UTILIZING OUR LIMITED HUMAN RESOURCES

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

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Mr. Reginald E. Gillmor, Vice-President, Sperry Corporation, was born in Menominie, Wisconsin, in 1887. He was graduated from the U. S. Navy Academy in 1907, and served at sea on a destroyer, a light cruiser, and the battleship Delaware. In 1911 he went to the Postgraduate School at Annapolis to study electrical engineering. In 1912 he left the Navy to join the Sperry Gyroscope Company. The company then had four employees and was having its experimental gyrocompass and other devices produced by contracts with job shops. In February 1913 he went to England to establish the Sperry Gyroscope Company, Ltd., and the European agencies of that company. Upon the entry of the United States into World War I, he re-entered the Navy and became flag secretary to Admiral Sims, commander of the U. S. Naval Forces in European waters. In 1918 at the request of the Navy Department he undertook to reorganize the Sperry Company of New York on a war basis. He later became successively the Washington representative, sales manager, vice-president, and was the president of the company from 1932 to 1946. In 1946 he relinquished the presidency of the Sperry Gyroscope Company to become the vice-president of its parent company, the Sperry Corporation, which at that time had twelve subsidiaries or divisions. In August 1947 he was loaned by his corporation to the State Department as director of the Industry Division of the American Mission for Aid to Greece. In September 1947 he was appointed vice-chairman of the National Security Resources Board; he returned to his former status as vice-president of the Sperry Corporation in March 1949. In August 1950 he was loaned to the Federal Maritime Board for service on a special committee for ship construction subsidies. He is a member of the Board of Advisers of the Industrial College of the Armed Forces. He is a visiting lecturer at M.I.T. and the author of numerous papers on "organization and industrial relations." He is also the recipient of the Melville Medal of the American Society of Mechanical Engineers and the Scott Medal of the American Ordnance Association.

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UTILIZING OUR LIMITED HUMAN RESOURCES

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GENERAL HOLMAN: Gentlemen, our subject for discussion this morning is "Utilization of our Limited Human Resources," particularly in those fields which involve engineering and management. Our speaker is Mr. R. E. Gillmor, who has been a leader in industry for many years. He served the Nation with distinction as a Naval officer, as vice-chairman of the National Security Resources Board, on the American Mission to Greece in 1947, and more recently on a special committee with the Federal Maritime Board.

Mr. Gillmor is a very valued member of our college Board of Advisers and has helped generously in the shaping of our curriculum in the past year or two. He is thoroughly conversant with our educational mission here.

Mr. Gillmor, it is a great pleasure to have you here and to welcome you to the platform.

MR. GILLMOR: Thank you, General Holman. Good morning General Vanaman and gentlemen of the Industrial College. The last time I spoke to the Industrial College was, I think, in 1939, when its quarters were in the old Munitions Building. There has been a very effective change since then--these commodious quarters and many other things. The most impressive change, I think, is the three services participating together. It is one outstanding example of the increased cooperation that is generally felt throughout our country.

When General Vanaman did me the honor of inviting me to talk to the Industrial College, he suggested the subject of motivating factors in executive development. I wish I had felt adequate to speak on that subject. It is a very complex subject, about which I think we know very little. I would like to devote about six months to studying it and making researches in it, talking to other people, getting the groundwork which would be necessary.

What was it that made the Greeks the most brilliant people in the world for four or five centuries? What makes engineers? What makes executives? What is due to inheritance and what to environment? We have much to learn before these questions can be answered.

You gentlemen who are soon to graduate from this distinguished institution are members of a very small and critically important fraternity--the fraternity of the trained administrator and executive. Upon this group rests the very heavy responsibility of planning for others and providing to others a service of coordination. Because of

your training in the Industrial College, many of you will be called upon to serve in administrative and executive capacities in organizing and directing the utilization of our country's industrial resources in the struggle for the survival of our Nation which is just beginning. And the forces engaged in industry in that struggle will be at least twice as great as those in uniform.

