RESEARCH AND DEVELOPMENT IN HUMAN RESOURCES

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RESEARCH AND DEVELOPMENT IN HUMAN RESOURCES

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COMMANDER WEHMEYER: General Hollis, Ladies and Gentlemen: The subject today is "Research and Development in Human Resources." The study of human resources cannot in my estimation be classified as an exact science. Research, we are reminded, is the diligent investigation to discover facts by study. In the field of human resources, this study is extremely complicated because of the almost unlimited number of variables that influence the facts. Unraveling this maze of human source material takes a keen understanding by a devoted and exceedingly well qualified professional man. Today you will hear from such a man. He has long been a leader in his profession. He is presently active as Executive Officer in the AAAS, which is the American Association for the Advancement of Science.

It is with great pleasure that I now introduce to you, Dr. Dael Wolfle.

DR. WOLFLE: General Hollis, Gentlemen: During the few past years there has been a substantial and important change in the attitude we in this country hold toward our human resources. To a considerable measure that is also true of England, France, Scandinavia, and most of Western Europe, but I will talk only about the United States.

A dozen years or so ago, we were relatively unconcerned about our manpower resources. Now we are very much concerned. This change of attitude seems to me to have come about as a result of several facts and trends that are closely related but that can be separated for purposes of description.

First is the fact that we have had a real change in the relation between manpower supply and manpower demands. If we look back through the decades of our expanding country, we see that we had a period of bountiful supply of manpower, with wave after wave of immigration bringing new workmen from Europe and then later from other parts of the globe. As we built the West, we had immigrant groups coming to New York and other eastern ports and pushing on west through the plains and the mountains to the Pacific coast. When we

wanted to build railroads, we had an immigrant supply. Among the immigrants there were not only laborers, but also skilled artisans, scholars, and teachers. There were also the mothers and fathers of many of the scholars, teachers, leaders, scientists, military officers, and specialists of other kinds on whose brains our growth has depended.

Out of this background, we had a relatively ample supply of men for World War I. Mobilization for World War II took place following as long and deep a depression as we have ever had in this country. Consequently we did not have a serious manpower problem until after World War II, and it was not until about 1950 that it became generally recognized that we did have such a problem.

The birth rate changes of the past several decades have been a major cause of the problem. Relatively low birth rates during the twenties and thirties mean that, relative to the whole population, we now have a smaller number than we would like of young men and women in the age brackets of 18 to 30. Because of the medical advances we have a large number of oldsters to support, and, because of the high birth rates of recent years, a much larger number of children to support. There has, in fact, been a very real change in the age distribution of the population. We no longer have what appears to be an unlimited supply of manpower for almost anything we want to do. On the contrary there is a growing concern about the shortages in many fields of work.

A second factor in the manpower situation is the higher expectations that people have. They want higher salaries and positions. They have come to expect a higher standard of living. They want more education for themselves and their children. They want more services and luxuries. These heightened aspirations have increased our demands for teachers, for doctors, for nurses, lawyers, scientists, and technologists of a variety of kinds.

The third trend is the change from a relatively unspecialized to a relatively specialized supply in our total labor force. From an earlier time, when we had a large number of unskilled and semiskilled laborers and relatively few highly skilled and professionally educated workmen, we have come to a situation in which a much larger proportion of the total labor force is in the highly skilled and professional categories.

During this century the number of people engaged in medicine, in dentistry, in nursing, and other health professions has increased some

2-1/2 times as rapidly as the population as a whole. The number of engineers has increased some five times as rapidly, and the number of scientists about ten times as rapidly, as has the total population.

This trend toward specialization grows not only numerically, but it grows by multiplication. Specialization begets additional kinds of specialization. As we have developed more highly complex industry, we have come to need a larger number of fiscal experts and a corps of management personnel, such as personnel managers, in order to keep the industrial flow moving smoothly.

The fourth, and final, factor contributing to our concern over the Nation's manpower situation is the recent general awareness of the startlingly and sometimes forbiddingly effective educational system of the Soviet Union. Russian emphasis on science and technology in its educational system poses for us a threat that is usually phrased in some such terms as: "Are we winning or are we losing the technological race with Russia?" Many of you are familiar with some of the figures that have been cited on the Russian production of scientists and engineers. The U. S. has had a head start and still has a larger supply than do the Russians, but they are training scientists and engineers at a more rapid rate than we are, and we can expect to take second place in terms of numbers in the very near future.

