

Chapter 1

OPENING REMARKS

Dean Robert K. Weatherall, assistant dean of the Graduate School and director of Placement at M.I.T., after a few general remarks, introduced Dr. Jerome B. Wiesner, president-elect of M.I.T. Dr. Wiesner, recalling his responsibilities as the Science Advisor to President Kennedy, reviewed some of the decisions that had been made in Washington to commit the country to the space program. He also touched briefly on the questions of science and technology in our society.

Robert K. Weatherall: We are at what seems to be, and perhaps is, a turning point in the history of science and engineering in this country. In 1969 we reached the moon, after a tremendous decade of effort, and the nation is wondering where to go next, if anywhere. We have cut back on our defense spending after a longer period, perhaps a quarter of a century, of intense activity, and the nation is unsure what kind of investment in defense is called for, whether indeed there should not be more cutbacks. There is questioning by the scientists themselves. I was struck by Dr. Bentley Glass, president of the American Association for the Advancement of Science, talking in Chicago in December about the status of genetics, quoting colleagues in his field, asking whether the subject of Molecular Genetics has reached some kind of an end point. Scientists are not sure where their disciplines are headed.

In the nation at large there is a strong feeling that perhaps technology has gone as far as it should go, that society is spoiled by technology, that the environment is hurt by technology. In recent months we voted down the SST, a particularly striking illustration of that national feeling at work.

Compounding the situation is the state of the economy. We are caught in an inflationary recession, and the universities, which are a major employer of scientists and engineers, are having to cut back on their hiring of new people. The financial outlook in the universities is bleak. Industry too has been hurt by the economy, and commercial firms as well as defense companies have been letting people go.

Many scientists and engineers who have lost their jobs or who are in danger of losing their jobs are wondering whether they can continue in the career for which they were trained. Should they make a change, and if they change to some other part of science or engineering, what change should they make? What other sector of the science economy is in better shape than the one they are in? This is really the focus of this seminar. In planning the seminar we have addressed ourselves not to the immediate predicament of the man who has lost his job, who wants to know how to find another one, but more to the longer-range implications for scientists and engineers of the cutbacks in so many areas. What does the present situation really amount to, where is the economy headed in the next 5 years or so, what are the prospects in the

different branches of science and engineering? These are the questions with which we are concerned.

It may be that the present distress in the science economy will turn out to be only a perturbation. I have had occasion to read recently an account of measures taken in the thirties to help science through the depression. The scientific agencies of the federal government suffered serious cutbacks, and our own President Compton was appointed chairman of a committee to see what could be done to rally support for science in Washington and to seek out new ways of supporting science. The ring of the situation is strikingly familiar to us today. In retrospect, the situation that President Compton and his committee were worried about looks like a little wobble on the curve, not such a serious thing as they felt it to be. It would be nice if we could feel that our present situation is a similar wobble on the upward curve of the science. We can hope to learn something about this during these next 2 days.

Jerome B. Wiesner: I have the courage to stand up here and talk on this subject because my favorite philosopher is Thurber and my favorite line from him is that "It is better to know some of the questions than all of the answers." There is no problem that I have spent time with in my professional career that has more uncertainty to it than projections and predictions about manpower needs in the field of science and technology. I remember a Saturday afternoon in April 1961, a decade ago, I sat for an

afternoon with President Kennedy while we studied all the memos and charts provided us by people from the Labor Department, National Science Foundation, Bureau of Labor Statistics, National Academy of Sciences, and other agencies that kept statistics on scientific manpower problems and tried to decide whether if we were to launch into the lunar program there would be manpower enough to do the job. We came to a very interesting conclusion that we never told anyone about. We observed from our analysis that because of the stabilization of the cold war, which had begun under President Eisenhower, and the consequent leveling off of the defense budget, which we expected to continue during the decade in which we hoped we would have some influence on the world affairs, in 3 or 4 years there would be indeed a manpower surplus, given the rate at which schools were turning people out and the rate industry was then absorbing them. This was rather a startling conclusion to us, but it was clearly indicated in the material that the people had supplied to us. As a matter of fact, those conclusions motivated some other things that we did in the years immediately ahead which relate directly to the questions you are talking about here today. We concluded that, as a matter of fact, a technical program of a magnitude we were contemplating was almost necessary to take up the manpower surplus, or we would be facing a very different kind of problem. On the other hand, I think some of the problems we face today stem from the decision we made later that spring to go ahead with an accelerated space program.