It will be my endeavor in this lecture to place before you some of the factors with which our country has to contend and some suggestions as to how our limited human resources can be used to the maximum advantage.

Through a long series of events the world of men is gathering together under two principal political ideologies. These two ideologies are primarily two ancient and mutually antagonistic administrative concepts. One, the centralization concept, is based upon the assumption that the governing authority is omniscient and that the best results will be obtained if all others obey its will. The other, or decentralized concept, is based on the assumption that the governing organization is a ministry for providing order and that the best results come from the maximum of delegation and individual freedom. The American system is simply a way of making possible a complete delegation of responsibility to any individual who cares to accept it.

The ancient autocratic leadership of the Russians has now been streamlined and brought up to date. The modernizing has included a very effective disguise as a "Free Democratic Socialistic People's Soviet Republic," thus repeating six times promises of freedom which they never can fulfill. Under this disguise it has enlisted under its banner many millions of the world's destitute people, as well as many who pity the destitute or who aspire to power over the destitute.

Your own estimates of the Russian strength are more complete than mine, but for purposes of comparison with our own resources I will summarize the potentials of the two countries.

According to published information, the Russians have a marked preponderance over the free world in numbers of primary weapons--airplanes, tanks, submarines, small arms, artillery, guided missiles, and the means for launching such missiles from land, sea, and air. They also have a superior momentum in the production of these weapons and are therefore likely to maintain their preponderance for some time to come.

The Russians also have superiority in numbers of trained, disciplined troops and can constantly add to that superiority by pressing into military service the people of other communistic nations, especially such vast forces as the Chinese. Contributory to this superiority in manpower are the highly developed techniques of the Russian Government in mass control--propaganda, secret police, and an elaborate system of summary punishments and rewards.

The nearest equivalent to a state religion in Russia is the worship of the laws of nature--science, you might say. They have a considerable number of good fundamental scientists and fair engineers. My company has some acquaintance with them and has worked with them. I was over there myself in 1936. They have added to their scientists and engineers by taking over en bloc many groups of Germans and Austrians, among them almost the entire personnel of the guided missiles and nuclear physics research organizations formerly at Pinneminde, in Germany. Like all others in Russia, the scientists and engineers are subject to Communist doctrine, but the indications are that the incentives for accomplishment are effective. According to the estimates of those who have visited or worked with their industries, the skills of the people below the level of the engineer are mediocre but improving.

We have a marked preponderance in industrial potential which can be converted to military purposes. We also have superiority in all forms of transportation and communication, but this is to some extent offset by the greater vulnerability of our industrial interdependence, brought about by the very high concentration of industry in some of our cities. The greatest superiority of the free world, and especially the United States, is in the free and imaginative application of technological knowledge, experience, and skill. The proof of this is in the high level of living to which we have advanced by the free application of this knowledge, experience, and skill. In this resides our greatest opportunity for attaining military superiority. By this we can make one man and one weapon equal to ten to one hundred of our opponents.

Our survival depends on our ability to outdesign, outdevelop, outproduce, and outperform our opponents. In all these efforts our scientists and engineers are absolutely essential. Unfortunately, however, they are very limited in number.

At present the total number of graduate engineers of all ages in all branches of engineering in the United States is 375,000. In addition, there are approximately 200,000 scientists. The rate of attrition of engineers by retirement and death is approximately 10,000 per year. The normal minimum peacetime requirement for new graduate engineers is 30,000 per year. In 1950, however, industry absorbed 52,000 engineers.

Because of an unfortunate series of events, the supply of engineers for the next three years will be abnormally low. The primary causes of this are: (1) the lower birth rate in the 1930's and the consequent smaller number of young men of college entry age since 1947; (2) the decreased entries and graduates during World War II; and (3) an abnormally high entry of GI engineering freshmen in 1946, which created a prevailing belief that the engineering professions were becoming overcrowded, and consequently led to a very low rate of entry from 1947 to 1950. As a consequence of these three factors, the output of engineering graduates in the near future will be inadequate and will lead to a cumulative shortage in 1954 of at least 40,000.

