TECHNOLOGICAL PROGRESS AS A NATIONAL RESOURCE

10 September 1951

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

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CAPTAIN MARCY: Gentlemen, if you were seated in your favorite movie rather than in auditorium "A" of the Industrial College of the Armed Forces, this part of the program would be entitled "Preview of Next Week's Big Attraction." But unlike the movie preview, we are not going to try to lure you in next week with some short glimpses of some of the amorous scenes from next week's big feature, nor will we try to beguile you with such words as stupendous or supercolossal. Instead, we will devote this period to two things: (1) getting acquainted with the general organization and conduct of the Technological Progress course and (2) a short preview of technological progress as we view it here at the college. I will take the first assignment, that of explaining generally the organization and conduct of the course, after which, Colonel Diehl will take over and lead you through, as gently as may be, into the mysteries of technological progress.

Each member of the Production Branch will handle one of the six major areas into which we have divided our study of technological progress this year, as follows:

1. Colonel G. W. Seaward will handle the subject, "Technological Progress as a Factor in the Cultural and Economic Growth of the Nation."

2. Colonel Cave will take, "Technological Progress as an Element of Military Strength."

3. Commander English has, "The Role of Educational Institutions in Technological Progress."

4. Colonel Kleff has, "The Contribution of Scientific Institutions and Nonprofit Organizations to Technological Progress."

5. Mr. John Swaren has, "Technological Progress in Basic Industry."

6. Mr. Alden Baum will take, "Technological Progress and the Federal Government."

And, lastly, Colonel D. B. Diehl will follow me on this platform in just a few minutes.

Each of these gentlemen will meet with you tomorrow afternoon at 1:30 to discuss in detail your subject assignments and answer any questions you may have in the area.

Now a word about your individual relationship with these instructors. I hope that you will consider them, not as teachers or instructors in the usual sense in which those terms are used, but rather as members of a steering committee who have been over this ground before and can, therefore, help you to avoid some of the imbedded rocks and shoals and help you to take advantage of any favorable winds and tides.

If you get to know them on an informal "Bill" and "Joe" basis, you will find it a big help. They will meet you more than halfway in this regard, but it is going to take some conscious effort on your part to achieve a good working relationship with the instructor in your particular area and with the branch as a whole.

Just a word about your written reports. You have probably noted from your curriculum book that each of you in this course is to prepare an individual report upon your assigned subject. Since this is the first of several papers you will write here at the college, I think it is important that you get off on a sound footing. I therefore strongly recommend to you that before you put a pencil to paper you read and study the "Preparation of Reports."

There are other reference books and treatises on style and techniques of writing available to you in the library, but a good working knowledge of this little pamphlet will enable you to write your reports without undue concern for format and style and will allow you to concentrate on the subject because we of the faculty have to read all of these reports and we are interested in substance rather than quantity.

For that reason, we haven't set any fixed limitation as to the length of the reports. Instead, we have attempted to so design the subjects and scopes so that a soundly conceived and well-executed report of about 2,500 words should suffice. That is neither a maximum nor a minimum, and we may have missed the target in our attempt to so devise our subjects. But, before relinquishing the stage to Colonel Diehl, I would like to give you three simple rules for preparing reports for the Production Branch. Here they are:

1. "Never write a chapter when you can say the same thing in a paragraph;

2. "Never write a paragraph where a sentence will suffice;

3. "Don't write a sentence unless you have something to say."

Thank you.

COLONEL DIEHL: As Captain Marcy stated, my purpose is to preview the course of instruction and explain some of the basic concepts of "technological progress." Here at the college, it's customary to begin

a discourse such as this with definitions of the terms to be used, just to be sure we are all speaking the same language; far be it from me to transgress from tradition.

What is technological progress? At this college the following formalized definition has been developed: "Technological progress is the improvement of man's control over his natural environment through the application and utilization of scientific and engineering knowledge in any of the practical arts and sciences." Note well the word improvement. Man may be born in a culture rich in scientific knowledge and may be capable of great engineering achievements, yet technological progress may not exist. In fact it could well be in retrogression. This has occurred in many cultures of the past.