Some of the problems we are facing stem from the fact that there has been a more rapid increase in salaries for workers in these science-oriented categories than there had been in the society at large.

I am basically optimistic about this problem on the longer pull, but that does not help the people who are caught in the present bind very much nor does it help institutions like ours that have to live through these difficult periods. But there have been other difficult times in the postwar period. I remember the 1958-1959 recession in science and engineering which was due entirely to a cut-back in federal spending. That occasion was dictated largely by fiscal constraints because President Eisenhower was not anxious to increase the debt ceiling, and therefore he imposed budgetary controls largely to stay below the debt ceiling.

My view is that the proportion of highly skilled people who will be needed to continue the growth and development of our economy will go on increasing on the average. This reminds me of the time when Michael Michelas, who was working with me on the White House staff, came in and said he just made the remarkable conclusion, having looked at some numbers, that by 1984 the President was going to have to be a scientist! And I asked him how he arrived at that conclusion, and he showed me a graph he had drawn with two curves on it; one was the GNP and the other was the cost of research and development in the country. The GNP was doubling at about half the rate of the cost of R&D and these two crossed in 1984. I finally got him to admit

that he fudged the numbers a little bit to get them to cross; if he had not, it might have been 1985 or 1986 or even 1987. So it was perfectly obvious that things were going to change in our business, and that I was probably the last science advisor who was going to be able to live in an uninhibited budget environment, in the sense that we could run a free-flowing R&D establishment, that is, that the natural development of things as people did research, got new ideas, wanted new equipment, and saw new opportunities, trained young people in this society could be supported. This had been true for quite a while in the Defense Department; it was true at that stage in the NIH (National Institutes of Health) budgets, whose budgets were growing very rapidly; it was not quite so true in the NSF (National Science Foundation) budget. But the fact of the matter was that the federal R&D expenditures were then going up at 15 percent a year. I doubt that the best year of the GNP growth ever approximated that in this country. As a matter of fact, we began to wonder how we might put some brakes on the R&D growth, how we might learn how to be more selective, and how we might think about directing some of the activities into more productive uses.

In the decisions that President Kennedy eventually made about the space program, he was very conscious of the fact that this was not a wholly productive use of resources. His decision was obviously a political one. He came to the conclusion that the nation could not afford to run second to the Soviet Union in space. We had created a

psychological situation that was terribly costly to the United States that had to be reversed. But about once a week he would say to me, "Can't you think of something that we can do with that money here on earth that would be more productive and still have the same impact on the international scene in demonstrating that in fact we are not a second-rate nation compared to the Soviet Union in science and engineering?" And we looked at a great many things, but we ultimately became convinced that the fact of the matter was that the space activities and, particularly, the large boosters and the satellites and so on were so closely linked with the defense activities in people's minds that there was nothing else that we could do with the comparable expenditures that could possibly offset the political liability that the space program created for us. We, I think, very reluctantly came to the conclusion that that was what we had to do.

