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MANAGEMENT AND UTILIZATION OF MANPOWER IN THE ECONOMY

Dr. John A. Hutcheson

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Reviewed by: Col Ingmire Date: 5 February 1963

INDUSTRIAL COLLEGE OF THE ARMED FORCES

WASHINGTON, D. C.

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MANAGEMENT AND UTILIZATION OF MANPOWER IN THE ECONOMY

5 November 1962

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5 November 1962

GENERAL STOUGHTON: Gentlemen:

We have seen the changes which have occured in the composition of our Nation's labor force over the last 25 years, and particularly in the post-World-War-II area we have seen the rapid growth of the technical manpower segment of the labor force. This has certainly created management problems in the utilization of manpower in our Nation's industry.

Our speaker this morning has faced many of these problems and has lived through them, shall we say? in responsible positions in one of our Nation's principal industries.

It is a privilege to introduce Dr. John A. Hutcheson, the Vice President of Westinghouse Electric Corporation.

Dr. Hutcheson.

DR. HUTCHESON: General Stoughton, Gentlemen:

I was remarking to Captain Hyde a few minutes ago that, in view of the fact that I set down at the airport just 23 minutes ago, I feel something like I did some few years back when I was to make an appearance on television, a national sort of hookup, and we had rehearsed from something like 5:00 P.M. until 7:25. The show was due to start at 7:30. I had been scheduled up to 7:25 to go on the air at 7:45. So I thought, "I've got 20 minutes. I've got a break, so I'll see if I can't roust up a cup of coffee." I hadn't had anything to eat in that interval. So I went down a couple flights of stairs, and I had just started to raise the coffee to

my mouth when there was a scream from up above, "Where's Hutcheson?" In that intervening few minutes they decided I would go on at 7:30 instead at 7:45. So I whipped back up the stairs and dropped in a chair breathlessly. A red light on the camera came on and I started to read what was written on the teleprompter. You know what happened: The thing stuck. I had a 90-second bit to show. So any relationship between what I said and what had been on that teleprompter was purely accidental. I hope my teleprompter doesn't stick this morning because I am equally breathless at the moment.

I would like to talk with you a bit today and I hope, incidentally, that you will take the opportunity to ask questions later so that we can really do a bit of chatting about it. To start off I would like to talk a bit about the subject of the Management and Utilization of Manpower in the Economy, with emphasis on the management and utilization of technical manpower.

I think this is one of the very important problems facing this Nation today, perhaps more so today than at any point in the past. In the first place let me give you a couple of facts. If you take a look at our total labor pool of all kinds, you find that there about 70 million people in it, and if you take a look at the engineering content of that labor pool, at least as it was about 2-1/2 years ago, you find slightly over a million engineers--1 million 96 thousand, to be specific.

Now I'd like to make a few assumptions. The first assumption that I will make is that it is going to be the policy of this country to maintain, or to, preferably, improve our present standard of living. The second assumption is that the demand for goods of all kinds, military and nonmilitary, will continue to increase

at a greater rate than the supply of people to make them increase. Nothing much can be done in any short interval about improving the supply of people in the overall. The third assumption I am going to make is that technology is increasing at a greater rate than ever before. To illustrate this point let me tell you this, something you may or may not know: Of all the scientists who ever lived in this world 90 percent are living today. When you think of that for a moment you realize, therefore, that at this time the contribution of the scientists in the form of technology must be increasing at a substantially greater rate than at any point in the past. Finally, let's assume that competition, whether it be commercial or military, has as much brains as we do, and has available to it all of the technology and in fact is using it.

On these assumptions, then, we can draw one logical conclusion, and that is that we must so manage and utilize our people as to permit us to maintain our standard of living and at the same time to meet the threat of competition.

Now there are some implications of that conclusion. It is clear, for example, that we must find ways to increase the productivity of people of all kinds. Where necessary and, perhaps I should say, where possible we must increase the number of people having specialized kinds of training.

To increase productivity, and thinking now of the gross labor force, the technique that is being used in this country today, and, as far as I know, the only technique that really works, is that of providing the individual laborer with more tools. This is another way of saying, "Increase automation." Automation, incidentally, is a word which is used these days to describe a situation which,

as far as I can tell, has been in existence not just in the last few years but has been inexistence for perhaps 100 years or more. Let me illustrate the significance of automation in this way:

On this lectern there are a couple light bulbs and there are some in exit signs and some overhead. The light bulb is a very common article of commerce. You pay, I suppose, somewhere between 25 and 30 cents for a 100-watt light bulb. Did you ever think of making one yourself by hand? Starting with the raw materials--as is done by us--if you set about to make a light bulb, you would have a little pile of wolframite, tungsten ore, some sand, a little copper, zinc, and a few other bits and pieces. Let's not worry for the moment about how we produce the vacuum in this thing once you've got it made. If you were smart and worked hard and diligently, and had all the techniques available to you, I think, after some practice and training, you might be able to make by hand about one a month. This seems to be a reasonable guess. It would be hard to do that at the start but, if you made one a month, and if that was the way that the Westinghouse Company made the light bulbs that it makes today, it would turn out that it would take the entire labor force of the Nation just to make light bulbs, and just to make the light bulbs that we make, which are less than a quarter of all those made in just the United States.