Unfortunately, this definition is very broad and all-comprehensive and does little to help us understand our subject, so let's try another approach.

All through your ten months here you are going to be exposed to the five big "M's" of economic mobilization. These five are: men, materials, money, management, and machines. Technological progress has a profound influence on two of these and, conversely, is just as profoundly influenced by a third.

Manpower—our greatest national deficiency when compared to the forces available to the men of the Kremlin—must be made to stretch and stretch if we expect to meet on equal footing the hordes that may oppose us. Superior firepower, superior weapons, superior use of equivalent weapons, superior procedures of manufacturing, whereby fewer men are required to produce an equal number of end items, are needed. These are the equalizers we must have to make up for our lack of numbers. A better way of making a better item—be it, again, a mousetrap, an atom bomb, or a flying saucer—is technological progress.

The Bible tells us that a sling and a stone enabled a comparatively frail young man named David to overcome a huge hunk of muscle called Goliath. This is one of our first written records of technological progress overcoming a manpower deficiency. In more recent times a piece of ordnance developed by Mr. Samuel L. Colt was known far and wide as "the equalizer." Those of you who are up to date on your western movies know whereof I speak.

These examples definitely tie in with the definition of man improving his control over his natural environment through the application of science. It illustrates, as well, a way of overcoming a manpower deficiency.

From the materials standpoint, how can we make our limited resources stretch farther? Technological progress again comes to our aid through the development of new and less-wasteful manufacturing techniques, substitution of less-critical materials for those in short supply, and the

development of new synthetic products capable of better, more easily, more quickly doing the required job. In this manner, what we have is made to go farther and still do the job better.

Where we have had in the past to depend upon materials from foreign, faraway places, materials definitely considered critical, now in many cases this condition is changed and we find the job can be done even better with cheap materials readily available within the boundaries of our country. Take, as an example, the jet engine--here is an item that might well determine the fate of our Nation. In one make, as originally designed, 17 materials used were listed as critical. Today, that engine does not contain one material on the critical list. In addition the output and the reliability have been increased while the cost has been reduced.

Rubber--and all of you know how important in your daily lives rubber can be--is another good example. In 1940 the United States was completely dependent upon distant foreign sources for its rubber. However, by 1945, when our industry was consuming rubber at a higher rate than at any time in history, over 85 percent of that rubber consumed was American-made synthetic rubber.

Many other examples could be used, but those will give you some idea of the way technological progress can help us conserve materials and free us from dependence upon foreign sources for raw materials.

Let us see how the third "M"--money--enters into the picture. It takes a tremendous amount of money to carry on research, to develop new products, or even to improve old ones. All we have to do is to look at the money set aside in the military budgets for research to give us some idea. Or to look at some of the laboratories operated by companies like Du Pont, General Electric, Bell Telephone, Westinghouse, or the labs of MIT, Cal. Tech., and Chicago. The building, equipping, and operating of these labs cost plenty of money.

Money is a commodity you and I can very easily, very readily, appreciate. The amounts spent on research may sound fantastic. For instance, since World War II the sum of over three billion dollars has been spent by the Government on research and development. Du Pont spent 37 million dollars developing nylon. We may even wonder whether these staggering amounts are necessary, and, with industry as our guide, we ask, "Does it pay?" I refer you to a statement made by the Director of Research for Eastman Kodak Company, who said, "I've never heard of a company going broke because it spent too much on research."

In my mind the big question is, Are we actually spending enough? I will leave that for you to answer. It will be up to you to decide during your course whether we as a nation are spending enough and also to decide whether that which we are spending is being spent wisely.

So far it may appear to you that I've trespassed upon territory sacred to the Manpower Branch, to the Natural Resources Unit, and to the Procurement Branch's Economic Stabilization Course. And, in a sense, you'd be right. But these illustrations were used to bring to your attention something that will become increasingly evident to you throughout your stay here. Each unit in some way ties in with other units of the course. Each unit is a piece of the jigsaw puzzle that, when finally put together, spells out "economic mobilization."

Going back to our examples then, technological progress can be defined as "The application of scientific and engineering knowledge as a means of multiplying our manpower, conserving and extending the use of our natural resources, and making it pay."