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The number of people possessing talents applicable to military developments and trained for that purpose is far more limited than the foregoing figures would indicate. We can only guess at them. In the scientist and engineer levels there are probably no more than 50,000 talented engineers who are specializing on complex military developments. In the designers, draftsmen, instrument makers, toolmakers, and other experienced personnel upon whom the engineer relies for support, and who if effective can greatly increase the effectiveness of the engineer, there are probably no more than an additional 250,000. This relatively small group of 300,000, or possibly 500,000, specializing in the engineering of military equipment, constitute an exceedingly important military asset.

These shortages of scientific and technological personnel are coming at a time when the momentum in the acquisition and application of scientific and engineering knowledge is at an all-time peak and gaining every day. To give you some perspective on this, I would like to construct for you a curve of this acquisition of knowledge, so that you can better see where we now are.

From all the facts and assumptions that we are able to put together, it is apparent that man's acquisition and application of scientific knowledge proceeded for many milleniums on a very gradual slope. In prehistoric times he conformed so absolutely to what his ancestors had done that for periods of a thousand years or more there was no apparent change in his artifacts. Then, suddenly, one new invention appeared, such, for example, as the bow and arrow, the use of metal, or the potter's wheel. A single invention of this sort changed the life of the people so much that we now designate it as a new culture. One invention per century was a high rate in those days. Invention is another name for technology, that is, the application of science to the arts.

When our country was founded, one of the wisest and most far-sighted ideas of George Washington and Thomas Jefferson was to introduce a strong incentive for invention into the first draft of the Constitution. This was passed by the first constitutional convention and is still the basis of our patent system. At first all patent applications were handled by a committee of three Cabinet members. Several years later a separate Patent Bureau was established. In 1850 the Patent Bureau comprised the Commissioner, two patent examiners, and two assistants. In his annual report to Congress at that time, the hard-pressed Commissioner stated: "We are 900 applications behind and we expect over the next three months to remove this embarrassing amount by working twelve hours a day, reducing the lunch period, and applying ourselves to the disposition of this tremendous backlog."

Today, one hundred years later, the personnel in the Patent Bureau numbers over 2,000. The backlog which worried the Commissioner has now grown to 150,000 applications. The total number of United States patents

granted is now over 2.5 million. The technology represented by these patents has completely changed our life. For instance, in 1810 each family in the United States had on the average one energy slave, including in that term water wheels and farm animals, as well as human slaves. In 1950 each family had on the average 1,400 energy slaves.

Up to World War I man's inventive applications of scientific knowledge were accomplished largely by the "inspirational, perspirational, and observational" process. Facts were usually obtained and put together in new forms by sensorial methods, that is, by seeing, feeling, and hearing. During World War I a remarkable change began to take place toward the more extensive use of extrasensorial methods, that is, methods of abstract thought and mathematical calculation for the purpose of predicting the behavior of that which could not be seen, felt, heard, or otherwise observed sensorially. For example, it was found that guns wore out too rapidly. It was obvious that if they could be made to last twice as long, the extra life would be equivalent to doubling the production. This increased life was obtained almost entirely by extrasensorial methods.

Another example of the sharp upturn in the use of the extrasensorial method is given by the fact that at the beginning of World War I there were less than 100,000 man-made chemical compounds, whereas at the end of that war there were nearly 200,000. By the time World War II came, there were 2,000,000. Now that the 92 universal atomic building blocks and their isotopes are available, they can be put together into almost infinite numbers of combinations. The only materials that are worth stockpiling are the elements themselves. Specific combinations of them, such as steel, are likely to become obsolete before they can be used.

Both the acquisition of scientific knowledge and its application, including invention in the more complex fields, are now almost wholly a result of analysis and synthesis. This involves the very extensive use of mathematics, the first of the sciences, without which no other science is possible.