Consequently, you can see that there must be something in the way of automation that has been in existence for some time in that particular field. This is true to a greater or lesser extent in all the fields in which we work. So we have to provide more automation if we are going to increase the output of our labor force.

The kind of tool, the kind of automation, that we have to provide is becoming more and more sophisticated all the time. For example, in a steel mill these days you can find a mill operating in which one man, sitting up in a little control tower, can operate all the necessary devices whereby a billet of steel, which comes from a soaking pit, is passed through rolls, beaten down in size, stretched out in shape, until at the end steel sheet is coming out at the rate of about 6000 feet a minute. It takes one man to do this. As a matter of fact, all he does is sit and monitor the thing to make sure everything is working all right. The thinking, the corrections in screws done on the rolls, the change in speed to avoid tearing the strip or having it all pile up in wrinkles--all these kinds of things, all of this kind of thinking--are carried out for him by a computer. This illustrates the kind of sophisticated control, sophisticated tool, that we have to supply these days in the form of automation.

Now there are some implications about that. You see, while this little man sits upstairs and has at his command the various devices necessary to actually control this operation--incidentally, if any of you has ever been in a steel mill in which the steel broke between rolls and nothing was done about it for perhaps a minute, you know you would find yourself in one hell of a snarl of steel coming out at some 6000 feet a minute--in order to be able to operate this thing this particular operator has to have considerably more skill than the average working man. Consequently, one of the implications of automation, and automa- through the provision of a sophisticated kind of tool, is that we are going to have to somehow upgrade the skill of our labor force.

There are some difficulties involved with this--management-type problems that arise through the operations of labor unions, for example, that arise because of the necessity for relocation of people, that arise because of the necessity for training these people. These are certain of the management problems that relate to the overall labor force and must be solved if we are going to get on with the job of producing goods at a rate greater than the labor force is expanding.

Let me talk for a bit about the engineering and scientist aspect of this particular problem. The National Science Foundation has a report called The Long-Range Demand for Scientific and Technical Personnel. I wouldn't be surprised but that each one of you has a copy of it. I want to take from it only a few figures in this particular area. This report states that in 1959, as I told you, there were 1 million 96 thousand engineers and scientists of all kinds engaged in all manners of occupation, all the way from agriculture to building bridges to making electron tubes, or what have you. The survey in this report indicates that by the year 1969, in that decade, there will be required 2 million 32 thousand engineers and scientists. In other words, about 6-1/2 years from now we have to have something over 2 million engineers.

This means that, if you just take the average, there are 85,000 new engineers and scientists that have to be added per year in the interval between 1959 and 1970. This ignores, of course, the number of engineers, like myself, who are not going to be in business as of 1970, for one reason or another. The management may catch up with me on the one hand, this airplane might not have made it, or maybe I'll just get tired and quit. But, in any event, in that same interval

of time, replacements in the existing engineering staffs will have to be made at the rate of an additional 21,000 per year. This totals then 106,000 engineers and scientists that have to be added per year at this particular time and on to 1970 if we are going to meet the foreseen demands for these kinds of people.

I could say, too, that this report indicates that of this total of 106,000 81,000 are engineers and 25,000 are scientists.

Now, not all of the people who are called engineers have engineering degrees, have gone through college and have qualified with the piece of sheepskin that says, "You now are an engineer." The study has gone in depth into this point sufficiently to find out that of the 81,000 per annum that need to be added only 72,000 would be those who had gone through an accredited college course and graduated with an engineering degree.

So let's say we are looking for on the average 72,000 engineers per year at this present time. In 1960 there were 45,753 engineers graduated from all the colleges and universities in the United States. The edcators, based upon their knowledge of enrollments and on their knowledge of the attrition to the enrollments, with the passage of the 4-or 5-year course, predict that under the existing circumstances the best they are going to be able to do is turn out 58,000 per year. This is a deficit of 21 percent, a deficit of 14,000 per year, that has to be made up in some fashion or other. That takes care of the engineering situation for the moment.

With respect to the scientists, however--you will remember there were 25,000 of these per annum required--and ignoring a few factors that are not too

important--at least we don't think today they are too important--it would seem that the colleges and universities will turn out in the interval the necessary number of scientists. There is actually anticipated a small deficit, but in the order of just a few percent. So we can say that we will have the necessary number of scientific personnel, but we are going to be away short on the number of engineering personnel as foreseen by industry at the present time.

What can we do about this? There a n umber of things we can do about this, and this gets really down to the subject that I was asked to talk about, the Management and Utilization of Manpower in the Economy, with particular emphasis on the management and utilization of engineering or scientific manpower.

We have to find ways of improving the utilization of engineers that we have. I imagine many of you here are as familiar as I with the many ways in which we waste the talents of the engineers we have on board today. In our own company I have undertaken in the past, in the not too far distant past, some studies on this particular subject, by going directly to the engineers and finding out how they put in their time. Now, the answers vary depending upon the particular locations that one find these engineers in and the kind of work that they are doing. But in general I think it is safe to say that an engineer in our company, and I believe and certainly hope that we are no worse than anybody else in this particular regard, will be devoting less than half of his time to doing the kind of work for which he has been particularly trained, that is, to doing the engineering kind of work. Thus it would seem possible to improve the situation materially, and indeed it is possible to do this. Interestingly enough, the same techniques that one uses to

improve the productivity of the ordinary labor can be used to improve the productivity of the ordinary engineer--to provide him with tools, for example--a form of automation, if you will.

