TECHNOLOGICAL PROGRESS AS A NATIONAL RESOURCE

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TECHNOLOGICAL PROGRESS AS A NATIONAL RESOURCE

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Admiral Hague, gentlemen, fellow broken down ball players.

This morning I will discuss Technological Progress as a National Resource. This subject, as will be shown, hits every part of our course on Economic Mobilization. I also intend to cover some of the general administrative details of this unit.

Additional details, which apply to your individual assignments will be covered when you meet with your area instructors this afternoon.

A definition is usually helpful for a complete understanding of any subject. This subject is no exception. Technological Progress has been defined as:

> "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."

The key word here is "improvement". It is the word that we must never forget. We may be born into a culture rich in scientific knowledge. We may be capable of great engineering feats and yet Technological Progress may not exist because there is no improvement. There may be no progress. History is full of examples of this. The incas of South America are one very good example.

Let us constantly keep in mind this definition of Technological Progress. This Unit of your course will be a study of scientific and technological resources. It will be a study of their relationships to the mobilization of the national economy and to the maximum development of the nation's economic war potential.

This unit will include studies of the nature and conditions of research and development. Of the organization, operation, and relationships among government, industry, educational, and private agencies concerned with research and development.

We will also study the relation of joint planning in research and development to joint logistic, strategic, and national policy planning. We will examine representative programs and also give attention to special projects such as atomic energy. We will study the logistical problems arising from developments in new weapons and weapons systems.

Briefly, our purpose in this Unit is to provide you with an understanding and appreciation of Technological Progress. To point out where it fits in an element in the national economy. To help you--and I'll quote from the book: "assess the capabilities and limitations of research in advancing national security."

I believe this scope alone will give you a hint as to why Technological Progress is considered a "National Resource."

Now let us consider the relationship of Technological Progress and Manpower. Manpower is one of the five "M's" of Economic Mobilization. Colonel Van Way told you last Thursday, very dramatically of the present state of our manpower resources. In your manpower studies you will learn how our population compares in number with that of the Soviet Union and how the free world compares with that of the Communist controlled bloc.

This comparison certainly does not favor the United States, or the Free World. Obviously, we can't just order the number of people we might need off the assembly line. The lead time is a trifle too long. People might be machines but they definitely are not machine produced. I believe that the word "machine" is the clue to solving our problem. All of us take pride in our ability to make machinery itself produce more and more of the other machines that satisfy our almost insatiable demands. In this ability to produce complicated machinery the United States bows to no one.

But just being able to produce more, and of superior quality, is not in itself enough. Alone it will not equalize this disparity in manpower.

As Mr. Laurence told you on Tuesday morning, it is the spirit of freedom in scientific endeavor--compared to Russia--which is the foundation for our attack on this disparity of numbers.

In my opinion what we require is the ability to design, develop, and produce end items that can out-perform any that our opponents can develop or produce in the same time. If we as a nation are able to produce munitions of superior performance--then we will be well on our way toward equalizing the difference in numbers that our only potential enemy could hurl against us.

We must enable every one of our people to be the equal of from 3 to 10 of the opponent and this must apply not only to the fighting man, but also to the man in the factory. We must never lose sight of the fact that the outcome of this tug-of-war between nations and groups of nations depends upon every one of us. It does not depend solely upon the statesmen and the combat forces.

I've just stressed the word "production" even though by now you know my subject is Technological Progress. The ability to produce is just as important to the economy and military strength as the ability of the nation to design and develop.

We have only to look at England and her aircraft industry. Discounting her performance claims by 25 percent, England is still a leader in the aircraft development field. But, as we have just noted from Eddy Rickenbacker's experience, England's inability to produce these advanced models, deprives her fighting forces of the superior weapons that would help overcome her manpower shortages.

I think you will agree with me that a man equipped with better weapons can overcome a bigger force.

Korea furnishes us with a fine example. There our jets are scoring kills over the Russian built Migs in an 8 to 1 ratio. Even though some belittle our equipment, this score cannot be ignored. This is good news but it must not give us a feeling of complacency.

One of the earliest written accounts of Technological Progress in its role of an equalizer is contained in the Bible. You are all familiar with the account of how David who was a relative weakling, killed the powerful Goliath. He used a new weapon giving him advantages in range, accuracy, and power over that possessed by his enemy.

Simple though that analogy might be, it does point up the basic idea of how technology is a resource in the manpower field.