Now, with a definition of technological progress clearly and firmly fixed in your minds, let us take a look at some of the principal problem areas. The research activities associated with technological progress can be divided into two broad divisions—basic and applied research. Basic, or pure, science provides the foundation for all technological progress. Here is the lair of the long hair. When we think of pure science, we immediately see an Einstein immersed in a sea of formulae. We picture Newton sitting under an apple tree, or Franklin flying a kite. And from just such humble experiments as those conducted by Franklin, by the analysis of natural phenomena by Newton, by the involved mathematical reasoning of Einstein, and by the repetitive experiments in laboratories everywhere, have come those fundamental truths of nature from which all of our gadgetry have evolved.

As a further insight into pure science may I quote from Dr. Dubridge, president of California Institute of Technology, who, in an address to the General Advisory Committee to the Atomic Energy Commission said:

> "The chief goal of science is not to develop weapons of war; it is not to develop new or improved industrial products, nor even to find cures for human diseases. The primary goal of science is to understand nature. Its purpose is not to invent but to comprehend; its aim is not to produce gadgets, but to discover knowledge; its most valuable products are not atomic bombs, radar, or penicillin, but new facts and new laws concerning the behavior of the natural world."

No discussion of the processes of research and development would be complete without a reference to Dr. Vannevar Bush. If we accept the definition of science just quoted as the foundation of all products, then what are the essential elements or phases in the cycle that lead to these end products? Dr. Bush lists eight. These are:

First, an expanding body of science in general, a storehouse of fundamental knowledge constantly being replaced through basic research.

Second, there must be a constant alertness to discern in the growing body of basic knowledge those points from which practical applications can grow. This is a step all too easily taken for granted rather than recognized as a distinct step in the cycle.

Third, the ideas discerned must be tested to determine whether they have merit. This is the stage of primary applied research. Well done, it results in the diminution of some possibilities and the recognition of those having the greatest promise, thereby permitting major effort to be centered on the latter.

Fourth, there must be reasoned and deliberate examination of the possible outcome in terms of technical performance and of development of ideas which have stood the test of primary applied research.

Fifth, the setting up of programs for the purpose of producing prototypes. It is here that careful attention to steps two and four really pay off. Both of these steps are evaluation processes. By one we increase the number of possibilities to be explored. By the other, we eliminate the least promising of these possibilities. Thus the expensive and time-consuming fifth step—the building of prototypes—is undertaken only when worth-while development is almost a certainty. To pin down an idea may take only paper and pencil. To build a prototype may take millions of dollars.

Sixth, the testing of the prototype and re-evaluating it in the light of test results.

Seventh, the incorporation of changes and adaptations as indicated by test results, and the setting up of experimental or pilot-line production models.

Eighth, this step is not, as you might suppose, the production of the final article, but is another evaluation and analysis, conducted, where possible, through field testing of the pilot-line or experimental article for final elimination of bugs before going into large-scale production.

To Dr. Bush's eight steps our experience here indicates that we must add a ninth to complete the cycle. This step is the continuous follow-up of an article in service with the changes and modifications needed to meet ever-changing service requirements. It is through this ninth step that we determine the need for and the timing of new programs to develop improved models or replacement items.

Let us briefly examine some of the problem areas in the field of technological progress as it relates to our over-all subject of "Economic Mobilization." We will consider again basic or fundamental science. As stated before, by definition, basic science has for its purpose the

discovery of new knowledge; its only products are new facts and new laws governing the behaviour of the natural world.

We have listed basic research as the first step in the research and development cycle as the means of building the stockpile of material we must have on hand before we can start work in the fabrication of the structure. Our problem, then, is to build and maintain this stockpile at a safe level. We could compare the present position of the United States in regard to basic science with our position in the aluminum industry. The spectacular growth of American technology to a position of world leadership has been based largely upon foreign sources of basic science, just as our aluminum industry has been built upon the importations of high-grade bauxite ore. True, we have some high-grade aluminum ores in this country; we also have some top-grade scientists. But in neither case do we have enough to support our industry for long should foreign sources be denied us.