One of the kinds of tools that are popular today, as a matter of fact--and if you are going to keep up with the Joneses you just have to have them--is the computer. A computer is a gismo which adds and subtracts fast, as you know. It's virtue is that it does this quickly. Consequently, you can imagine that if you program this computer intelligently it can do in much less time than an engineer can many engineering calculations. Indeed, this is so. There is a hooker in this, however, in our experience, and it goes like this: It seems that the engineers who use computers--in the first place, what they do is calculate the value of pi out to 400 or 500 decimal places--this is a good piece of experience, I guess--when they get down to trying to use the thing you find, [illegible] have been sort of frustrated in the past and, realizing that, for instance, to design a particular motor, let's say, a 1-horsepower motor, they have always had to use certain rules of thumb in order to short-cut the calculations even with a slide rule, down to the point at which they can crank out a design in a reasonably short period of time, and, now, instead of taking the computer and programing it to do just the sort of thing the engineer did long-hand and with a slide rule, they instead program it to make it possible for them to look over the whole field of motor design and provide really an optimum design for a motor, based on the kinds of materials that are available to them today. They get right back to fundamentals and design the motor in that way rather than just taking the rules

of thumb that have been established by practice in the last 75 years or so and programing those into the computer.

So, whereas you might say that the computer would save a great deal of time in engineering design work, instead, up to this point the computer, in our experience, has taken about as long to do the job--but it has done a better job, which is all to the good. But I did want to make the point that just the provision of a computer in an engineering department doesn't necessarily mean that the design work comes out more quickly and hence the engineering productivity has gone up. It has gone up, but in quality rather than in quantity.

Engineers use a lot of systems in their work--drafting, for example, is one of the systems that are necessary in an engineering department. There is much work that has been done and much work that is being done today in the automation of drafting systems. All this is to the good, and this does really turn out information in a shorter time than has previously been possible.

Another way in which one can make use of engineers and better utilize them, those that we have, is through the addition to the engineering department of an appropriate number of technicians. Here again there is an interesting little problem. You might think that, if you added a technician—and for the moment I am going to define him and I am degrading him in doing so--and I'll define him as the guy who has an intelligent pair of hands to work under the direction of the engineer--or 4 or 5 technicians to a particular engineer that this would result in a substantial increase--maybe not by as much as 4 or 5 times but certainly a substantial increase--in the output of this combination. Well, we have

run some experiments in this area, too. One of the results that intrigue me is this: It depends upon the particular engineer who gets the technicians. We have them, you know, one at a time, just to see what happens. In some cases the output does indeed go up as you add technicians to the service of an engineer. But in other cases the output actually falls down. In fact, in more cases the output is actually lower.

When you take a look at this you find that just adding technicians doesn't do the trick, because the poor old engineer hasn't learned how to manage them. It turns out that the problems that this presents are greater than the technical problems, so, while he worries about them for a while, he goes ahead and does his technical work all by himself. The technicians sort of get frustrated hanging around doing nothing much. Unless we can provide the engineer with some training in the management of people, the chances are very good that his output will actually go down instead of improving.

Another way that we can do something about the foreseen lack of engineering talent is to improve the supply of engineers and to increase it. Actually, at the present time, all indications are that the supply is decreasing rather than increasing. At best it seems to be static just now. The reasons for this are being studied right now and I don't have any pat answer for this one, but I do feel certain that there must be ways of encouraging young men to seek engineering careers. We have to find these ways and apply them to the end that more of our young people registering in colleges these days seek to be engineers than presently do.

The last item that I'd like to mention in this business of the improved utilization

of engineers is to become quite a bit more concerned with "what makes Johnny run," with the motivation of engineers. I'll tell you a little story that illustrates what I have in mind. A few years ago I initiated a crash program to get a particular kind of device. As a matter of fact it was a thermoelectric refrigerator. This involved the efforts of roughly 100 people of all categories, including secretaries as well as engineers and technicians. They had the job of starting from zero, with the idea that we were going to do this, to create this device and to make it work as well as we could make it work, and to accomplish this in 8 weeks. This was to be a fancy-looking 10-cubic-foot refrigerator. So we did it.

In this process we had to make some 2500 or so thermocouples, which were made, as I remember, out of mixtures of bismuth and tellurium. Now, one has to be careful about the ratio of bismuth and tellurium in a thermocouple if one is going to get the maximum of efficiency. Consequently, there was a tedious task of carefully weighing the bismuth and carefully weighing the tellurium per thermocouple, mixing them, and thereby making it possible to get the device with maximum efficiency.

The chap who was doing this was a colored boy, a technician, and his sole job in life for 8 hours a day was weighing bismuth and tellurium. This is a fairly dull prospect for most people who would be concerned, but, somehow or other this fellow had been fired up by the necessity of doing this job. So that, instead of working 8 hours a day, it turned out he was putting in about 17. He was only getting paid for 8, and nobody asked him to work the overtime, but he just really thought

that this job had to be done, as indeed it did.