The Soviet Government has produced this situation by emphasizing science and mathematics throughout the entire school system and by providing handsome rewards for scientists and engineers. As students, they receive larger scholarships than do other students. After graduation from college they receive higher pay and are given greater prestige and more privileges than are most other workers. Moreover, their scientific work is given strong support. Yesterday afternoon I listened to a lecture by the Director of the Institute of the Soviet Academy of Science, which provides abstracting and translating service to Russian scientists on the scientific literature of the rest of the world. It is an amazingly large and useful organization to Russian science and technological industry. With a staff of about 1,800 full-time workers and with the help of some 1,300 scientists who serve on a part-time and voluntary basis, as abstracters and translators, this organization publishes eleven abstract journals. They search the literature of some 10,000 scientific journals that are published in this country, in England, in France, in Germany, and other parts of the world. Within a relatively short time after a scientific article is published anywhere in a major country of the world, an abstract of that article

is in the hands of all the Russian scientists in that particular area. If the scientist thinks that he would like to see the entire article, he sends in a note saying that he would like to have a translation of that article, and a Russian translation is promptly sent to him. For articles that appear to be of major importance, the process is speeded up, so that two or three weeks after publication an abstract of the article is sent by the Soviet Academy of Science to the industries and the engineering schools where that article might be of use.

We are, therefore, in the situation of being in competition with a country that is placing more emphasis upon science and technology than we do. That is the fourth of the general trends that have served to create in this country much more attention to the problem of how we are using the brainpower of the Nation than we gave to that problem five or ten or more years ago.

Moreover, I am convinced that the trend toward greater emphasis upon good utilization of the brains of the country will continue. We are witnessing, on a worldwide basis, strong pressure on the part of backward nations to catch up. Those nations have Russia as an example. Russia had its Five-Year Plans. Now China is having its Five-Year Plan. There are strong evidences of nationalism in India, in Egypt, and elsewhere. The lesson that the more advanced nations are setting before the more backward ones is that progress can come about through education, through industrial development, and through the allied efforts to develop technology, to develop industry, to develop science--developments that all depend on highly specialized, well educated men and women in a number of fields.

In the more advanced nations we are witnessing the changes that are described under the tag of automation. Automation will reduce further the requirements for relatively unskilled workers and will still further increase the requirements for highly skilled and highly trained manpower.

Industry has become thoroughly convinced of the value of research. It points with pride and sometimes with amazement to the high percentage of the income of companies such as Dupont that is derived from products that twenty years ago none of us had ever heard of but which were just beginning to emerge from the research laboratories. You are familiar with changes in military technology that are allied to these industrial changes, and you know the growing number of military specializations that those changes have made necessary.

The current situation, then, and the situation against which I think we ought to consider the whole problem of research on the human resources of the Nation, is a situation of shortage rather than one of bountiful supply. The shortages can be expected to become greater because of the increased recognition of the importance of highly trained specialists and the continuation of the trends that lead to specialization.

Since we must expect these trends to continue, and the demands for the highly educated and the highly skilled to increase, we face the problem of what to do about it. At any point in time that problem has to be answered in two ways. In the first place, and quite obviously, we do the best we can with the resources available to us and with the knowledge we have at that time. In industry, there have been many efforts made to improve the utilization of engineers. Some engineers have been shifted into engineering duty from duty that required less of their special competence. Some engineers have been supplied with technical aids of one kind or another, such as computing tools, to make their work more efficient.

We have a shortage of school teachers, and we try to do the best we can by standing somebody up in front of every classroom whether he knows much about what he is teaching or not. In the military service, you have problems of good utilization, of both the officer and the enlisted groups. Throughout the Nation we face problems of the manpower supply; we debate from time to time questions such as the desirability of student deferment; people shift from one job to another in terms of salaries and the attractions that the free economic situation makes available to them in different types of work.