In many problems the mathematical calculations are so vast that solution by human computers is impracticable. It is here that modern technology has come to the aid of the older art, and electronic computers and analogue or simulator machines have been developed for these weighty labors. These mathematical tools range from elaborate engines half a block long to comparatively simple devices that are suited to a particular problem.

Another consequence of the present high peak in scientific and technological activity is the virtual elimination of the individual scientific worker from the field of major discovery and invention such

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as those required for the military services. Such is the complexity of present-day scientific knowledge, and so high the number of factors influencing any particular problem, that it is seldom any single human being can acquire a sufficient sum total of experience in his lifetime to solve many of these new complex problems of discovery and invention.

In many instances the vastness of the problem is such that the mathematical and laboratory tools cannot be provided by individuals or even by large corporations. They must, therefore, be provided by the people as a whole. An example is the discovery and application of the laws of nuclear physics. Here was a problem that in its initial stages was almost purely mathematical, but that later fanned out into countless scientific researches, engineering developments, and inventions involving risks and expenditures that only the people as a whole could afford to undertake.

From these few facts you can see that the curve of acquisition and application of man's knowledge proceeded on a very gradual slope for thousands of years; began to turn upward at the beginning of the twentieth century; and is now, fifty years later, rising on a rocket-like path. The probable end is beyond prediction. Superiority in the race along this path depends upon the proper utilization of a relatively small number of talented people.

One serious factor which is jeopardizing the proper utilization of our limited human resources is the demand of the military services for technical personnel who are in the Reserves or who are draft-eligible. The services have a need for such men; but, unfortunately, the decision as to their utilization now often rests with branches of the military services and of the Government who are not qualified to make the best judgment as to the utilization of technical people.

There is an old administrative axiom which says that a decision should be made in the first instance at the level where the problem arises. This principle is not being observed in the utilization of technical personnel for the military services. It could be. They could make available technically qualified personnel at the level of the problem in industry and in the military services. Many of you gentlemen will be at that level.

Mrs. Rosenberg, the Assistant Secretary for Personnel in the Department of Defense, fully understands the importance of proper utilization of technical personnel and will in time be able to solve this very difficult problem. Up until now, however, it remains unsolved, and is jeopardizing the development of military projects by the withdrawal of irreplaceable technical personnel.

The situation of the United States is quite different from what it was in World War II. Then we had a preponderance of the world's population, weapons, and natural and industrial resources on our side. Now in many cases the opposite is true. In World War II we could afford to be inefficient in the use of our experienced, skilled, technological personnel. Now our survival demands that we use them with the utmost effectiveness.

One consequence of our shortage of technical personnel, as well as our inferiority in total number of people, will be to force a more scientific understanding and application of the principles of good administration. This impact will arise from the fact that the rapid progress in science and technology involves a rapid increase in specialization. Specialization is effective only to the extent that it is accompanied by commensurate cooperation. The executive and the administrator are usually the limiting factors in organizing to get cooperation. Progress in cooperation cannot reach a maximum until it is the result of a balance between freedom and responsibility. Therefore, the effective use of the rapidly increasing specialized knowledge will require the development and application of administrative techniques which will bring cooperation through the development of individual responsibility and commensurate freedom.

You gentlemen are students as well as practitioners of the art of administration; but, since I also am an old practitioner, I will endeavor to give you a few administrative and executive tools that have been fashioned from my experience and that I find are easy to remember. The things in the books are sometimes not so easy to remember. There are too many of them.

One tool that I think may be of value is an understanding of the law of distribution of human talents. In any group of 10,000 people the distribution of any one measurable talent will always fall on what mathematicians call the "probability curve." It is a bell-shaped curve. Very few people have little or none of the talent, the great majority fall somewhere in the middle, and very few have an extraordinarily high degree of the talent—at the opposite end of the curve. This bell-shaped curve is also characteristic of the distribution of the magnitude of the stars, the size of grains of sand, and a great many other things. It can be said that the curve expresses a natural law, which for want of any other name we can call the law of universal inequality.