But that wasn't the real payoff from my point of view. One day he showed up in the morning as usual, and he looked up his supervisor and said, "Can I have the afternoon off? You see, a while ago I arranged with a gal to get married this afternoon." He was about half-way through this whole job at the time. What do you do? Of course, you have to say, "By all means go and get married. God be with you. Have lots of fun. We'll look around for somebody to do your weighing job for you." So we wrote him off. He left at noon, and at about 7:00 o'clock that night he was back weighing. As it turned out, he told his little bride after they were married, "Honey, you-all go home and stay with your ma now. I'll be through with this job in about a week, and then we'll go on our honeymoon." Now, that guy was really motivated.

This illustrates the point that, if we can find those ways in which to motivate not only engineering people but all the people that work--and while I wouldn't recommend carrying it to that particular extreme--I do feel there is a great deal that can be done to improve the utilization of the engineers that we have through this area of motivation.

So you see, what I have tried to point out here is that there are a number of management problems, all of which can be dealt with, but all of which require, in my opinion, the attention of very intelligent management-type people. Herein I think we have a problem. At the risk of alienating some friends, I would like to describe the problem by quoting from an article which appeared in the July issue of The Atlantic Monthly. It was written by Ernest Dale. I have never had

the privilege of meeting Mr. Dale, but it says in the introduction to this article that he is a Management Consultant to companies in the United States and abroad, and has been associated for the past 8 years with the Graduate School of Business and Public Administration at Cornell University. He was for many years an economist for the American Management Association, and is the author of lots of books.

Mr. Dale--Professor Dale, perhaps I should call him--in this particular article raises the question of executives who can't manage. That's the title of his article. He asks the following kind of questions and then sort of answers them. He says:

"What are the peculiar skills of management as opposed to such technical skills as engineering or accountancy? There are various definitions, but theory here seems closely analogous to that of the educators who believe that a teacher who has learned to teach can teach successfully with minimal knowledge of the subject to be taught. Thus the management skills are often listed as planning, organizing, staffing, directing, and controlling, and in the textbooks on management used in colleges and in other material widely read by managers it is frequently contended that these skills, once acquired, can be applied successfully no matter what is to be planned, organized, staffed, directed, or controlled. The manager who possesses them is supposed to function equally well as a production manager or a sales manager, as president of a steel company, or a department store, or as the head of an army or a political party, for that matter.

"In many of the colleges, young men destined for business now solemnly

study principles of management which treat all of these activities in the abstract. They learn, for example, that in planning they must (a) get all the facts, (b) consider the alternatives, (c) make a choice among the alternatives, or they memorize such definitions as 'coordination is the orderly synchronization of efforts to provide the proper amount, timing, and direction of execution resulting in harmonious and unified actions to a stated objective.' There is little emphasis on learning how the facts may be acquired and/or applied. The true manager is a generalist and can easily hire specialists to get the facts for him. How he can separate the experts from the charlatans without any knowledge of the subject matter is not disclosed."

Then he goes on to take a look at what has happened in U. S. industry, non-military, and winds up with a fairly dim view of what has been taking place in the last 10 years.

I recommend this to your reading. I shall recite only a couple of the things that he has discovered. He says that in Germany, England, and Japan we find that, whereas these countries averaged in the last 10 years about 5.5 percent increase in their gross national product per annum, and Russia averaged about 7 percent per annum in the last 10 years, the U. S. in turn averaged about 3.2 percent.

Now, of course, one has to take these facts--I presume they are facts--with some grains of salt. I will tell you that Professor Dale takes a look at these grains of salt and concludes that this not necessarily quite as bad as the figures sound. But he does go on to say that the overall record is certainly not going to

be judged by the manager's ostensible standards of efficiency. Then he says, "It is not contended, of course, that a manager should not make use of experts. In fact, in modern large-scale business it is impossible to operate without them. But the manager who believes he can direct them wisely when he knows nothing about the subject matter is likely to be employing more than his company can support and too many whose expertise is actually skill in devising new boondoggles to make themselves appear essential. For example, one company had no less than forty people working full-time on organization charts and manuals. Their full employment was terminated only after the total employment and profits had dropped substantially for several years."

He says, "Nor is it contended that a manager's work does not require planning, organizing, and the other management skills, but these skills cannot exist in a vacuum, and successful exercise of them depends largely on a knowledge of what is being planned and organized. The older managers were often the founders of their companies, and they tended to have an immense grasp of the details as well as the broader questions."

You are getting the point, I am sure, that he is making, and that is that a manager to be successful in this business not only has to have the techniques of management but also has to know quite a bit about the subject matter related to his particular management job.

I think with this particular point I would like to summarize by saying that there are indeed many management problems that relate to the improvement of the utilization of laborers of all kinds, that these problems are particularly acute

in the engineering area, that solutions to these problems are reasonably evident, that there are more to be discovered, it is true, but that we could do a great deal with the solutions that we have in hand, and that what we need is managers who understand the problems and who know how to manage, in order to achieve the solution to these problems.

With the solution of the problems there will be no long-term difficulty in meeting competition, be it political, military, or commercial.

