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DEFENSE REQUIREMENTS

Honorable John H. Rubel

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

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DEFENSE REQUIREMENTS

12 October 1962

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington 25, D. C.

Mr. John H. Rubel, Deputy Director of Defense Research and Engineering, was born in Chicago, 27 April 1920. He received his B.S. in electrical engineering with honors from the California Institute of Technology in 1942. Following his graduation he was associated with the General Electric Company for 3-1/2 years in the GE Research Laboratories, briefly with Lockheed Aircraft Company and then joined Hughes Aircraft Company in 1946. Mr. Rubel's industrial experience encompassed the field of airborne systems including radar, digital and analogue computers, guidance and control systems, communications subsystems, etc. While with Hughes, Mr. Rubel contributed to the development of one of the earliest successful automatic celestial navigation systems in this country and also was associated with the development of the Falcon family of missiles. In 1952 he joined the radar laboratories, later renamed the Airborne Systems Laboratories of which he was named director in 1955. It was from this post that Mr. Rubel came to the Department of Defense on 19 May 1959, where he was Assistant Director of Defense Research and Engineering (Strategic Weapons). Mr. Rubel served as Acting Director of Defense Research and Engineering during the several months in the summer and fall of 1960. For this service as DepDDR&E and Acting DDR&E, Mr. Rubel received the Secretary of Defense Meritorious Civilian Service Award on 16 January 1961. This is his first lecture at the Industrial College.

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12 October 1962

ADMIRAL ROSE: You have only to read the daily papers to realize that the amount of money being spent on research and development in the United States is not only very large, but is still increasing. A great deal of this money is spent by the Federal Government, and of that, a very, very great deal is spent by the Department of Defense. You all know perfectly well that there are sometimes growing pains; there are even differences of opinion about where this money might best be spent.

I can think of no one better qualified to tell us about this program and what is going on than our speaker this morning. It is a great pleasure to introduce Mr. Rubel, the Assistant Secretary of Defense, for Research and Engineering. Mr. Rubel.

MR. RUBEL: Thank you very much, Admiral Rose. I would like to say, to begin with, that it is a great pleasure for me to be here today and to have this opportunity to address this very distinguished audience. Before I came I looked over the list of people who have addressed you before. I signed the guestbook just under Roswell Gilpatric's name and I must say that I would rather be sitting where you are than standing where I am right now.

I have been asked to speak about "Defense Requirements," but the guidance that I received and the guidance which I would tend to give myself is to limit my remarks, or at least to focus them on the part of requirements that concerns research and development, and that is what I am going to do today.

These requirements, of course, are really the most important, in a sense. They are the most important because they have the biggest impact upon the shape of our military forces, especially our military forces in the future. They are the most important also, because they are the least routine. We have requirements for all kinds of logistic supplies. I am sure somebody has to figure out how many shoes and how many shoelaces, and how many items of ordinary use are required for troops located in very remote parts of the

world. This is a complex but nevertheless routine kind of business in the field of requirements.

But in the field of research and development the term "requirements" has other meanings and deeper significance, and that is what I would like to concentrate on today. We all know, of course, that modern military developments, modern military evolution, is governed by technical and by technological developments and opportunities to an increasing degree. This is so much the case, that sometimes I think we almost overlook, some of us, the great impact of nontechnical and nontechnological factors in the growth, maintenance, and conduct of our military affairs.

But technology is all-important, or, if not all-important, very important. And in many ways, requirements affect the growth and development of technology. And requirements are important of themselves because when we concern ourselves with requirements we find ourselves confronting several very important and difficult interfaces. We have interfaces between people of different skills; between people of different backgrounds and disciplines; and between people of different attitudes toward the job they are trying to do. And these differences are of transcendant importance.

Another way to express these interfaces in terms of people and their skills, is to say that we have an interface between the scientific and technological community on the one hand, and the military community on the other--whatever those generalities mean; between the user and the specifier--another important interface; and between industry and government--another important interface. All of them have a bearing on how we go about our job. Requirements enter into every one. These are some of the principal facets that I will try to touch upon during the balance of my talk.

I am going to cover this subject under two principal headings. First I am going to talk about what "requirements" mean. What does that term signify? And after I have talked about that, I am going to talk about some of the principal problems associated with requirements, with the way in which we handle them, and the manner in which many of you, as well as some of us, are involved and will become involved in the requirements process.

The term "requirements," of course, sounds very simple. Dr. York used to have a saying, though. He said, "the word 'work' sounds verysimple too, and every housewife thinks she knows what

'work' means. But to a physicist the term 'work' means something utterly different from what it means to the layman or to the housewife." And, he used to say, "The word 'requirements' means something entirely different in the Pentagon than what everybody outside of it thinks 'requirements' means."