Good utilization is an attempt to solve the problem of our manpower supply, but it is not basically a research effort. It is, rather, the process of doing the best job that we can at any particular time in terms of what we know and what we have to work with at that time. Since it is not a research problem, I simply call it to your attention and go on to the second type of effort to make better use of our brain power and human resources; that is, we try to find out how to do a job better than we know now or than we have known in the past. That is the problem of research.

The chairman has already pointed out that personnel research does not have the niceness of precision and elegance of result that one can

expect in the physical and biological, sciences. In personnel research we are dealing with human beings, who are pretty complicated, and with the social mass, which is even more complicated. Consequently we must expect a considerable amount of fuzziness in some of the data and results.

I would like to mention four areas of research on human resources: The first is the need for more and better information about the supply of manpower, the supply of intelligence and ability, and the use and demand for people of various qualifications. We have only recently realized that we need that kind of information. Fifteen years ago the Department of Agriculture could tell fairly exactly now many pigs there were in the United States, but nobody knew how many physicists there were, or mathematicians, or electronic engineers. Nobody had thought to try to count those with the accuracy with which we can count our livestock. Recently, however, the Department of the Census has been attempting to get information of that kind and has extended the work of the Census Bureau accordingly.

For four years, from 1950 to 1954, I had the pleasure of serving as director of an organization that was established to make a rather thoroughgoing study of the supply of specialists in engineering, science, law, medicine, nursing, business management, and other fields; how those specialists were used; and what the demands for them seemed to be and were likely to be in the future.

The National Science Foundation has, in the last few years, assumed responsibility for collecting and publishing information about the supply and demand for people in the sciences and has become the best source of information on that topic.

Other agencies are working on the supply of students and the qualifications of students, and are measuring and predicting the flow of students through the various school levels and out through colleges and universities into the labor force.

I might mention a fundamental lack that exists in this area of statistical information about our manpower supply. We need to know much better than we do how to make such studies. We need some basic methodological investigations of methods of forecasting manpower supply and demand trends. There has been a little work in this field, but on the whole there has been very little, and it has not been satisfactory. We are still doing a great deal of guessing and our methods of forecasting are still very crude.

Turning now to the other areas of research on human resources, I will mention first the selection problem, then the problem of training, and finally the topic of human engineering, or the design of equipment to fit human capacities. These three--selection, training, and equipment design--are the familiar headings under which this broad area of study is usually classified.

People differ in practically every way in which they can be measured; obviously, in height and weight and color; less obviously in general intelligence and ability, and all kinds of special abilities. It seems common sense that when there is a job that calls for a certain type of ability, we should look for people who have that ability instead of taking anyone who happens to be available.

Military acceptance of this type of selection philosophy, and the development of tests to measure ability and assign people to areas of work in which they could be most usefully engaged, got its start in World War I. During and since World War II it has expanded so that we now have great varieties of tests for all sorts of maintenance operations and operating responsibilities.

I say it got its start in World War I in the military area. Five years ago in a conference on the selection of military manpower, one of the speakers called the attention of the audience to a very much older story of the experimental selection of military manpower. The speaker who brought this old story to our attention was Wallace Fenn, a physiologist from Rochester, who went back to chapters 6 to 8 in the Book of Judges and analyzed the story of Gideon. I would like to read you a paragraph or two of Dr. Fenn's lecture:

> "It is recorded how Gideon was called upon by God to raise an army to smite the Midianites. Gideon responded by raising an army of 32,000 Israelites. But the Lord told him that was too large and that its success would be impaired by the cowards within the ranks. So Gideon told all those who were afraid to fight the Midianites to go home. He was left with 10,000 men. This may be regarded as the first use of the personal interview or personal preference that we find today.
>
> "The Lord then told Gideon that his army was still too large and designed a performance test to screen out those recruits who were most alert to their soldierly duties. To this end, Gideon led his men to the river for a drink, where he eliminated those who

carelessly threw down their shields and spears and lapped up the water like dogs, with their backs to the possible enemy. He retained only 300 men who kept a wary eye on the bushes, and with the spear held ready in one hand, scooped a hasty gulp of water with the other.

"This ingenious psychological performance test was proclaimed a success because the Midian camp was duly liquidated in the night when Gideon's 300 men smashed their pitchers, revealed their circle of light, blew their war trumpets, and rushed upon the unsuspecting sleepers."