Let us turn, now to another field in which Technological Progress can be considered a National Resource. This is in the field of Materials. As you have probably read recently, the Paley Commission points out with alarm the present and predicted status of our natural resources. To summarize and paraphrase this report, we as a nation have very little left and we're using that little bit at a terrifically fast and ever-excellerating rate. At the present time we are a "have not" nation for many critical materials. Even if you discount the Paley Report the fact remains that we must face diminishing proven reserves. And it is in this field--the important field of making our natural resources stretch, that Technological Progress holds forth the greatest promise.

A few of the techniques that are already being used to stretch our supplies include improved methods of exploration and new ways of obtaining greater yield of petroleum and ores from present sources. There are also new methods to profitably extract minerals and oils from low grade sources. There is also the development of entirely new

sources such as the extraction of minerals from sea water. The reclamation from discarded tailings and scrap, and the substitution of the more plentiful for the critical materials are others. Technology is the best way of increasing our natural resources. Spectacular improvements in our national resources position are possible through Technology.

Lets look at money, another of the five M's. Certainly money is a resource, particularly valuable when you don't have it. The financing of our enormous committments, both at home and abroad is not an area which we will study in this unit. However, technology is largely responsible for our expanding world economy. On the one hand Technology is responsible for the expensive weapons of war and for the equipment which we need to be able to use these weapons. I believe we can agree that without these weapons and equipment we would be but a third rate power. They are necessary. But on the other hand technology has given us methods to reduce costs--both in time and money. These benefits apply equally well to those things we just cannot possibly live without, such as toasters and television, as to weapons of war.

Machinery is another one of the M's of economic mobilization. And the machine is probably the best symbol of technological progress that we have. I am now thinking of machinery as the tool of research and production. With machinery we can make more things faster and cheaper. And we do it with less use of labor. With machinery we are able to develop new machines that make possible our research into physical realms, that were undreamed of until a few years ago.

Only recently we read of a machine tool being developed which is completely controlled by an electronic computer. This may permit tremendous savings of skilled operators, set-up men, supervisory personnel, and the time to produce.

I can almost sense the questions that are flashing through your minds. Maybe it will save on operators, but how about the Ph. D's required to maintain it? How about the initial cost? What about its flexibility? Who will furnish the brain to tell the electronic brain what to do? These, and many other questions like these are the type you will be given the chance to explore. My answer to those generalized questions would be--I'll bet the machine will save people, will turn out better work in a shorter time, and it will pay for itself.

The last "M" is for Management. All too often we are prone to think of research and development as applying only in the physical sciences. We are prone to forget about the arts and the social fields. But research in these sociological areas is assuming greater magnitude and importance every day. It is here, in the art of learning how to live with our fellow man that technological progress faces its greatest challenge.

Our moral values have generally been unable to keep abrest of scientific achievements. We need better management, not only in our industrial activity--of our employeer-employee relationships--but also better management of our personal, national, and international affairs. This improved management must come if we are to achieve on a world-wide basis the freedoms that we are so justly proud --those freedoms which are our individual and national heritage. The challenge, gentlemen, is one that faces every one of us in this room--it is a challenge none of us dare ignore.

Let me repeat, then, my contention that technological progress affects every aspect of our lives. It's here to stay and it depends upon every one of us to meet its challenge.

As it applies to our Economic Mobilization Course, I've shown how technological progress ties in with all five of these M's--Manpower, Materials, Machinery, Money, and Management. All through the course here the results of technological progress will enter into your studies, into your thinking and into planning. Our intent is that you will acquire an appreciation of the factors which affect, limit, or control technological progress in the United States and abroad.

We have so far considered technological progress as a National Resource. Let us briefly consider some other aspects of this subject. In the definition remember we have a key word--that word is "improvement." Without research there is very little likelihood of achieving "improvement." Now we find that there are two generally accepted types of research--basic and applied. Basic, or as it is sometimes called, pure research, is the foundation for most technological progress. Applied research, as its name suggests, is the application of this knowledge to some practical pursuit. Development, which follows research, is the production and modification of prototypes and experimental or pilot line models.

Probably the best concept of basic or pure research has been stated by Dr. Dubridge, President of the California Institute of Technology. He says:

> "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."

This then is the beginning or the foundation of all technological progress. It is from this spring of knowledge that all technology flows.