Thank you very much.

CAPTAIN HYDE: First question?

QUESTION: Dr. Hutcheson, in our previous courses we have had pointed out to us how about 60 percent of our engineers now are in defense industries, and in few industries producing civilian products. What I want to ask you is whether in your company this has been a serious problem to you in your purely civilian operations.

DR. HUTCHESON: I am not sure I understand your question.

STUDENT: The availability of engineers that you need for your civilian products.

DR. HUTCHESON: You mean we have a tough time getting engineers for nonmilitary sorts of things.

STUDENT: Yes, sir.

DR. HUTCHESON: No, we have not.

QUESTION: Doctor, I have seen that Vance Packard has written a book recently called The Waste-Makers in which he deplores the great amount of obsolescence

that is being cranked into some merchandise being offered to the public. Does Westinghouse have a program to increase the quality of their product as well as the productivity?

DR. HUTCHESON: Very definitely. Let me just add that I haven't read Mr. Packard's article or story, but I have heard a bit about it. I am inclined to agree with what I understand he said. It is in no small measure because of an understanding of this that we have undertaken in the last couple of years to put a real emphasis in our organization on the quality of hardware we are cranking out. We have done some lousy jobs, but we are dedicated to not doing them again.

QUESTION: Dr. Hutcheson, will you comment on the use of operations research as a tool of management in improving the utilization of engineers?

DR. HUTCHESON: Operations research can be, and of course is, a very worth-while tool for management, in the sense that it provides management with some of the alternatives from which to choose, some pluses and minuses associated with each one. If, however, it is a tool, the judgment still has to be applied by the manager, based upon his experience and understanding of the overall situation. It does not give the answers, I believe.

QUESTION: All papers are filled with enticements from personnel people trying to get engineers to come to their companies. It is fairly apparent that there is a lot of job-jumping going on. Is there any attempt among the large companies to try to organize this throat-cutting?

DR. HUTCHESON: You mean to promote it?

STUDENT: To try to organize so that there is not so much job-jumping going on among the engineers.

DR. HUTCHESON: I am not aware of any organized effort to keep this sort of thing from happening. I would be at a bit of loss to know how to go about it myself. Our feel for the problem goes like this: There appears to be about 10 percent of the total population of engineers that enjoy hopping from job to job. Naturally we will on occasion employ these people, frequently to our regret but not always.

To get back to the answer to your question, I do not know of any specific attempt on the part of any company, and certainly not our own, to do anything about this particular problem. We wouldn't know how to go about doing this. We might set up a company, you know, in competition with the flesh brokers, and handle it that way. We haven't thought of that yet.

QUESTION: Does industry have any program to stimulate young people in the high-school age into engineering?

DR. HUTCHESON: We certainly do. We have several, as a matter of fact. The one that appeals to me most is this one: I don't know how many high schools there are in Allegheny and Westmoreland Counties, which are the two counties that contain the major population that centers about Pittsburgh, but we have a scheme whereby we provide lectures to certain youngsters in these high schools. With about three exceptions, no high school can have more than two people attend. The exception provides for four. By definition those who attend are seniors. They have to stand No. 1 and No. 2 in their class in science, without particular

regard to what the science is. These kids have to make their own way out to the laboratories where we hold this particular series of lectures. There are 13 of them during the course of the school year. The lectures are held on Saturday mornings, which means that the kids have to give up at least Saturday morning and sometimes a good part of Saturday afternoon. As I say, they have to find their way there and their way back.

The only enticement we offer them outside of the lecture is a couple cookies and a glass of milk. This has been going on now for six years. There are some rather stringent rules about this. If a student misses one assignment, that is, one Saturday, he can come back, but if he misses two he is dropped. We have never dropped a single one. The total number that come are about 250, and these are the cream of the local crop, so to speak.

This particular program, I am happy to be able to tell you, has not only found favor in the eyes of the students—obviously, or they wouldn't give up Saturday and stick it out as they do--but also apparently has been recognized by many of the colleges and universities as being something worth while, because the students tell us that, when they can put down in their applications that they have attended the so-called Westinghouse Science Honors Institute, this is a plus mark in their favor and gives them a better chance of enrolling in the college of their choice.

This, however, is just one of the things we are attempting to do. This is all aimed at increasing interest in science and in engineering in our particular area.

QUESTION: Dr. Hutcheson, many engineering graduates enter non-engineering fields immediately or shortly after graduation. I have two questions. First, do you have any data on what this ratio is, whether it is increasing or decreasing, and what the underlying reasons are? Second, in your opinion is this loss of trained engineers to other professions harmful or nonharmful?

DR. HUTCHESON: I don't have any data, to answer the first part of your question. I'm sorry I just can't say. While I would regret it, because I am a fellow who is looking for good engineers, at the same time a good engineer can help a lot of the other professions, too, you know. So it is not a complete loss.

QUESTION: It seems to me that it takes quite a bit of motivation to get an engineering degree, and the educational institutions are giving students this motivation. Why can't industry motivate the engineer after they get him?

DR. HUTCHESON: I think industry can, but I think industry to too great an extent has not. It is not a question of lack of ability. It is lack of a realization of the necessity of doing it, so far as I have been able to determine. So we can. What I tried to get across is the idea that industry needs to recognize the necessity of doing it and then doing it. There isn't anything mysterious about that.