Dr. Fenn went on to say:

"I can't vouch for the accuracy of this story, but I can point out that, while it may have been effective, it was not a research study. It lacked a control. There is no proof that the well-hydrated who drank on their knees wouldn't have killed even more of the enemy than the more cautious segment. So that is why Gideon's divinely inspired test is no longer in use."

The illustration points out the major difference between ad hoc methods to accomplish a purpose and the experimental research technique of setting up a control situation in which you are able to compare different results, and by making comparisons can determine the effectiveness of the methods you have tried out.

In selecting men for military duty or for a civilian occupation, if one wants to know how successful the selection methods have been, it is necessary to have a criterion. A criterion provides a method of finding out at the end of an experiment whether or not your guesses were right. For example, if one is selecting salesmen, actual sales records, after the men have been hired, provide a criterion for checking on the value of the selection methods used.

The need for a criterion, the need to have at the end of a study some method of determining how good a job has been done, is the hallmark of a research study. But it is most difficult to get a good criterion in a practical situation dealing with human beings in all their variety and in all the variety of circumstances under which they work. It is a serious problem in civilian selection as well as military selection. We can select men who do a pretty good job of getting through

a military school, but getting through the school is not the same thing as successful leadership and successful work later on. We can do a pretty good job of selecting men who can learn relatively quickly radio code or maintenance responsibilities in electronic equipment, but getting through the training program isn't the same thing as effectiveness on the job.

To turn to a civilian example: Next month I will spend a couple of days with representatives of the American Association of Medical Colleges. The medical schools are very much concerned over the supply of candidates wanting to enter medicine. Medical schools used to be able to select their freshmen medical classes from three or four or five or ten times as many applicants as were placed in the class. Now, in the country as a whole, there are less than twice as many applicants as are actually admitted. A few of the medical schools are accepting almost every applicant who wants to come to that school. Medicine is very much concerned about this problem of supply of medical personnel for the future.

They also face the problem of a good criterion. It is possible to select students who get through medical school, but after that what is it that makes a good doctor? Earnings? The number of patients? Name anything you like and it is difficult to use that as a measure of effectiveness of the physician.

Personnel selection is the area of personnel research which is best developed and on which there is the most encouraging and successful body of results; yet it is always plagued by the difficulty of getting a good criterion against which to assess whatever selection methods are being investigated. I point this out because it is a practical problem in all military research on selection.

The second of the traditional areas of personnel research is that of training. There has been a substantial body, but only within relatively recent years, of military research work on training. Practical work, of course, goes back as far in history as there has been military organization, because training has been a primary and major responsibility of the military services; but research on how effectively training can be given for this or that job is only of World War II recency. Since World War II, however, there has been extensive work on the training of pilots, code operators, and maintenance personnel of various kinds. Such studies have been carried out in all of the services. Again, I would like to call attention to the importance of a criterion in determining whether or not the training given has been effective.

Fifteen years or so ago, it seemed just plain common sense that giving aerial gunners practice in skeet shooting would help them to be better aerial gunners. It seemed good common sense, and lots of them were given lots of practice in skeet shooting; but nobody has ever demonstrated that it helped their shooting one bit. From the last report I heard, the idea had been completely dropped.

We are spending tremendous amounts of money in manufacturing and using complex synthetic training devices, and I am sure that many of these devices are effective and economical. But to a considerable extent this belief is just a sort of article of faith on my part, because most of the synthetic training devices have not been tried out in carefully controlled experimental conditions to determine how effectively they add to the skill of the trainee. This is not true of all training devices, for this is an active area of research and there have been some interesting and well-controlled studies of the usefulness of synthetic trainers.

The final and most recently developed of the areas of personnel or human resources research is the area that is sometimes called human engineering, or work on the man-machine combination. Human engineering covers the effort to design equipment so that it can be most readily used by human beings, with all of their shortcomings and limitations and peculiarities and tendencies to behave in one way or another. Here is an area in which the military services, instead of taking over from civilian life, have led the way, because the real start of work of this kind took place under military auspices.