According to Dr. Vannevar Bush, Wartime head of the Office of Scientific Research and Development, there are eight essential elements to technological progress. These are:

First, "an expanding body of science in general--a storehouse of fundamental ideas." "(This body must constantly be replenished through basic research)".

Second, there must be "A constant alertness to discern in this growing body of basic knowledge those points from which practical applications may grow."

Third, "the ideas thus discerned must be tested to determine whether they have merit." (This is the stage of primary applied research).

Fourth, there must be "Reasoned and deliberate examination of the possible outcome in terms of technical performance and of development of ideas."

Fifth, the "setting up of programs for the purpose of producing prototypes." (It is here that careful attention to the second and fourth steps begin to pay off. By the second step we increase the number of possibilities to be explored; and, by the fourth step, we eliminate the least promising of these possibilities. Thus, this fifth step--the expensive and time consuming step--the building of prototypes--is undertaken only when a worthwhile development is almost a certainty. Thus to pin down an idea may only consume paper and pencil, whereas when we build a prototype it may take millions of our dollars.)

Sixth, "Testing of prototypes and re-examining them in the light of these test results."

Seventh, "incorporation of changes and adaptations (as indicated by the test results of the sixth step) and the setting up of experimental or pilot line production models."

Eighth. This step is not, as might be supposed, the production of the final article, but rather another "evaluation and analysis through field testing of the experimental or pilot line models for final elimination of difficulties," before going to large scale production.

To these eight steps we have learned that we must add a ninth to do the job. This ninth step is the "continuous follow-up of the article in service," with the changes and modifications needed to meet the 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.

The most important thing we must remember about these steps is that there is no clear line of demarcation between these various stages. Although the first step is basic research, and the remainder are considered development, each of these overlap. Basic research, applied research, and development are three parts of technological achievement. No one of them is exhausted prior to the consideration of another.

As we consider these essential steps the question naturally arises as to how long it takes from the beginning until the cycle is completed. We cannot give a definite or general answer to such a question. This does, however, bring to mind the importance of time. One should never under-estimate the importance of time. Something available today--now--must have been thought of and started a long time ago.

Let's take the glamour boy of our present day as an example--the atomic bomb. The basic research that lead to development of the atomic bomb happened over forty years ago. Notice I used the word "happened." These very basic discoveries of new fundamental laws of nature were made by more than a dozen different scientists. These discoveries occurred in several different countries. There was little if any realization on their part of what each of these little contributions would play when the jig-saw puzzle was finally put together. That was Step One as shown on the slide.

Step two occurred when a group of able scientists visualized piecing these bits of knowledge together, visualized the end result.

Up to this step, a period of approximately 30 years, much time, but relatively little money had been spent.

Then came Step Three--the Manhattan Project. 3 years and 2 billion dollars worth of extensive, exhaustive development effort under forced draft.

Step Six was White Sands.

Step Eight occurred--as we all know--in Japan. From this there is one positive conclusion that can be drawn. TIME in Research and Development costs MONEY--lots of it.

Step Nine started at Bikini, and is still continuing.

The argument still goes on as to whether or not it was worth it. Whether it was worth the time, the money, the manpower, the moral suasion.

But no matter how much we debate this point, I think you will agree with me--technology is a national resource.

Let us now consider some of the more mundane aspects of the Technological Progress Unit of the curriculum.

Since it is our aim to have each of you develop a broad understanding and appreciation of technological progress, we have drawn up this year's unit to provide timely and challenging areas for your reports. What is more, we have laid out the lectures which support this unit so that the more important and general aspects of the subject will be presented to all of you by lecturers from this platform.

The scopes of the lectures include most of the principal elements of the areas of your reports. Your area instructors will give each of you a copy of the scopes of all lectures which directly support this unit of the curriculum. We sincerely believe that the best in the field have been obtained for your benefit. We take equal pride in the men who have been selected as panel members for your individual group seminars. The knowledge will be made available. The rest will be up to you.

The class is divided into six major areas. Each of these areas has three sub-areas. As all the assignments in this unit are individual reports, seven or eight of you will write on the same general area.

There are 8 students however, who will not be required to submit a written report in this Technological Progress Unit. These 8 will, however, attend each of the seminars and interviews scheduled for the group to which they are assigned. The reason for this arrangement is that each of these 8 students will instead, submit written reports in the Natural Resources Unit.