Most human talents can't be measured; and, even if they could, the results would be only a partial indication of the complex combination that makes the whole person. Nevertheless it is true that there are very few people of exceptionally high inherent ability, very few with none at all, and a great middle ground with a useful amount.

People with a high order of ability should understand that their natural and acquired gifts carry with them a corresponding responsibility to use them for the good of their fellow men as well as for themselves.

Moreover, those who do not have those talents should realize the great value to them of the services rendered by those who do have the talents. Our whole civilization is lifted up by a small percentage.

An especial responsibility of those in executive positions is to find and fully utilize the talents of those who are subject to their direction. You can't say: "That fellow is just a no-good bum. He had just as good a chance as I did, but he didn't take advantage of it." That is not true. He didn't have as good a chance. He wasn't born with the same talents.

One consequence of the wide distribution of human talent is the specialization which I have described. People like to do that which they know they can do well. As our acquisition of knowledge increases, specialization increases automatically to correspond. For example, the field of atomic energy is comparatively new. It began a little more than ten years ago in pure mathematics. Even though most of us know very little about this subject of atomic energy, because it is so highly classified, we know enough to venture the guess that even in its early mathematical stages it involved scores of specialists, each working on some phase of its mathematics. At present in its practical applications, even though it is a new branch of science and engineering, it is involving thousands of specialists. One indication of this is that the labors of the Atomic Energy Commission staff and its contractors have in the past few years resulted in the publication of sixty full-sized volumes which are unclassified and another sixty volumes which are classified.

I think you will agree that a basic human characteristic is the desire to be worthy, whether it be as a member of a gang of hoodlums or as a participant in a useful organization. Anyone who does not have a sense of worthiness feels himself to be an outcast and is likely to go berserk. Therefore, one of the principal responsibilities of the executive and the administrator is to so plan things that those working with him will have a sense of worthy participation, a sense of dignity, if you wish, using "dignity" in the best sense of that word.

Closely related to the desire for individual worthiness is loyalty to the group with whom the individual is working. The so-called Hawthorne experiment of the Western Electric Company, the studies of Elton Mayo, and the psychological researches made by the military services during the last war all show that the sense of loyalty and allegiance is most intense in a small group of comrades working together. It becomes less and less intense toward higher and higher echelons, until finally, when it gets to the United States, it is a very abstract thing. One lesson for the executive that can be gained from these studies is that he is most effective when his loyalty toward those he is directing is at least as great as that toward those above him. People accept our orders and directions and act upon them most readily when they know that we are loyal to them.

It is extraordinary how loyalty and consequent effectiveness within a small group down the line in an organization can affect the whole organization. An example of this is given in Commander Lederer's interesting and amusing book "All Ships at Sea." In this book he tells of a demoralized ship. Then he tells how that ship was completely rehabilitated by the example of a negro steward, who came in and with firmness, but also with intelligence, made his own group spic and span. He made them keep the officers' quarters clean. That made the officers so ashamed that gradually the whole ship became completely rehabilitated. Eventually it became a very efficient ship, standing near the top in the competitions of the Navy. I have seen that happen in other places--in industry as well as in the military service.

Elton Mayo in his book "The Social Problems of an Industrial Civilization" says: "The business of the manager is to facilitate a balanced relation between various parts of the organization so that the avowed purpose for which the whole exists may be conveniently and continuously fulfilled. If he is not successful in this, he will have no actual authority in the organization, however important may be his title." That is a simple thing, something I always bear in mind and find easy to remember. I find that it always is true though sometimes forgotten.

An approximate definition of authority which Mayo quotes from Chester Barnard is that "It is the character of a communication (an order) in a formal organization by virtue of which it is accepted by a contributor or member of the organization as governing the action he contributes. Thus, authority depends upon a cooperative personal attitude of individuals on the one hand and the system of communication in the organization on the other."