The President had three choices as he saw it: one was to quit the space race completely, another was to accept the sort of second position that Eisenhower had, trying to tell the world that it did not matter very much, and the third was to make an all-out effort. Kennedy would, I think, have been willing to quit had he seen an effective way to do it, but he was not constitutionally prepared to remain in a defensive second position; so ultimately, he made the only decision he could. But the impact of those discussions, which went on for several months, did convince us that there were some deeper problems in the society and that we should try to find ways

of directing some technical resources to more productive domestic uses. It is interesting to note that at that time we began to worry about two things which are still very important. One was planning for conversion; to make plans that would enable us to steer some R&D activities into more immediate domestic problems of cities, education, and so on. We did try to begin some activities in these fields, and we began many studies about them, but their limited usefulness is demonstrated by the present situation. We doubtless developed some understanding but we obviously did not acquire plans that have been useful to the nation. The second worry arose because we recognized a trend that looked serious then, and looks more serious now: namely, a great many of our more mature industries were not using technology or R&D to advance their product quality, their efficiency, and/or their opportunities to the degree that we thought was possible or desirable. For example, in the shipbuilding industry it was very clear that a major use could be made of automatic control. But we never got anywhere promoting this idea. Interestingly enough we were thwarted in these activities by a combination of industry and union resistance. Neither the unions nor the industries were very anxious to see this kind of innovation promoted, and they lobbied very hard against it in the Congress, and by and large our efforts to develop R&D activities in these fields were not very successful. In 1962 and 1963 Herbert Holloman and I tried to stimulate civilian R&D activities through the Department of Commerce. Herb has gone back

to some of our numbers and tried to make some estimates of whether if had we been able to stimulate the greater employment of technology that we tried to do would the manpower problems that we have today still exist in those fields. It is obviously very dangerous to draw many conclusions, but the numbers are interesting. If one compares the use of technologists, scientists, and engineers in the American civilian industry with that of Europe or Japan, for example, we find about a 30 percent lower manpower per dollar output in this country as compared to those countries. It is also in terms of salaries that the normal trend in this country for those categories of people is about 30 percent higher. One could ask the question, how many people would be employed in those industries if that 30 percent had gone into hiring people instead of raising salaries? We have estimated that the number might amount to as many as 100,000, which interestingly enough is near the estimated figure of the unemployment that exists today. None of this, of course, gives you any indication of how to correct the situation, and I hope that maybe this conference will have some ideas.

From the point of view of the Institute, a conference of this kind is not wholly altruistic. We are desperately in need of some judgments about the future to guide our own evolution. We are experiencing reduction in federal support for graduate students; many fellowships have been eliminated. The argument is that the federal support, federal encouragement for graduate student education, stemmed from the fact that the government recognized that

it was a big consumer of technical manpower and was causing shortages in these fields and therefore had a responsibility to add to the numbers. Now that there is no shortage and the government has quit being a consumer, it should correct the situation and stop encouraging production, at least its support of production of scientists and engineers, so that fellowship programs are being cut. Coincidentally, and I think even more seriously, the Woodrow Wilson Fellowships in the social sciences, which were supported by the Ford Foundation, have been cut. This has created an even more drastic problem in the social sciences. Every institution like ours is now faced with the choice of either finding additional support for graduate students or seeing the numbers decrease. If one believed that there was going to be a long-term decrease in the demand, in the needs of society, or the opportunities for people, it obviously would be wise, nationwide, to cut down the production. If, on the other hand, this is just a fluctuation, then both from the point of view of the health of our institution and opportunities for youngsters coming along, we ought to try to find the resources for students who are not now being supported by the previous sponsors. At the moment we are trying to find new ways of supporting students. We are not convinced that there is a major and permanent new trend in society, de-emphasizing technology, so we are stretching our resources and stopping other things we might be doing in order to find ways to support graduate students both in the sciences and in the social sciences.

Also from our point of view, even if there is going to be a decrease in the total demands for scientists and engineers in the country, we have to make a judgment about whether it is wise for us to join in a 10 or 20 or 30 percent reduction in the graduate output or whether institutions like ours should try to maintain their output in view of the fact that we do believe in our superior quality. The total graduate student output of the Institute is a substantial fraction of the total output of the country, so we do have an important decision to make here.