Now let us look at the areas that are laid out. These in the first area, Area A--will report on the social influences that affect technological progress. They will analyze the ways in which social influences retard or promote such progress. Phases such as "the characteristics of technologically static and dynamic societies,"--"war as a stimulus and deterrent to technological progress" and "international cultural relations to the spread of technology" will be the subject basis of reports. The instructor for Area A is Dr. Ben Williams, who I would like to present to the class now.

Area B, aided by Colonel John Cave, of the Ordnance Corps, Army, will report on science and technology as a factor in the accomplishment by the Department of Defense of its military mission. This study will include the problems of coordinating military research and development of the complicating influences of research and development on munitions and an analysis of the principal time-consuming elements in the research and development phase of munitions.

You may be surprised to learn that not all research and development of the federal government is conducted within the agencies of the Department of Defense. Those of you who are assigned to Area "C" will report on the various research and development programs conducted by the civilian agencies of the federal government. This will include their contribution to national development and security, and the impact of partial and full mobilization on these programs, in civilian agencies. Your course through the tentacles of the National Science Foundation, the Bureau of Mines and the Bureau of Standards will be charted by Mr. Alden Baum.

The contributions of industry to technological progress are well known, but perhaps little understood. Captain Henry H. Hale, U.S. Navy, known better as Bill will be the instructor in Area "D". This area will report on the motivation, organization, operation, and administrative procedures and techniques of industrial research. Here consideration will be given to the factors tending to advance, limit, or retard technological progress in industry. It will include the effect of partial and total mobilization on this program.

If I may use the dollar as a varying denominator in measuring the importance of research in industry--let me point out that in 1952 industry spent 1.2 billions on research. The federal government--including the Department of Defense--spend 1.6 billions. Alongside these 2.8 billions spent by industry and government--universities spent 100 million dollars over and above their research and development contracts with government.

The next area, Area "E" will report on the part played by scientific education, and nonprofit institutions in the advancement of science and technology. This will include the factors that motivate research. It also includes the administration, personnel staffing and financial support of these nonprofit scientific institutions. Their contributions to the advancement of the national security and welfare of the nation will be evaluated. This breeding ground of future Einstiens will be aided by Commander Bert English, Navy.

Perhaps you thought that when the Orientation Unit was completed you could forget economics for a little while. Perish the thought. Science is profoundly affected by economics, just as surely as science itself affects economics. Area "F" is a study of techno-economics. "Techno-economics" is a recently coined expression. It includes the relationship between applied science and economics--the development of this technique--its organization and operation--its contribution to national development and security--and the impact of partial and full mobilization upon it. To ferret out the mysteries of Techno-economics your head huntsman will be Colonel Pierre Kleff, Chemical Corps, U.S. Army.

I would also like to introduce a member of our branch who has just joined us. He is Captain J. B. Swain, U.S. Navy, who will play safety on this team, stopping any plays the rest of us might let get away.

These instructors will meet with each of the area groups this afternoon in the room as shown on the regular weekly schedules. Your assignments to areas are listed in the curriculum book.

A word now about your individual relationships with these instructors. We hope that you will consider us not as teachers and instructors in the usual sense in which these words are used. Rather we would like you to feel that we are members of a steering committee. Most of us have been over much of this ground before. We feel that we can help you to avoid some of the rocks and shoals--and help you take advantage of favorable winds and tides. We will do all we can to help you in charting your course, but a successful voyage into port will require a conscientious effort on your part.

That subject of written reports, requires a word or three. I strongly recommend that before you write down your first word you become thoroughly familiar with the contents of the Industrial College pamphlet entitled "Preparation of Reports". There are other reference books and 'treatises' on style and techniques of writing available to you in the library. However, a good working knowledge of this little guide will help you to write your reports without worrying about format and style. It will permit you to concentrate on the subject. We are interested primarily in substance and not in quantity.

For this reason, we haven't set any fixed limits on the length of your reports. Instead, we have attempted to design the subjects and scopes so that a well-conceived and well-executed report of about 2,000 words should be enough. But again, 2,000 words is neither a minimum nor a maximum. Here now are three simple rules you should remember when you prepare your reports in Technological Progress. They are:

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

(2) "Never write a paragraph when a sentence will suffice."

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

With those pearls 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. Our research institutions, our industrial establishments, and by our 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 any nation, to achieve a balance, but patience and understanding offer the best hope for the future.

As expressed by Saint Paul, "We glory in tribulations also; knowing that tribulation worketh patience; and patience, experience; and experience, hope." (Romans 5:3-4)