QUESTION: Dr. Hutcheson, the Society for the Progress of Engineering Education 20 years ago was worried about the fact that too many engineers didn't gravitate to higher levels of management. They felt perhaps there was something lacking in the education that was given engineers. The trend even then was broadening the liberal arts base for engineering education. Has this trend continued? There is the contention that the business schools have filled the vacuum

rather than the engineering schools.

DR. HUTCHESON: I suspect that to a considerable extent this has been the case. I think it's a bit unfortunate. At the same time, the better engineering schools, and I think actually most of them now, have moved in the direction promoted by SPEE and are giving a broader-base training to their engineering people. This training certainly is of value to those who later assume the management type of responsibilities.

QUESTION: Do you think that technological progress may be moving at a more rapid pace than the economy can absorb? I am thinking specifically of the rather high unemployment rate even in a time of prosperity.

DR. HUTCHESON: No, I don't think that technological progress is moving at a rate greater than the economy can absorb. I think if we recognize the rate at which it is moving and take the steps to use it we can. But again I think it requires an understanding on the part of management of what it takes to do this, and again the desirability of doing it. It is not that it can't be done. It's that we have to get about the chore of utilizing the greater storehouse of technology that we have.

QUESTION: Dr. Hutcheson, I would like to explore a little further this matter of the engineers leaving the profession, with the added emphasis of recognizing the fact that these are the types who normally are capable of supervising and managing others, or they wouldn't have the initiative to to out into another area. Are we looking into that end of it?

DR. HUTCHESON: I am sorry that I can't help you in this particular area,

I really wasn't aware of any major problem as a result of what you say. So I am not equipped to answer.

QUESTION: You mentioned the need, as pointed out by Dr. Dale, for giving management some substantive knowledge in addition to theoretical knowledge. It seems to me that in the past we also were handed a counter problem in that when we were giving technical knowledge to management sometimes they learned it at the bottom and by the time they had gotten to the top it had become somewhat obsolete, when it was closed in a hierarchy of direction and control. One of your competitors, I believe, follows a dictum which says that the functions of management are planning, organizing, integrating, and measuring. They simply eliminate directon and control. Do you believe this is adequate ?

DR. HUTCHESON: No, sir, I don't think that's adequate. I think management to manage must have control. We certainly are not following along the lines that you suggested.

QUESTION: To what extent, sir, do you believe the shortage of engineers is due to an overstatement of engineering requirements, in the sense that many engineers in many companies, I dare say including your own, are in jobs requiring little or no engineering talent, such as selling consumer products, and so on?

DR. HUTCHESON: This is the point I tried to make, that is, that we are not utilizing the engineering talent we have to the best of the ability that we have. Until that is done this situation will exist. I am a heretic. I believe that there is no demonstrated shortage of engineering talent yet. I can foresee the

possibility of this existing, but, if we just use the tools that we have and the intelligence that we have, I think we can do all right in the engineering area for some time to come.

QUESTION: Sir, what is the Westinghouse policy on the layoff versus retraining of technologically displaced workers? What does it cost you? And how many technologically unemployed did you lay off last year?

DR. HUTCHESON: Actually we employed more than we laid off last year. So I guess I don't have the answer to the last part of that question. Fortunately I don't know specifically. In our case technological employment is a continuing problem. By this you mean displacement of men by machines, of course. We attempt to minimize this to the maximum extent by training the people that we have in other kinds of jobs. We will actually transfer people from one plant to another in an effort to alleviate some of the problems, although this is a real toughie to handle. We have training programs for these people to train them for jobs not only in Westinghouse but elsewhere. In general we try to do the things we can do in an effort to minimize the impact of technological unemployment.

It has cost us a great deal. I can't cite the numbers of millions of dollars. I have heard this number given. It is several million dollars annually that we pay in training, relocation, and extended layoff benefits and that sort of thing.

QUESTION: Dr. Hutcheson, about 20 years ago some economist wit made the statement that the Navy was an organization devised by geniuses to be operated by idiots. This, however, has a lot of good points, particularly in view of

the fact that we have the present and the prospective shortage of skilled technical laborers. Is there anything that you know of that management is doing to upgrade our genius scientists which we now have to get them to downgrade and simplify some of the machines, automation, and so forth that are being produced nowadays?

DR. HUTCHESON: This is a subject with which I perhaps have more familiarity than you think. You see, I was one of the geniuses designing stuff for the Navy 20 years ago, and I learned about this the hard way. There is a very real problem here that you are touching on, because it is necessary in a time of crisis to have hardware which can be operated by people we used to call cherry-pickers. Anybody you can sweep in off the street, you know, has to be able to run one of these things.

We are aware of this particular problem and are doing those things which occur to us in an effort to minimize the problems that arise due to the ever-continuing complexity of the hardware we are called upon to develop. This is a really rough one. I am sure we don't have a complete solution to this problem today, but I think this is one in which the services and industry have to work together, to the end that we get the simplest kind of stuff that works every time rather than the more sophisticated kind of hardware that works only when some of the geniuses are at the control.