Successful coordination requires good organization structure. Most of us know from our own experience how much more effective we are when we have a job which constitutes a challenge but is still within our powers, when we know what is expected of us, when we know to whom we are responsible and that he will trust and cooperate with us, when we know the duties of others with whom we must cooperate, when we know how we will be judged and that the judgment will be objective and as free as possible from human prejudice. That is the very heart of good organization. You can write books about it, but the principle is simple. The techniques for obtaining good organization are well known. As in many fields of human endeavor, the trouble arises not from the complexity of the unknown, but in the failure to apply that which is known.

There are many simple techniques which I have found it well to bear in mind when organizing any activity. The first step is, of course, the distribution of responsibility, which can be expressed by charts and manuals. A lot has been published on how to divide it, but I will start with a rule that I learned a long time ago, and that is to divide into the minimum number of distinct and dissimilar entities.

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In dividing into the minimum number of dissimilar entities it is useful to bear in mind a maxim of Mooney & Reilly, who point out that there is no conceivable job, no matter how simple or how complicated, that does not involve three things, these being (1) planning, (2) doing, and (3) interpreting what has been done. If your wife asks you to peel some potatoes, you must first get the potatoes and the utensils and a place to do the job. This is planning. Then you must do the job. Finally, if you want to stay on good terms with your wife, you must inspect what you have done to see that you didn't leave on one of the eyes or leave in a rotten potato.

At the opposite extreme, we have in the Government of the United States the legislative (or planning) branch, the executive branch, and the judiciary. We are so instinctively aware of the very vital importance of those things that at the time of the attempted manipulation of the Supreme Court by the executive some fifteen years ago there was the biggest public uproar that ever had occurred in this country. The Western Union Telegraph Company was so tied up in knots by the traffic in protesting telegrams that it took four days to clear up the backlog into Washington.

In any well-organized industrial institution you can find the planning (or administrative) function, the doing (or executive) function, and the interpreting (or judiciary) function distributed throughout the vertical and horizontal lines of the organization chart. The board of directors is primarily interpretive; the president is usually the policy-making or planning officer; and the general manager or executive vice-president carries out the plans. In the horizontal distribution we find the same thing. Engineering is a planning function; manufacturing is a doing function; and sales engineering is an interpreting function. In each of these you will find it broken up again, vertically as well as horizontally, into the three things—planning, doing, and interpreting.

In any large organization, whether industrial or governmental, there are many auxiliary services required, such as those for legal advice, purchasing, public relations, building services, economic advice, and so on. These auxiliary services are usually referred to as "staff." The "line" represents the authority of man, the "staff" the authority of ideas. Staff, as the term implies, is something to lean upon, not something to hit you over the head with, although staff sometimes tries to do that.

Another useful maxim is that relating to span of control. I don't know how many organization charts I have looked at where the span of control of interdependent functions was such that nobody could coordinate it. The rule of span of control is very flexible; but, if the functions are interrelated and dissimilar and have to be coordinated, and if you get beyond five, you are going to be in trouble.

There is a limit in size and complexity beyond which a line and staff organization cannot be developed without incurring diminishing returns. It is for this reason that so many organizations have

decentralized into a multiplicity of autonomous and relatively self-sufficient units. A manifestation of this principle of decentralization was the task forces of the military services which were organized during the war and which established a trend that will probably become more and more manifest in military operations.

One of the finest executives with whom I ever served was Admiral Sims. At the risk of stating the obvious, I am going to conclude this talk by giving you some of the precepts I learned from him and that I have proved through long executive experience of my own. You won't remember these precepts in detail, but I hope you will remember the general idea. Here are some of the things he used to say.

"When you have inspired loyalty in all your men, more than half your troubles will be over.

"Maintain discipline with the minimum reference to higher authority.