Also, like our almost unlimited supplies of low-grade aluminum ores, our population contains a high percentage of undeveloped scientific talent. It takes a tremendous amount of electrical energy to extract pure aluminum metal from even high-grade ores, and it requires equally vast amounts of energy of another sort to produce top-flight scientists from the best of raw materials. Later on in this course you will hear Dr. A. T. Waterman, Director of the National Science Foundation. He will discuss the problems facing the Nation in extracting talent from our scientific resources and the way the National Science Foundation anticipates alleviating this deficiency of high-grade scientific personnel.

Attain a degree of self-sufficency we as a nation must, because, while there is no serious problem in the aluminum industry so long as the channel of world trade remains open and, likewise, while there is no serious problem in the technological field so long as there is free exchange of scientific information among the scientists throughout the world, when we begin to think in terms of national security, when we consider the possible circumstances over which we have no control and which may block the channels of trade and prevent the free exchange of scientific information, then, gentlemen, then it will be necessary for us to have obtained a degree of self-sufficiency that will see us through any emergency.

Possible annihilation faces the nation that runs second in technological achievements because, as you all know entirely too well, there can be no second best in an all-out war.

Our problems in the second division of research and development—applied research—are not so great, comparatively speaking. The United States has long led the world in this field. But even here, with our acknowledged supremacy, we dare not be smug, dare not sit idly by just resting on our laurels. There have been frightening indications from

captured Russian material, from reports of our military observers, that Russian techniques are not far behind ours in most cases and in some are superior. Complacency cannot be allowed to exist.

So far, I've been talking primarily about end items, how we get them and their importance to us as a nation. Let's digress from that theme for a bit and look at the picture from an historical and social or cultural point of view to see what it has meant to us in terms of everyday living; how we bacame what we are, and—by inference—where we are going.

The present cycle of technological progress began with the Renaissance. In the fifteenth century gunpowder was applied to firearms, the printing press was invented, and astronomical studies began to flourish. The culture of western Europe developed rapidly. New industries, better transportation, and more powerful weapons enabled western Europe to exercise world dominance. An era of exploration, colonization, and exploitation was inaugurated. Later, and concurrently with this era, came the industrial revolution. Again, it originated in western Europe and is still marching rapidly around the world.

Technology has not blended easily into the culture of western Europe, not to mention the world as a whole. Disastrous political and economic upheavals occurred. A series of wars ensued. They gradually increased in ferocity. We, today, have witnessed World Wars I and II and are talking about a third one.

The steamship, radio, airplane, and automobile have caused a rapid shrinking of the world. Advanced technology has been carried to all areas. To some it has meant more food, better health, and a rapid increase in population; India is such an example. To others it has meant a high standard of living, exhaustion of resources, and a stagnate population. Various European countries fall into this class. There is a great problem of balance within countries, on one hand, and between countries, on the other. Or, in technical parlance, we might say the gears do not mesh.

The traditions of a culture, as expressed in its political, religious, social, and economic structures, are greatly stressed under the impact of new technological developments. The net result is that we have forces which are driving toward unity on one hand and chaos on the other; toward interdependence and toward independence; toward standardization, cooperation, and organization as opposed to disintegration, differentiation, and disorganization. We have the materialists who concern themselves with invention, technology, resources, and science; and we have the idealists who are concerned with opinions, wants, policies, and faith.

Does technology determine world order or does the culture determine the technology? "Which comes first, the chicken or the egg?" When the British pulled out of Burma they left a railway system that was fully operative and in good order, but within nine months not a single train

was running. Saudi Arabia has received considerable compensation from the operations of our oil companies on the Persian Gulf. What is she doing with it? Most of it is going into a railroad from nowhere to nowhere. The sultan feels that a railroad is indicative of a modern state. On the other hand, England has an industrial economy based on technology, but world events have undermined the foundations upon which it was built.

Life is like a gyrocompass—you can't expect it to hold a true course if the rotor is out of balance.