The questions of science and technology in our society are obviously very deep ones. And as the SST vote shows, the nation is wrestling with the question of whether or not it should allow the unabated and uncontrolled development of all new technology. Many of us who have been watching intently the evolution of our society have felt that this was a process that had to be stopped, that we have to develop meaningful ways of making judgments and allocations. But the fact of the matter is that we do not yet have processes which are really very sensible for doing this. It is clear to me that the continued healthy evolution of our country, of the world, to a more decent society does require the continued assistance of people with technical skills. But it is also clear that, unless we learn how to control both what we do and the consequences of some of the things we do, we shall have both great advances and great difficulties. And one of the problems that I hope we shall address ourselves at M.I.T. in the years ahead is how to make this bridge between the

social problems and the technological opportunities, how to create a responsible society that still allows us to be a relatively diverse pluralistic society, with many opportunities for experimentation and entrepreneurship. I think that the kind of discussions that will go on here may give us some guidance in this.

Mr. Secor D. Browne, chairman of the Civil Aeronautics Board, discussed some of the interactions of Washington politics with the employment market for engineers. He did not see a bright future.

Secor D. Browne: I would like to make my remarks brief and turn the floor over to you for such discussion as you may wish to have. I have thought about this meeting more than any that I have been to in recent months. It is quite easy for me to talk in my field, which is civil aviation, and the appurtenances to it, such as airports, air traffic control, supersonic transport, routes, rights, but what you are considering today has troubled me greatly and is vital to the system and our country. The implications of the problems for those of us who are engineers or scientists or people in the technical spectrum of our country are tremendous.

I have a few thoughts that I hope will be helpful to you. I was here last week for a luncheon attended by Senator Brooke and other political figures. It was a small luncheon. The heads of some of our more important industries were here, and it was not exactly a very cheery luncheon.

One of the things that disturbed me was the question of geography. The business editor of the *Boston Globe* said that Massachusetts has lost over 100,000 jobs in the last couple of years, and whereas he agreed that things would come back they might not come back to Massachusetts. There are a variety of reasons for that. At least for the time being, the day for the large government bundle will be over. There will not be a big enough package any more to put in any one place to get any political lift out of it.

Massachusetts's appeal as a place to put a center in for any political gain or any conspicuous achievement has lost a lot of interest or a lot of plausibility. So Massachusetts may not be favored in any distribution of large lumps. If the work is going out in small lumps, it is pretty hard to control any flow to any one particular area. I should like to point out that I have nothing to do with the Department of Transportation or Defense or anybody else that gives out money in large lumps. I suggest that large lumps of money may not of themselves come to Massachusetts in the future. Whereas the economy of the nation as a whole will in my judgment recover, it may not all come back here. Also the economic climate for a manufacturer is not the greatest. Taxwise, Massachusetts is very discouraging to a manufacturer. Such things as strike benefits, they are fine if you pass them here, but they could well drive people away from the state. All these things enter into the whole problem of what I call "geography."

I think the job future of the engineer and the scientist is a problem of the individual. There is some talk in the government, whether it be from the administration or individual senators, of retraining. I think again we have to ask, retraining for what? It is all very well to talk about pollution and training to fight pollution, but that is sort of an "un-thing." You can train people to design mufflers for cars, you can train them to design quieter engines, you can train them to learn the chemistry of cleaning up atmosphere, or water or whatever, but you do not train them to fight sin.

There is considerable gloom forecast for the future of engineering and science. I am not sure that is right. A senior officer of a very large engineering company based here in Boston tells me they were having a hard time finding engineers. The kind of engineers they are having a hard time finding are people who can design sewer systems, steam systems, power distribution networks, and other less glamorous or perhaps less inspired fields of technology. Again I think it comes back to us as individuals to see what we will do next. I think we need to take the widest possible view of our own future, to regard the problem as an individual one, to understand that whatever education we had was only the beginning.