The Air Force has done a great deal of work on cockpit design and on the design of instruments by which data come to the pilot or other crew members. These studies have investigated the location of instruments, the ease with which they can be read, the accuracy with which they can be read, how easily one can be differentiated from another, and so on. Experimental work on shape coding or color coding of airplane controls has made it easier to discriminate one from another. The other services are also carrying on human engineering studies, for they all have dozens of problems of designing the materials with which a man works partly in terms of how easily, how accurately, and how errorlessly an ordinary human being can handle them.

The three fields of selection, training, and design of equipment all fit together, because they are all part of the broader problem of determining how a human being can work more effectively. Any improvement

we make in any one of the three makes the other two easier. If we design equipment so that it is easier to use accurately and effectively, we thereby simplify the problem of selecting and training men to use that equipment. If we select more efficiently, we make the training problem easier and make utilization easier also. If we can improve our training methods, we can ease up on selection restrictions.

If we ask how much progress has been made in human resources research, it seems only fair to try to answer in terms of the time scale. Work on selection in civilian life started perhaps 50 years ago. In the military sphere, it started in World War I, but was dropped immediately afterwards and no more was done until World War II. In terms of that kind of a time scale, my own appraisal is that we have done a pretty good job for immediate criteria, such as selecting men for schools and training programs. I am more doubtful about the effectiveness with which we select them for more remote criteria, such as effectiveness on the job after training.

On training research the civilian experience goes back perhaps 50 years and military experience perhaps 15. We have had some success; we know some of the basic principles on which to develop training programs; but we have a long way to go.

On the design of equipment, military experience goes back perhaps a dozen years and civilian experience less; and there we have a good start but not much more.

On the first area of research I mentioned, that of securing basic statistical information on the supply and demand concerning the human resources of the Nation, there also we have simply gotten started.

In summary of our progress, I think we should feel encouraged but we can't be satisfied. There is still too much ignorance and too much that is desirable for us to know. There is ample room for lots and lots of further work.

In conclusion, let me try in about one minute to summarize. During the past decade or so we have had a sweeping and fundamentally important change in the attitude we have taken toward the intellectual and human resources of the country, a change from a comparative lack of concern about our manpower resources to one of great concern. The attitude has changed from one of: "There is plenty; we don't have to worry about the supply" to one of: "There is a shortage and the shortage is likely

to continue. We do have to worry about the supply and therefore we must learn as much as we can about how to use the supply most effectively."

There is a correlative change from an attitude that stresses interchangeability of men to an emphasis on specialization. You are much better acquainted with, and I am sure much less confused than I am by the growing number of military specialty numbers, career ladders, and paths of military specialization.

The trend toward industrial specialization and the pressure for higher standards of living point to a continuation of the demand for men and women with specialized education and specialized skills.

Comparisons of the United States with Russia in terms of education, technology, and military, political, and economic strength dictate an increased emphasis upon good utilization of our manpower, for our own economic and social development, and for our national survival.

In this situation there are two essential elements for sound manpower policy. One is the obvious one of making the best utilization of available human resources. The other, and the one I have emphasized more heavily today, is the responsibility to support and to carry out research on human resources so that in the future we will be able to make better utilization than we can now.

QUESTION: We have heard a lot of late about the growing dependency of the older age groups. It seems to me that some arbitrary determination of the age beyond which we are useless is a somewhat oversimplification of the case. Do you have any research on that that you could refer to?

DR. WOLFLE: During the thirties, when we had too many people and wanted to get rid of them just as soon as we could, a lot of fixed retirement policies were established. A good many of those policies are changing and retirement ages are being raised, or are being made more flexible.

People in medicine with whom I have discussed this problem point out that one of the major changes of better health is that people get to age 65 or age 70 with fewer scars than they used to have; that is, they have had fewer diseases. They are in better health than 65- or 70-year-old people might have been in an earlier age. So we not only have a lengthening of life, but a lengthening also of the span of life in which a

person is still useful and retains his physical and mental ability. The obvious thing to do is to make better use of older people.

There are, however, administrative problems. It is much easier to say to a group of employees, "Retirement age is 65" or 68, or whatever it is in a particular concern. This is arbitrary; this is simple; this is easy to apply. It is harder to apply a flexible policy when to one 68-year-old you say, "You are through" and to another 68-year-old you say, "You're okay; you can continue for a few years." This raises lots of headaches. Whenever you make such a distinction, you are bound to have complaints from one or the other or both of the people. But it makes good sense, and I am sure it is going to be more generally the policy to have more flexible and higher retirement ages.