So then let's look at some of the trends which have been generated by technological progress through recent years. We find:

1. Tradition is relegated to a lesser role.

2. Technological skills are rendered obsolete.

3. Education is directed toward science.

4. Social control is becoming more and more a matter of public administration.

5. Emphasis is placed on food, clothing, and housing because technology is capable of supplying those items.

6. Legislation is directed toward the material wants of life, and that such wants play an important part in the structure of new constitutions.

7. In the conduct of war, materiel receives more emphasis than personnel.

8. Power differential between great and lesser nations becomes more pronounced.

Now let's consider the course as it is being presented to you. It is divided into six major areas. One group will be delving into those problems just enumerated in great detail. Personally, I consider an understanding of the explosive, disruptive sociological effects wrought by our advancing technology to be of extreme importance. Admittedly, it's somewhat like having a bull by the tail and trying to look him in the eye—a difficult feat at best. But only through the establishment of a balance ethically and technically can we as a nation—and on a global scale between nations—achieve that well-deserved, peaceful, bountiful life we all long for.

While I have just placed much stress on the sociological side of technological progress, please do not infer that this is the only important part of the course. It definitely is not!

In addition to the study of technological progress as a factor in the cultural and economic growth of a nation, the course includes a comprehensive study of technological progress as an element of military strength. Here you will study the relation of science and technology to the accomplishment by the Department of Defense of its military mission. Certainly the need of obtaining and maintaining technical superiority over any possible coalition of adversaries cannot be passed over lightly.

To achieve superiority demands the translation of ideas into materials. Our vast industrial empire exists primarily because of its ability to accomplish this translation. How it takes the seed of an idea and nourishes it into the ripened fruit will be the subject of another group. Production of the item--or the harvesting of the fruit--will be studied later in the year. This year, in the industrial field, prime consideration will be given to the search for new materials, new sources of established materials, more effective utilization of existing sources of materials, and the methods and equipment of organizations engaged in such research and development.

The questions then arise: Where do the people come from who carry on this research work? How are they trained? To answer those and other questions, one area is devoted to a study of the role of educational institutions in technological progress. In this area are included the general nature and extent of their activities--personnel, facilities and administrative practices, motivation and financial support, methods employed in the dissemination of information, and their employment in the interest of national defense.

While the technical institutions could be called the cradle of technological progress many of the yearlings are fattened in the scientific institutions of the Nation. Their importance in the over-all picture is often too little understood and is consequently minimized. To provide you with an understanding of their role in the field, a group will explore this source of scientific achievement, giving consideration to the administration, financial, geographic, and functional aspects of such organizations, their affiliations, and the methods of their employment in the interest of national defense.

To complete the picture of technological progress in this country we will have the remaining group study the departments and agencies of the Federal Government--other than the Department of Defense--in order to obtain an appreciation of their influence on and contribution to technological progress. This study will include such factors as scientific and technological resources, plant and manpower, and those elements of government policy and action which condition the advancement of technology, particularly as it relates to national defense.

There, gentlemen, is a brief outline of what the Technological Progress Unit has in store for you. We hope to make it interesting and educational.

Tomorrow, the 1330 period will be devoted to group meetings with your area instructors. Your curriculum book, which has just been distributed,

informs you of your individual assignments. During the question period to follow, those questions which I have raised, applying to your area of study, should be discussed in the group meetings. All questions of a general nature about the course, I will endeavor to answer here.

So let me now summarize briefly: Technological progress is the most dynamic force acting on the world today. It is based on science. Science is advanced through research and development. The people capable of successfully carrying on research and development are generally produced by our universities, research institutions, industrial establishments, and the Government. As research and development impinges on humanity it exerts influences which are both stabilizing and disrupting. It may well be beyond the power of any individual, or nation, to achieve a balance, but time, patience, and understanding offer the best hope for the future. As St. Paul expressed it: "We glory in tribulations also: knowing that tribulation worketh patience; and patience, experience; and experience, hope." (Romans 5:3 - 4.)

Thank you, gentlemen!

I am now ready for your questions.

QUESTION: A short time ago, Dr. Elliott said here that the biggest bottleneck we had was cobalt and carborundum for jet aircraft engines. You stated there was no problem and the jet was off the critical item list; could you elucidate?