What does "requirements" mean? We use the word in a number of different senses, and I am going to begin to describe these to you, but in the process of talking about it in the balance of my presentation you will find that even I will start to use the word "requirements" in more than one way.

Well, first, the word "requirements" can mean the same thing as "needs." We require or need something, and in this sense the two words have the same meaning. What is an example that is relevant to research and development for military weapons and supporting systems, of that connotation, the connotation of needs? Well, we need to be able to deploy the military forces of the United States quickly to areas which are remote from the United States. We have determined that time is important and that the consolidation of enemy action or of potential enemy action can put us at a very significant disadvantage. Therefore, our posture needs to be one in which we can quickly respond to confrontations, or potential confrontations. How can we solve that need?

One way would be to develop long-leg air transport to carry our forces from the United States to any part of the globe where they may be needed. Another way is to deploy our forces in forward areas like Hawaii and Alaska so that we do not have to transport them as far as if they were located in the United States, although intertheater transportation may still be needed.

A third solution is to deploy them right on the spot. We have forces in Berlin, Hawaii, and the CONUS, fulfilling our needs in each of these three ways and we are developing long-leg air transport.

Our requirements relative to that can be perceived under two headings also; the quantity of that transport and the character of that transport; how many airplanes of a given type should we buy; how many supporting and auxiliary systems should we provide ourselves with; and what should be the character of those improvements or of those follow-on developments that we can perceive as fulfilling needs relative to this basic military requirement?

Now, the word "requirements" can mean something just a little different than just needs. It can mean something which we often call "desirements" as distinct from requirements. And there can be some very valid and important "desirements" which nevertheless differ from "requirements" in the previous sense.

Many betterment programs, programs to improve, alter, modify, are responsive to this kind of requirement. Let me try an example here. Suppose we could reduce, through advanced development, the weight of all weapons and auxiliary equipment needed in the support of troops by 50 percent without changing the characteristics of these weapons or equipment. We could then greatly lower the numerical requirement for transport aircraft because we could put more equipment on a given airplane. Now, we could not put twice as much in all cases because there is a bulk limitation as well as weight limitation on what one can carry in an airplane, but nevertheless great reductions in weight would accomplish great savings in transport. And so, we could establish, and we do establish, requirements to reduce the weight of equipment, largely, or in any case, partially, for the purpose of easing the burden of transporting our forces to remote places.

Now, here a decision is required which clearly involves tradeoffs. We must assess the costs versus the gains. Is it cheaper to buy more airplanes, or is it cheaper to develop new materiel? And there will be advantages to having developed that new materiel from an operational point of view. What are those? There will also be advantages to deploying more aircraft for transport. What are those?

Clearly, this sort of "requirement," then, does not exist in a vacuum. It is not an absolute. It is not a given. It is not a thing that can be handed down as if not subject to modification in any way, but rather, is the product of a process of assessment and evaluation. It has no sacrosanct, unalterable quality, or, it should not have.

Now, the word "requirements" can mean "desirements" which sometimes appear to other than the originators to border on wishes. Wishes is a hard word, and it may be an inadequate one, but it is the best that I have been able to think of so far. For how else would you describe "those military missions essential to the maintenance of our national position and prestige" including a system of manned bases on the moon?

Such "requirements" have been officially presented to the Department of Defense. They were presented more than four years ago. What do they have in common with the kind of examples that I have given before? To some of us they seem to belong to a somewhat different logical category.

But now I want to make my next major point, and that is, that "requirements," whether they represent "needs," "desirements," or "wishes," are documents, and they are documents on which action is based. Requirements lead not only to things that will be used by the fighting man or that will support the fighting man, requirements lead to action and to the expenditure of effort.

Now, not all requirements lead to action and to the expenditure of effort, but all major actions and the expenditure of all major efforts in the field of weapons development stem from some kind of requirement document.

Now, let us talk about action and effort in the field of research and engineering. At the present time almost 50 percent of all the scientists and engineers in the United States that are working on research and development are being supported by the Defense Department, chiefly the Army, Navy, and Air Force. The ARPA and the National Security Agency support a very small fraction of the total; eliminating those would not alter significantly the statement I just made.

This effort represents $7.1 billion in fiscal year 1963. In the entire United States all sources, public and private, for research and development add up to a total of only approximately $17 billion for R&D of every variety. And in many fields--in electronics particularly--which involve physical science and physical scientists, the military departments are far more dominant than these statistics would indicate. In many fields we estimate 80 percent of the scientists and engineers working on advanced developments are doing so on military projects supported, directed, and managed by military personnel and military departments.