QUESTION: Sir, there has been an increasing trend to the use of value engineering, particularly to cut production cost in government work. Could you give us your views as to the merits of value engineering, the source of value engineers and, if they are from some other area than the engineering profession, the effect

of this process on the morale of practicing engineers?

DR. HUTCHESON: In the first place, I think there is a great deal to be said for this so-called value engineering. This is not the term we use. You are referring to one of our competitors, which is all right. They do a good job.

I do not think that value engineering, as I understand it, is practiced by a separate group of engineers. Value engineering as I understand it, and I believe in it, ought to be the job of every engineer in the place--not some outfit set aside over here to look over shoulders at work people are doing.

The way we are trying to go about it is to make sure every engineer we have understands his responsibility in this area. The responsibility that you referred to, that of cutting costs, I think is an important one, but we never say to our people, "It is your job to cut costs." We say to our people, "It is your job to cut costs only if the quality is maintained or improved."

QUESTION: The advance of technology has caused a burden between the specialist who needs to know more and more about his specialty and the generalist who has to put the specialties together to achieve a useful product. Can you tell me whether your company has devised different career patterns for these types of engineers?

DR. HUTCHESON: Yes, we have. One of the problems one always gets into in an engineering organization is what to do with the real, hot-shot engineer who, no matter what you do to him, will never become an administrator or a manager of any kind. We do have two paths down which an individual may

progress. They all go together, you know, for a while. They they come to the point at which the individual has to make a choice between the path on which he knows less and less about more and more until finally he knows nothing about everything, and the path on which he knows more and more about less and less until he knows everything about nothing. We trust that they stop somewhat short of the ultimate in each case.

In this case, however, we try to recognize that the purely technical contribution of an individual can be as important as the purely administrative contribution of a guy who may nominally be his boss. That this works may be illustrated by the following personal kind of story. At one point in time I had the distinction, I guess, of being the Director of Research for the Westinghouse Company, at which point in time I was not the highest paid guy in the research lab. Instead, the highest paid fellow was one whose sole contribution was technical. Eventually the situation was corrected, but not until I got kicked upstairs.

QUESTION: There has been some talk of extending the curricula in universities to 5 years. Now, do the current four-year graduates who are able to make a contribution require further training by industry?

DR. HUTCHESON: Well, this is where I will really alienate a lot of friends, I guess. Let me start off by confessing that I am getting old, crabby, and therefore think that the kids of today are a bunch of punks compared to what we were when we were young. Let me illustrate how bad I can feel about this by another little true story. We had a young fellow come into the operation one time who

was a graduate of an accredited engineering school, and a communications major. I got talking with this boy. He wanted a job in some electronic process we were doing. I was sort of struck with what appeared to be a fairly profound lack of understanding of anything that he studied. Finally, we put on the blackboard the symbol for a rectifier and the symbol for a transformer and the symbol for a resistor, and said, "Please hook these up so that you will have some DC running through the resistor." He couldn't do it.

This is a horrible example. Incidentally this kid was in the top ten of his class. This is a very bad example of what can be turned out by an accredited engineering school.

I don't want to leave you with the impression that they are all like that--far from it. But I do think there is some real merit to the idea of a longer engineering education these days than was adequate when I went to school. This was so long ago I'd hate to tell you.

Again, due to this tremendous advance in technology, it is just not possible for any individual, so far as I can determine, to be exposed to enough of the basic rules about the game that have been developed again since I went to school, to really be of maximum utility, and to acquire this training in a four-year period.

To answer your specific question about whether we find it necessary to train them, we do indeed give them additional training for this purpose.

QUESTION: Dr. Hutcheson, thinking in terms of the motivation of scientists, what agreements are made with them with regard to the ownership of their

inventions?

DR. HUTCHESON: In our company this is an easy one to answer. The man does not own his invention. He assigns the right to any inventions he makes to the company as a condition of employment.

QUESTION: In response to the question before last, you intimated that our educational system might not be all that it should be in view of today's technology. The solution appears to be to decrease the number of engineers by taking longer to educate them. How about the other end of the scale? Is education today meeting the requirement for the lesser than graduate engineer, the technician?

DR. HUTCHESON: It is beginning to. There are some very encouraging signs and some real progress in that direction. I think a great deal more needs to be done, but I think the educators have recognized the need for this and are doing what they can. They have a little problem, you know, because all of us in this room at some point in our careers were told that we could be President of the United States. Everybody who gets told this is inclined to look on it as a good idea, although I think that might be a mistake. Nevertheless, they are encouraged to think that they can become the boss. There are those who unfortunately just don't have what it takes to get to be the boss.

The educators' problem, as I see it, is to convince these people who, let's say, are on the lower IQ bracket, if that means anything, that they can nevertheless make a major contribution by taking a somewhat lower objective than that of being the boss. I think the problem is just as much getting the youngsters to accept

a technician kind of training as it is to provide it.

QUESTION: Dr. Hutcheson, is Westinghouse hiring any of the young so-called professional managers? If so, how do you use them?