COLONEL DIEHL: Yes. I took my information from the "Beehive," published by Pratt and Whitney. They were referring to the J-48 jet engine and in that they have succeeded in eliminating all but a very minute proportion of those two elements. So, as far as that one engine is concerned, the statement I made is true. As far as other engines by other manufacturers are concerned, I do not know.

QUESTION: Is the performance of that engine acceptable to the military?

COLONEL DIEHL: Yes, it is. We are buying it in large quantities.

GENERAL HOLMAN: I would like to make an observation, that is, that technology is probably one of our greatest national resources. It will provide, as Colonel Diehl has stated, this country with the means of multiplying the man-for-man ratio many fold. We must take advantage quickly and effectively of all those things that are done at the factory level, translate our knowledge into finished types of equipment, and actually master the use of very complicated equipment in the area of the battlefield. That really goes all the way through the operational phase, distribution, maintenance, keeping it in order, keeping it calibrated, and being out in front of any potential enemy all the time. I think that this one thing is probably as good a springboard as any we have here at the college to offer you as a guide in the approach to our problems in technological progress.

COLONEL DIEHL: Thank you, General Holman.

QUESTION: I would like to ask a sort of two-way question: First, does the course give the student a look at what is under development in classified information today? Second, if a student has classified information from his last assignment, is it desirable or even permissible for him to use that in his reports and in his public-speaking activities here?

COLONEL DIEHL: Yes, particularly in area B, where we study the military side of technological progress, he will be given quite a bit of information on classified projects; and it is permissible to use classified information in your reports.

However, we earnestly request that, unless it destroys all the meat of the report, that classified information be kept out of those reports. We like to keep them classified restriced rather than secret or top secret. These reports are generally pretty widely disseminated and the security angle there prevents a lot of dissemination that would otherwise be made. But it can be included if it is felt that it is pertinent to the report you are writing.

CAPTAIN MARCY: I would like to enlarge a little bit on the direct answer to your question. We will not, as such, attempt to give you a view of all the current, hottest, latest secret and top secret developments. That is not the purpose of the course at all. We will get into a number of things and touch on those, but it is not our purpose or intent to give you a status report on the bulk of research and development in the services.

QUESTION: Basic research is a universal language of science and the contributions that are made in basic research are pretty much communicated to the world as a whole, whereas in technological progress or applied research, there are certain things that are universally known and other things that are protected as national assets. I understood General Holman to say that technology is a national resource. Where do you draw the line or could you draw a sort of general line as to where applied research is a national wealth, a national asset which is not interchanged among other nations?

COLONEL DIEHL: That is a difficult question you give me, but in general any application that bears upon defense of the country, that has any military usage will most likely be classified, and, as such, the information will not be disseminated. Our development of the B-47 bomber, for instance, definitely, atomic bomb programs and development, those are applied research activities, yet they are classified, and the dissemination of that information is restricted to those who have reason for knowing it. Other items are published through the Office of Scientific Information in the Department of Commerce, those items which do not affect the security of the country.

COMMENT: One of the most difficult things that has come up in the Army recently, as far as the Ordnance Corps is concerned, is the protection of proprietary interests of individual concerns. In other words they have technology know-how that is not subject to patent and, therefore, if we give that away, in the first place we declare ourselves open to lawsuits of various types; second, if we give them away, there is a definite feeling, a fear that commercial concerns will no longer tell the Army some of their innermost secrets because they are not subject to patent protection.

QUESTION: Along the same line, I understood you to say that we in effect had to import most of our information on basic research. As I inderstand it, most of that which is done is done in colleges. Are we doing anything to subsidize that or set it up under basic research agencies?

COLONEL DIEHL: Nothing is being done to subsidize it. The CIA is one agency which, in its Technical Division, tries to collect all knowledge of that nature that it possibly can. These world congresses, which scientists attend, are another good source of that information. It seems that a scientist likes to toot his own horn when he has made a discovery. Scientists' very livelihood depends on the publication that they can give, the way they can spread their information. That is where our scientist gets his reputation. But, as I said in the lecture, the primary source of all our basic science has come from European countries, outside the United States. We have not contributed a great deal in the field of basic science.