QUESTION: Doctor, you mentioned cases in which specialists who had been diverted from their original field of training had been returned to this field to meet an outstanding requirement. Could you expand on this action, perhaps giving additional information regarding the availability of data upon which the knowledge of this digression was predicated, perhaps the means by which these people were induced or forced or otherwise returned to their field of specialty, and your ideas as to how we might go into an increased effort to return to their field of specialty those who have been diverted?

DR. WOLFLE: In the large, probably the principal means is salary and attractiveness. Go back a few years. We have talked in recent years of a shortage of engineers. In the 1930's we talked about a surplus of engineers. A considerable number of people who graduated from engineering colleges were not able to find engineering jobs, so they entered all sorts of other things. Then came World War II, with its industrial and military mobilization; jobs became available and drew back into engineering work people who had had such training but who had not been practicing as engineers.

Contrast that with the situation that obtains now. One of the largest shortages of all in this country is the shortage of well-qualified school teachers. The great baby boom since 1940, and even more since 1950 is flooding the elementary and high schools and soon will flood the colleges. There are lots of people, mostly women, who are middle aged, who are college graduates, reasonably well trained in some area, and some with teaching experience, who might be drawn back into teaching if the positions were made sufficiently attractive to make it worthwhile for them to take up teaching duties again. I am sure that if teaching were

made more attractive, both financially and in terms of prestige, we could draw into teaching a larger number of people.

Now, on a smaller scale, individual companies have been worried about the way in which they have been utilizing engineers. A considerable number of engineers have moved out of technical duty into sales or administrative responsibility. It is unrealistic ever to try to bring all of them back because many are well content with what they are doing and are doing jobs that are important and effective.

Quite a number of industries have looked over their own staffs and have spotted a man here or a man there who was not doing a very critical job and they have simply done some reassignment.

The engineering societies and the Engineering Manpower Commission, which is a kind of umbrella organization over the major engineering societies, have given considerable attention to that process in engineering and have published reports on it. I think I can give you a reference or two afterwards if you like.

QUESTION: There have been various opinions expressed about speeding up the rate of education. Could you touch on any research that has been conducted in the field of speeding up education?

DR. WOLFLE: There has been quite a bit done in studies of speeding up education. It has been a controversial subject, because of the relative values people give to the intellectual development of the youngster, on the one hand, and his social and personality development, on the other.

On the one hand, the advocates of speeded-up or accelerated education point to the fact that within the whole range of eighth graders, tenth graders, or college freshmen, there is a spread from the very bright to the pretty mediocre. The very bright can learn faster; they can progress more rapidly; moreover, they do better work if they are pushed ahead more rapidly.

Occasionally, if you put a smart youngster with a group of children who are about the same intellectual level as he is but who are three or four or five years older and bigger and more mature socially, this has unhappy consequences; it makes him a misfit in the group. The people who put first emphasis on social adjustment tend to argue against acceleration.

My opinion and my summary of the experimental studies that have been conducted would be something like this: In the main, the youngster who is intellectually ahead of his age group, the very bright youngster, is likely to have more mature interests and to be able to take several years of acceleration without harm.

Now for specific studies: About the time of the resumption of the draft during the Korean period, Ford Foundation money started several programs of sending youngsters to college at an earlier age. Under one of these programs, bright high school sophomores and juniors were allowed to skip the rest of high school and go directly to college. By and large, the results indicate that these youngsters do considerably better than average college work, they get degrees sooner, they are happy in the process, and they go out of college into whatever they do afterwards with no handicap, but with the advantage of getting started two or three years sooner. I am all for it.

It seems to me to make no sense to require everybody to spend the same number of years in school. The number of years is the wrong measure of education; what you know or what you can do is a more useful one.

QUESTION: Doctor, you mentioned Russia's system of making abstracts from scientific papers in the free world. To what extent are Russian scientific papers available to us? I assume their system is a function of the state. Is our system on the basis of the scientific field or just on the basis of an individual obtaining these papers?