"Always be considerate of inexperience.

"Be absolutely just in all your dealings with your men.

"Avoid harshness in manner or methods.

"Never destroy or decrease a man's self-respect by humiliating him before others.

"Do not let the state of your liver influence your attitude toward your men.

"Remember that the purpose of all forms of punishment is correction—correction of the offending individual and a warning to others.

"Before you take any action, or adopt any line of conduct, consider carefully its effect upon the man's loyalty, upon the development of his character, and its effect upon the discipline of the organization.

"Remember that every single one of your official acts exerts a certain influence one way or the other.

"Avoid hostile criticism of authority, or even facetious or thoughtless criticism that has no hostile intent."

Perhaps these precepts are ideals which few people can fully live up to. Nevertheless, the spirit which runs through them is something we can all remember and use in dealing with our fellow men, getting our

decisions accepted, and attaining the highest level of cooperation within the organizations for which we are responsible. We can all learn, no matter what our age.

In my Maritime job I have a colleague who is a lawyer. He is a professor at Georgetown University. He tells me that there is a very sharp distinction in law between "malum prohibitum," meaning "bad because prohibited" and "malum in se," meaning "bad of itself." "Malum prohibitum" means that just because the law says so, it is prohibited. He says that all of the "malum in se" are offenses against human dignity.

Have I said anything provocative enough to arouse any questions?

QUESTION: You put forth a thesis that we are all born with certain inherent capacities and capabilities. In fact, you gave several instances to prove that. I would like to ask: If called on, couldn't you put forth an argument equally strong in the opposite direction--that we all have the ability to develop these things? Couldn't you make a very good argument in the other direction?

MR. GILIMOR: Yes. We have the ability to develop those qualities which we possess. We can develop them to a very high extent. The students of animal behavior tell us that every animal is the result of an inextricable combination of inheritance and environment. What we do with our inheritance and environment is largely under our own control.

QUESTION: It may be that your remarks on criticism may be an answer to this question. But in connection with your third element of "interpretation" in an organization, there are a great many people who hold that griping is a very excellent indication of a virile organization. Would you comment on that?

MR. GILIMOR: I think you are right if it is not hostile and destructive.

Our own diversities of opinion are very constructive and useful. A Japanese educator, when asked why they made the mistake of going to war with us, said they made three terrible blunders. One was, they overestimated the Germans. The second was, they underestimated us. But the worst was the belief that our diversities of opinion were an indication of weakness. He added that it was their own monolithic and state controlled opinion which was their greatest danger to them. Our diversities of opinion, if they are constructive, are very useful. Even if they are not constructive, they may lead to something which is constructive.

QUESTION: I was interested in your remarks with respect to the services taking technical personnel—specialists, I believed you called them. I wonder if you would take the reverse of that and discuss for a moment the responsibility of industry to ask for deferments of only

actually key people. I have in mind that during the war, where deferments were asked, people were declared to be indispensable when too often in fact they were not indispensable, but could have been replaced by older people or by female workers. I wonder if you would discuss that feature of the problem.

MR. GILLMOR: Yes. Unfortunately, that is one of the causes of losses of technical personnel--specious claims. One example was where toy manufacturers claimed that toy designers were indispensable. There were all kinds of misrepresentations of that kind. That is why the first decision should be made by an objective representative of the military service at the level of the problem. No graduate engineer employed on developments for the military services should be taken without reference to a technical board at the Department of Defense level.

QUESTION: I would like to follow that up a little and ask you if you would elaborate a little more on the question of utilization of technical personnel within the services.

MR. GILLMOR: Yes. For example, right now the services require noncommissioned officers with electronics ratings because of having a lot of these new electronic developments in the services. So they spot some fellow who has a bachelor's degree, who is doing electronics work and has been in industry for several years. They take him because he is in the Reserve, and they make him a petty officer or an electronics technician in one of the services. That is bad utilization. A good utilization would be to take a radio repairman--they could train him quickly.