DR. HUTCHESON: We are hiring a few of them, not in engineering. Instead we will take some likely looking candidates from among our engineers and subject them to training later. We do hire a few, relatively a very small number, actually. There is an organization, an entity, within the company, known as Business Management. I guess that is what they call themselves. Their function in life in general is to take a look at the non-technical side of an operation and to determine that one secretary can serve two fellows, instead of one for each, or something of the sort, and to make some suggestions along these lines. It isn't very profound in our shop at this point. Maybe it should be.

QUESTION: Sir, in your opinion is there any considerable waste of engineering and scientific talent on work which has perhaps been done successfully elsewhere?

DR. HUTCHESON: Let me divide that into two parts. I think the answer is yes, there is some waste. I think perhaps it is even significant. I am not sure it is because it hasn't been reported in the literature. There is so damn much literature that no one can possibly read it all. Consequently you will miss some worth-while references for that kind of reason. Again, work is going on, as I am sure you know, to grapple with this particular problem in the general area of information and so on. I think I should have mentioned that. Thanks for helping me with my pitch. One of the ways in which we could certainly improve the output

of an engineering organization is to make readily available to it the sources of information that are external to it, that are applicable in every way.

QUESTION: Sir, what is your evaluation of the technical and managerial skills of the military in areas of research and development and the major weapon systems?

DR. HUTCHESON: I'll be better equipped to answer that question in about 12 months. I was, I thought, at one point of time, about 25 years ago, fairly well equipped, but there has been a gap. In my opinion the various military departments are far more capable of administering the work they have to do than industry in general gives them credit for being. I will confess that in the days when I was working for a living instead of floating around like this, early in my checkered career, I had a very dim view of the competence of military people. This was until the time I had to work more closely with them, at which point in time I very rapidly changed my opinion. I thought then, as I do now, that I, for one, and I know many of my colleagues not only within my company but outside felt as I did but they also learned that the situation was by no means the way we had imagined it to be. When we got acquainted with you all we found a much higher competence than we had expected. I am sorry.

QUESTION: Do you find that labor unions have any effect on your furtherance or limitation of manpower, engineering and scientific?

DR. HUTCHESON: In general, no. We have what I guess you would call a white-collar union in Westinghouse. It represents a fraction of the total number of engineers that we employ. I think it represents perhaps about one-third, or

somewhat less than that. In those departments where they are represented by labor unions, to the best of my knowledge--and I do think I am informed on this one--the unions themselves do not stand in the way of the upgrading of engineering talent.

QUESTION: Dr. Hutcheson, what is your opinion of the Five-Year Coop Program between engineering universities and industry as a possible answer to the question of quality, and is Westinghouse participating?

DR. HUTCHESON: The answer to the latter part is, partly. You know how the company is organized. We have 60-some operating divisions. Not all of them have cooperative arrangements with this, that, or the other school, but those where it is appropriate do. I personally think this is a fine idea. I wish I had been smart enough to have such a course and take advantage of such a one when I was going to college.

QUESTION: Dr. Hutcheson, we have heard the views of other speakers on the relative importance of material rewards as a factor in motivation. Have you found that material awards are more or less a motivating factor, and to what extent would you say they are being replaced by other factors, such as freedom of choice of position and the opportunity to associate with other professional people?

DR. HUTCHESON: Well, again you are going to find me a heretic. I think the material reward aspect of engineering life has been stressed beyond its real value. There is real value to this. I don't want you to get the opinion from me that engineers should have no salary, but I think an engineer feels that he is being given fair treatment from that point of view if he can be satisfied that

he is getting the same shake that a fellow in a different unit of the company or in a different company is getting.

As to the other kinds of rewards, I would like to just make this observation. I have forgotten what you mentioned, but let me mention a few--hospitalization and insurance plans, retirement kinds of plans, better working conditions, better working conditions--you know, adequate lighting, ventilation, and that sort of thing. If you stop and think about rewards of that kind, I think you would have to come to the conclusion, as I have, that almost all of these rewards are enjoyed by engineers when they are not at work.

He doesn't spend his pay at work. He doesn't enjoy the fine hospitalization program until he is away from work. He doesn't have a nice retirement compensation until he is away from work. Most of the things we do or have done for our people have been benefits that they can use only when they are not on their job.

I think we have overlooked doing things that make the guy's job more meaningful to him. This is the area I believe in which real motivation of engineers can occur--to make the fellow's job his job, rather than looking on him as a flunkey to do a job for somebody else. I can speak for the rest of the day on this subject, but I can see that our time is about up.

QUESTION: What attitude does your company take toward engineers attending the American Engineers Conventions?

DR. HUTCHESON: Well, up to the point that we find them all there and none at work, we think it is basically a good idea. We want our people to not only

attend but participate in the affairs of appropriate technical societies. We encourage this. At the same time we are aware of the problem I suspect you had in your mind. I could spend the rest of my life going to conventions. I don't think I will. I know damn well I won't. It is possible to do this, and I think it is unfortunate. I think some way has to be found to deal with this.

We try to do it by encouraging the man to participate in the affairs of that particular society which is closest to his interest. He is welcome to attend the affairs of other societies provided he just doesn't waste his time in so doing.

CAPTAIN HYDE: Dr. Hutcheson, I am sorry that we have run out of time. We very greatly value your experience and your willingness to come here and discuss with us your thoughts on this subject. We hope that we will see you again. Thank you very much.