DR. WOLFLE: Ours is much less well organized. We have, however, several abstract services, such as the abstracts of chemical papers that are widely used by chemists. The editors search the literature that is likely to contain research studies in chemistry. If they can get Russian literature, they include it; but they have a limited budget and cannot give complete coverage.

There have been several foundation grants, and now support from the National Science Foundation, to try to abstract Russian literature in chemistry and in physics. There soon will be, under National Science Foundation auspices, such an abstracting service in biology; but it is not as extensive, not as rapid, and not as well supported financially, as the Russian service.

QUESTION: Doctor, one of the great factors in securing an education of a scientific nature or in a specialized field, such as medicine, engineering, and those various fields, is the economic factor. That is, it is

usually about four or more years before the individual is able to pay his way. Is anything being done on a national scale to alleviate that condition?

DR. WOLFLE: May I answer two questions, one you asked and one you didn't ask. First, the one you didn't ask. I quite agree that there is a serious economic handicap that keeps lots of bright youngsters out of college. The son or daughter of a professional man or one with a good income is much more likely to go to college than is the son or daughter of a poor man. But there are some exceptions. The son or daughter of a minister--and ministers don't rate among the best-paid members of the population--is very likely to go to college. The son or daughter of a school teacher--and school teachers don't rate among the higher-paid members of the population--is very likely to go to college.

There is a very strong factor here of interest, of the drive that you develop in the youngster, of the encouragement you give him, of what you expect of him. So far as we can tell from fairly extensive studies, this personal motivation factor is more important than the amount of money that is available. I would put the economic factor in second place and put more emphasis on the development of an intellectual interest on the part of the growing youngster.

The economic problem, however, is the easier one to handle, because we have lots of dollars in the country and for good causes we can get quite a few of them. There are many industrial scholarships for college students. There is, as the single biggest new program, one sponsored by Ford Foundation money, the National Merit Scholarship Program, that is offering four-year scholarships each year to several hundred high school graduates. Several hundred is a drop in the bucket, but we have several hundred from this source, hundreds more from various industrial sources, and now there is also a growing interest in starting a Federal scholarship program. In the last Congress a dozen or so bills were introduced that would have created a national scholarship program. Hearings were held by the Subcommittee on Manpower of the Joint Committee on Atomic Energy that led to no legislation, but that indicate a growing congressional interest. My guess is that there will be within the next two or three or four years enactment of a Federal scholarship program of substantial size.

QUESTION: Would you comment upon the use of aptitude tests in selecting college students in the interest of effectively directing their paths of study?

DR. WOLFLE: The thing that an aptitude test can do best is to give a general measure of ability. Much less well can they point to a specific field in which a person is going to do a better job than he would do in other fields.

There have been a number of efforts to develop what is called differential prediction, or differential aptitude selection, so that one could give a battery of tests to a youngster, analyze the scores he made on different tests, and say: "You would be good in profession A, not quite so good in B, much better in C, and you would be a flop in D."

How much of a success a man is in a particular profession depends not only on his ability but also, and very importantly, on his interest. That is one point. The other is that within any profession there is a wide range of types of work. The men who graduate with degrees in medicine may become small town practitioners, specialists, teachers, or research workers. The Ph.D. in physics may become a nuclear expert; he may become a teacher; he may become an operations research analyst; he may go into a variety of kinds of work. Interest is probably as important as ability in explaining differences in success. Aptitude tests can help and help importantly in selecting fields, but I would never use aptitude tests alone.

QUESTION: Doctor, in connection with this statement that you just made about interest, have you been familiar with the tests that Dr. Stone at Stanford University started some 20 or 30 years ago?

DR. WOLFLE: Yes.

QUESTION: They seemed to fill in that gap that you mention, because his tests reported not ability but only interest. Do they have any value? Has that been extended any?

DR. WOLFLE: That test is a very good one in helping a young man to find the areas in which he is really interested. If you ask a growing boy of 14, 15, or 16, "What would you like to be?" he has only a limited basis for answering your question. He has some knowledge of some fields he has seen doctors, he has seen businessmen, he has seen whatever his father does if what his father does gets carried home at night, he has seen school teachers, and so on; but there are lots of professions that he hasn't seen.