The services have the problem of operating and maintaining their complex systems. They can find men with a good understanding of electronics, who are not college graduates, and train them in a year or so to maintain these systems.

It is not a question of the nonutilization by the military services, but proper utilization. On the other hand, the military services require people with the bachelor's or doctor's degrees to initiate and supervise new developments but they should not rob the developments of one service in order to take care of the management of the developments of another service.

QUESTION: I have a philosophical question. It is generally recognized that the only edge which we might have in the scientific arts is the edge on technology here in the degree of literacy in this country, and that the prosecution of that edge, leading to scientific developments, is going to be the ultimate determinant. To carry that thing through, the more complicated these items become, the more difficult on the average it will be for the individual working on them to understand their complexities. So my philosophical question is simply this: Aren't we by our alleged edge developing a situation that is ultimately going to be a Frankenstein for us? What do you think about that?

MR. GILLMOR: I don't think so. I think the more complicated they get, the more specialists you must have but the more automatic they become. They require less effort really to operate than they would otherwise have.

Let me take an example--the bomb sight is something that used to be a very mysterious thing. It has a different name now. It is called a navigational bomb control system. It is infinitely more complicated. Six or seven years were required in which to develop it. On the B-36 it comprises 23 separate units, distributed over the frame. It costs about $250,000 a unit when made in quantities of one hundred. But it takes only fifteen minutes to teach somebody to operate it. That is about all. To teach a man to maintain it, he is put into training at the time when it goes into production. It takes one year to produce. By the time the production is finished, the man has learned how to maintain it.

That bomb sight is designed to take a plane from any point on the earth's surface to any other point, with or without visibility, and deliver a bomb load at any altitude from 45,000 feet to 200 feet, at any ground speed up to 1,000 miles an hour. To do that it automatically performs a lot of computations. It would be far more of a Frankenstein, as you call it, if you had to contend with those things without the electronic system.

It took a lot of master minds to work this thing out, but it is perfectly usable. It seems that no one person was able to comprehend it at one time, but little by little various scientists and engineers worked it out.

GENERAL VANAMAN: I have another illustration of the remarkable value of that bomb sight. When you are going in on a target, it is often necessary to take evasive action. When you do that, you just flip a switch. Then, instead of making all those calculations over again, by flipping the switch you throw in your memory system and come right back to the same place automatically.

MR. GILLMOR: That is a very good example.

GENERAL VANAMAN: It would be impossible to make that calculation if you had a thousand scientists on board. It is too fast.

QUESTION: I have a feeling that perhaps the point behind the last question may have been missed. I wonder if he is not driving at the fact that the development of luxury living by the individuals of our society will make us become so dependent upon every other person that one small slip, one break, will mess up our whole society, and that it may develop into a Frankenstein.

MR. GILLMOR: It may be a possible intermediate stage in the course of mechanized evolution, but I don't think it could possibly be the eventual stage. I have a strong conviction in the truth of the thesis

that Lecomte dü Noüy speaks of in his book "Human Destiny." He says that the trend in evolution is toward what he calls the spiritual evolution of man. He doesn't mean it in a religious sense. He means it in an intellectual and inspirational sense. In this evolution he is reaching the point where he will be less dependent upon physical struggles, and be able to develop a higher morality.

QUESTION: You gave us some figures as to the number of engineers in the United States. I wonder if you have any comparable figures on the Soviet bloc.

MR. GILLMOR: I don't think I have. The only indication I can give you is that in the last Five-Year Plan, which ends in 1953, I believe, they stated that part of that plan will be to produce 150,000 engineers. That is at the rate of 30,000 a year. Presumably they have been following that same plan, which would give them about the same number as we have. So they are probably no different in number from what we have, but in effectiveness they are far lower, as I know from my own observation.

COLONEL BARNES: Mr. Gillmor, on behalf of all of us I thank you for your very helpful discussion of a most important subject.

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