this precursor to modeling if you like, is already on the horizon. I think it should be formally developed and both taught and used in schools and in practice. The formal language would eliminate such phrases as "uncertainty in the likelihood of the probable result," which doesn't make sense to me and really shouldn't make sense to the manager if he has his concepts straight. I think that the source of this new language will be the field of decision theory. Although much has to be done to extend the language of decision theory to make it the language I am talking about, I can already see the birth of the new language in that field. (For expansion on this point, see "Decision Analysis: Applied Decision Theory," in *Proceedings of the Fourth International Conference on Operational Research*, Boston, 1966.)

Those are the seeds of solution, but what is the real solution? As I indicated initially, I think the real solution is the creation of a new profession. The difficulty is that we have no profession like engineering to carry out the steps of implementation or, as a matter of fact, to conceive of these steps and to take professional satisfaction from implementing them. Here I am touching on the topics of the TIMS Symposium on Implementation held in Monterey three years ago. In spite of the concern that we expressed about implementation, I don't see much change in our practice or education or even concepts over the last few years. The difficulty that we face here is evidenced by a recent quotation from a manager who said, "I must choose between a mathematician who pays lip service to my problems and a man with a traditional business training who has been given a quick coat of mathematical techniques." How accurate the remark was you can judge for yourself.

As I mentioned originally, the aeronautical engineer is needed to bridge the gap between the aeronautical scientist and the aircraft pilot, and a similar engineer in the nuclear area, but we don't really have such a liaison in the area of management science. The essential difference here is, to me, one of professional responsibility. Who in management science really worries about whether the decision is appropriate? Who is the decision-maker in the process of implementation? The physicist is motivated by curiosity, and I would say that curiosity should be the primary motivation of the management scientist. But the engineer in our profession should be motivated by making appropriate decisions in resource allocation by actually taking responsibility for the outcomes that he achieves. For him the statement, "The operation was a success, but the patient died," is not a meaningful one.

We might consider what we should call this new engineer—the management engineer, or the engineer-businessman—I don't think we have a good term for him. Maybe even a "managineer," if you want to be flippant about it. It is not uncommon to encounter the feeling that an engineer does low-level work, and yet this is the old business about how, when they launch a successful rocket at Cape Canaveral, we have a "scientific triumph" but a disappointment is an "engineering failure."

The role of an engineer in our society seems to command various amounts of prestige as time goes on. Yet, I think that the informed public realizes that there is a vital function performed by those who not only concentrate on a particular area of science but who also worry primarily about how to adapt that science to the needs of man. That's the kind of engineer I am talking about now—not a guy who runs out with our ten latest techniques and decides to bend the problems to fit them, but rather one who is fundamentally trained in management science as it exists at the time of his training, keeps up to date in his field, and yet has as his primary professional focus the application of this knowledge to man's problems.

To train this man, I think we will need something quite different from the present engineering school or business school. The boundaries of these schools must become fuzzy and ultimately vanish. I don't really see the need in the

long run in our society for both a school of engineering and a school of business. I think there should be one school to train both professions and that it should be broad enough to encompass the ideas of business and deep enough to encompass those of engineering. I would expect that one of the aspects of the training of this management engineer would be a period of internship or practice in the field to correspond to the laboratory training that the traditional engineer receives now in the areas of electrical science or chemical science. (See "Engineering-Economic Systems: A New Profession," by W. K. Linvill, *IEEE Spectrum*, April 1966.) We, unfortunately, cannot simulate very well the management environment in the laboratory, and so it seems likely that the intern will have to go out and observe it for himself.

Initially, I would expect these management engineers to form a new professional group within organizations as a period of transition. This group could be much like the German general staff, a group at the highest staff level of an organization with the respect of line people and, as a matter of fact, in true equality with them. The group would be detached from the day-to-day problems of operation. It would devote itself to some of the longer-run problems, such as what should the value function be, what changes should we expect, what long-run alternatives should we try to develop.

However, the creation of this new profession will not be really a success until at some point the management-engineer becomes the manager of the future and the need for a letter such as this one vanishes.

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