What Dr. Stone did was to take groups of people in a particular field-- a group of policemen; a group of YMCA secretaries; a group of salesmen; a

group of physicists; a group of ministers; a group of farmers, and so on--and make careful analyses of the things that interest people in each of these fields and how the members of each group spend their time. Then by finding out the detailed likes and dislikes of a young man, the Stone test says:

> "Your interests agree very closely with those of people who are successful YMCA secretaries. If you want to be a YMCA secretary, you don't have anything to worry about; you are going to like the life of a YMCA secretary. But I wouldn't advise your becoming a policeman, because your pattern doesn't fit the policeman's life at all. You are not going to be interested in the things that the policeman is interested in."

This is a very real help in making an occupational choice.

QUESTION: We hear mostly about the shortage in connection with the engineering and other technical fields. You mentioned school teaching. Are there some other areas that you could name, completely apart from those we hear most about, that represent serious areas in the growing shortages?

DR. WOLFLE: As part of the work of the Commission on Human Resources we tried to study all of the major professional areas, to size up the demand and supply situation. I would list as the areas of greatest numerical shortage, school teaching, nursing, the various scientific, and some of the applied science areas. At the other extreme, it seemed to us that we need not worry much about the supply of people in law, or pharmacy, or agriculture, or in the ministry. Potential supply seemed probably adequate in those areas.

Now, that leaves business, which is awfully hard to measure, because people flow into business from every area of college training under the sun. It leaves also the broad areas of the social sciences and the humanities. There we had to make qualified statements. There are going to be more people graduating from college majoring in English, in Latin, in psychology, in economics, in history, and so on, than there are jobs for English scholars, Latin experts, psychologists, economists, and so on. But at the higher level, at the teaching and research levels, at the Ph. D. levels in these fields, the number is much smaller and probably not as large as we ought to have.

A principal reason for prospective shortages at the Ph. D. levels in the fields of the humanities and social science will be the the great

growth in college population and the great increase in the demand for college teachers that is just now starting. We have to plan for approximately doubling the size of the college population in the next 15 years, as the baby boom of the forties moves up into the college age. A secondary reason is the fact that industry and government are making larger use of people in the social science and humanities field.

QUESTION: You mentioned an awful lot about the shortage of engineers in the country and the growing number of engineers in Russia. Do you have anything to say about the quality of the engineers that Russia is putting out compared to the quality of United States engineers?

DR. WOLFLE: It is a little hard to answer that question, because we are not on solid enough ground. I will tell you what I can.

The elementary and secondary school systems of Russia place much more emphasis on science and mathematics than we do here. By the time a Russian boy has got to the age of 17, he knows considerably more than would a boy of the same ability in the schools in this country.

The selection of youngsters going out of the common school and into the college level is more rigorous in Russia than it is here. It is more dependent upon ability. Only the ones who make good are allowed to go into the higher level. I don't mean this without exception, because there is a caste system in Russia, just as there is in the United States. It is easier for the son of a well-to-do Russian to get into college than for the son of a poor Russian, just as it is here. But, by and large, the selection is more rigorous. The Russians also have a longer school week, with more emphasis on science, and this emphasis begins much earlier. All of this points to a more rigorous training than we give our high school and college students in the sciences.

But there is also a higher degree of specialization. A person in this country is likely to go to an engineering college. Somewhere along the line, he decides he would like electrical engineering better than other kinds, so he does a little specialization. When he gets through, he can go into any job he wants that is offered to him. He has great freedom to move about. There is much less such freedom in the Russian schools. Boys go to schools that train people for transportation duties or mining engineering. The mining engineering colleges are run by the ministry that controls mining; and the graduates of that school are put into mining engineering jobs. Transportation engineering has its own set of schools and so does each of the other branches. So there is a narrower

kind of training, with less of the flexibility that we have in our educational system.

So in terms of whether or not Russia does a better job than we, I will say that they place more emphasis on science, they give more rigorous training, and they have better selection. I am not at all sure, however, that in the long run that high degree of specialization may not be a handicap. One of the strengths of this nation has been our flexibility; we built up our electronics industry and our atomic research and industry primarily out of people who switched into those fields from others because they had fairly broad training and were flexible and willing to move into something that looked new and exciting.

COMMANDER WEHMEYER: Thank you, Dr. Wolfle, for an interesting talk on a very difficult subject.