When we talk about continuing education, that is something very close to my interests. I do not normally admit it, but I have professional engineering licenses in two states and belong to all the proper marching and chowder societies. I have only one academic degree, and that

is in the History and Literature of England in the seventeenth century. I am talking about me only because I think it might be helpful to you. I graduated in 1938, and there were not many job opportunities, and I went to work as a draftsman. Fortunately, I got interested in air conditioning and instrumentation and went on in the general field of electronics and instruments and nuts and bolts, and eventually airplanes. What I knew in that area had to be beaten into my rather thick skull by very dedicated people, dedicated to keep the job I was working on from being a bloody collapse. The same way with the languages, they were important. They were important to the job I was trying to do; I was always fascinated by international business negotiation. The languages are, by the way, French, Italian, Russian, and Japanese. The latter two are not easy. I started learning Japanese in 1963. I have a pattern. I do not want to bore you with it but it cost about \$1400 in cash out of pocket and God knows how many hours, and how many Japanese foreign students here being taken off to McLean for rest and relaxation. My point is simply that you are the individual who must look after you. If you are going to be reconverted or redirected, you are going to have to do it, and you probably can.

Question: You are the expert on the SST, and we've all read the newspapers about Senator Proxmire's opposition. Would you care to comment on the possibility that he will stop any government support of the V-STOL?

Secor D. Browne: Why Senator Proxmire went after the supersonic transport I suspect does not have a great deal to do with the supersonic transport itself but is an extension of his concern with the so-called military-industrial complex. I think his concern has now extended to government design of anything, for, if you wish, this fear that industry will get something for nothing out of the government. So I suspect he will go after any V-STOL program on the same basis. In my judgment, he overlooks some pretty important things. As many of us in the room know, the engine always comes first. Once you have the engine, you wrap an airplane around it. The whole chain of engine and then airframe development has always rested on government R&D, on government funding. In recent years this kind of development effort has been lacking. I'm not talking about aerospace or anything else but commercial transport airplanes. They no longer rest on a base of military R&D. Therefore if there is or was to be an SST, there was a need for the government or for the community as a whole to put up the R&D muscle to make it possible. That's all that was behind the SST. I suspect that, similarly, if there is to be a successful STOL vehicle, or V-STOL, it's going to involve the community as a whole providing some sort of research funding. I'm not aware of any expensive government effort in the short-haul aircraft field.

Question: Would you care to comment on as to why Senator

Proxmire waited until practically all the money had been spent before he marshaled his forces for this?

Secor D. Browne: Well, in fairness to Senator Proxmire, he started a long time ago, and it wasn't Senator Proxmire that killed the SST; it was the current *mal du siècle*, a kind of general disenchantment with technology, with the whole society. I think Senator Proxmire and others have merely moved on a wave that is, I think, the chief disease of our time. Actually Senator Proxmire started a long time ago and nobody listened. Until, all of a sudden this whole wave moved along, as though we all ought to go back to the caves, we ought to be clean and sit in our bear-skins, scratching because they shut all the soap factories. I'm not against the environment; I just want to live in it.

Question: Who in the country, now, if we're going to throw bricks at Senator Proxmire, and I have no wits for it, but to whom do we send a bouquet? To whom do we look to for leadership?

Secor D. Browne: Well, if I understand what you're saying, is, who's going to lead the scientist or the engineer out of the wilderness in which he finds himself as a result of the technological climate we've been in? The era of the very large project, be it military or space, has probably disappeared, at least for the time being. Pollution,

which is offered by some politicians as an almost balancing size project area, in my judgment isn't. Fighting pollution means dividing the problem into the constituent parts and dealing with them as each of us is able to the best of our ability and our profession. I happen to be, although temporarily distracted, very interested in aircraft noise, and very much interested in, among other things, the emanations from jet engines, which are unsightly even if, in my judgment, not harmful in the extent that they are put into our atmosphere. We each have our small area that we work. Now, I doubt that the government is going to be able to marshal all these talents into one specific project called Pollution, which is like going to the moon.