GENERAL VANAMAN: What I understood his question to be was, Are we doing anything about it here in the United States? I was just reading this morning that one department alone has some 200 contracts with educational institutions for developing basic science—not applied science.

COLONEL DIEHL: That is true and I misunderstood your question.

The program of the National Science Foundation, which you may or may not know, is a going concern after a fashion. It got a very meager appropriation for the first year's operation. It is under the direction of Dr. Waterman, who was formerly chief scientist in the Office of Naval Research. They are getting a start. The program of the National Science Foundation is to correct that basic science deficiency by sponsoring and searching out scientific talent among secondary school boys, sponsoring their education, and so on.

Probably the one office or agency in the Department of Defense that is doing the most is the Office of Naval Research through its contracts with universities, and, of course, they are not confined to matters of purely naval interest. They are sponsoring innumerable projects. As General Vanaman said, one organization has over 200. I presume he was

referring to the Office of Naval Research. It sponsors a tremendous number of contracts with universities, nonprofit organizations, and the like. It is probably the greatest single source of support for that type of basic research in the country today.

QUESTION: Isn't the Associated Universities, Incorporated, up on Long Island doing a lot of work under the sponsorship of the United States Government to include this whole field?

COLONEL DIEHL: That is another thing I didn't mention. The Atomic Energy Commission now has, I think, three groups—correct me if I am wrong—the group which operates Brookhaven Laboratories, the group down at Oak Ridge, and the Arco National Laboratories. Those are a corporation formed of universities or areas and they operate under contract to the Atomic Energy Commission. They do a tremendous amount of basic research, mostly in the nonmilitary application of atomic energy, the use of isotopes, and so on. That is the general pattern. They operate as an association of universities under contract to the Atomic Energy Commission.

COMMENT: Since this question of what we are doing about basic research apparently is of such universal interest, I would like to offer one comment on it. I think this country did learn one lesson in this area, at least, as a result of the last war, where we effectively used up all of our accumulated basic research. They imported and learned from that. During the war years, we didn't develop applied research and development, prototype production, and actual production, and the end of the war found us with a fairly depleted storehouse of basic research. As a result there has come to us the consciousness of not falling into that error again.

One of the relatively few positive contributions the Research and Development Board has made to this particular question is the issuance of a policy statement which is tantamount to an edict, that no less than 6 percent of the research and development funds applied to the several services will be applied to the area of research, not necessarily basic research. Despite the fact that there is no distinction, clear cut, between basic and applied research, the fact is they are obligating considerably more than that in the Army and Air Force, depending on the definition. Of the 425 million dollars basic appropriation, plus the first couple of supplementals for the fiscal year 1951, from 12 to 18 percent was being applied to the area of research, again depending on definitions. That research, incidentally, covers not only the areas of physical research but human resources, and so on.

Now I should like to make one other observation—trying to reconcile what General Holman said about the actual significance of technological progress to the national defense effort—with reference to an observation made by a speaker this morning that to an economist everything is relative. I would infer from what that particular economist said—he has

made a reputation in research and development—that we are engaged in a very expensive business; that it costs a lot of money.

Well, all things are relative—I will go back to the economists. I think we ought to recognize at the outset that we are spending an infinitesimally small percentage of the total defense budget in so critical an area as General Holman indicated.

I think we ought to take that tack rather than the other. I think we ought to look back to the years prior to this one—where you managed to get close to a billion and a half dollars for research, much less than requested, much less than can be used—but go back to the years before this and look at the paltry sums appropriated for research and development in the World War I years up to the years 1942 and 1943. Compare the paltry dollars spent on research and development with the cost. Notice that the Strategic Air Command operated at a cost considerably less than one percent of the total national defense dollars. We ought to think in terms of what is the impact of the positive development achieved as a result of the application of those relatively few dollars compared to one percent improvement in the capability of the Strategic Air Command. I can't help but offer that thought because there has been a tendency to say that research and development is very expensive.

COLONEL DIEHL: I think we are anticipating the course a little bit by solving all the problems at this time. We could take considerable issue with a number of the statements of the last speaker. However, I think we have stimulated enough interest in the subject.

(30 Oct 1951—250)S