And finally, in this connection, in connection with effort, in connection with doing work, I would like to point out that every "yes" decision implies or is balanced somewhere else by a "no" decision or a set of "no" decisions. You can not just have "yes" decisions. For every "yes," somewhere there is a "no," or a set of "nos."

Now, some people have the notion that really is not quite true; that there isn't anything we want that we cannot get if we are willing to pay for it. But that really is not the case in the field of research and engineering where there are a total of only 300,000 or 400,000 scientists and engineers in the entire United States trained to conduct research and engineering undertakings in the field of advanced development. It does not make any difference how many dollars we say we have, we only have that pool of resources to utilize. Our dollars are no more than a measure and a means for dipping into that pool. And sooner or later--over any short period of time, particularly, every yes decision is equaled some where else by a no decision.

So, the fact that requirements leads not only to things, but to effort and to work, is particularly important in the field of research and development, where our national resources are limited and where a very large fraction of these are under the direct supervision and control of the Department of Defense.

I would now like to come to the third portion of my remarks, and speak about some of the problems of requirements. I am not going to talk about the problems of an organizational or administrative character, but rather about the problems associated with the nature of requirements, their impact upon the work which is stimulated by or stems from, or is based upon them, and the problem that we have in bringing into a common focus the variety of efforts, skills, and viewpoints necessary to accomplish the proper objectives at which these requirements are aimed.

Problem number one is to separate important from nonessential needs "in the large." Now, I often wish that those who are charged with the preparation and approval of requirements documents would ask themselves this question--"Suppose that requirements" were automatic commands?" (You see, I am using the word "requirements" now in the sense of a document, in the sense of an administrative or bureaucratic tool.) "Should this one be issued?" People are going to work to achieve what you have written down on this piece of paper. Should they? Is that what you really want? The fact is, of course, that we do not anymore really consider the bulk of our requirements that way.

Thence stems an important problem. It is the problem that arises when important and nonessential requirements coexist. For when important and nonessential requirements coexist it becomes

for somebody to separate the essential from the nonessential, the important from the nonimportant, the more important from the less important; and if that somebody is not the one who orginated the document one may then find that a different authority, a higher authority, a different echelon, perhaps even a different organization, has injected itself into the entire process of validating or at least of acting upon these so-called requirements.

I say "so-called," because documents such as these may not reflect true needs. I consider this an important problem--an important need--to separate important from nonessential needs "in the large," and to regard each of these as if they really were commands that were going to be followed, and ask, "Are these the commands that should be issued?" "Is this the work that should be done?"

The second problem is to recognize that requirements are part of a dynamic process, and must be developed in accordance with the requirements of the process. Let me see if I can tell you what I mean.

It is not enough to say that we need, desire, or wish that we could have another airplane that will fly higher, or faster, will stay in the air longer, or will go to a longer range. It is also necessary to concern oneself with the impact of such a device in many other ways and in many other areas. One needs to worry about the operational suitability of such a device, whatever it may be; of how it will be supported in the field; of its probable reliability, and the development goals stemming from reliability requirements; of the problems associated with training personnel in order to absorb the system in the environment where it must work. All too often, requirements really do not comtemplate all of these elements. In fact, many requirements that I have seen really contemplate what I call "an engineering tour de force;" a very interesting project, a very stimulating project, the kind of documents, the kind of goals, the kind of objectives that an enthusiastic engineer would like, but scarcely the kind of document or the kind of goals that one associates with military operations, with military needs, with the realities of military exigencies, especially in the field. And I think that is a problem, or at least an observation.

And thus the conclusion to this second problem.

One must place requirements, and especially the specifics thereof, in context of the environment, both technical and military, which are involved in the dynamic process that translates these into actions and things.

Third is the problem of attitude or viewpoint, particularly of attitude or viewpoint towards the requirements themselves. Now, there are some people--I have talked to many--who really think that requirements are goals, or even goads; that one should write requirements so that people will work hard to meet them and hopefully will do what you really want them to do somewhere along the the line. I have gotten that feeling--not only that feeling, that specific expression--from many of my military friends, particularly.

And I would like to comment here on this attitude that regards requirements as a thing that is going to stimulate industry, or stimulate scientists, or engineers--I would like to comment on that attitude as distinct from the attitude that says, "This is a need that I certify to as a military man, representing that need in my department.

I think there has been a very interesting reversal of roles between the military community, if you can use that term, and the scientific and technological community, if you can use that term, in the past 15 years. If you will read some of the books that were written and look at some of the testimony that was given in that period, you will find that the leading scientists connected with military matters during and after World War II felt that it was their job to force the military to accept the products of science and technology.

And there were a couple of common, if not universal stereotypes then. The scientific stereotype of the military man painted him as hidebound, unimaginative, and reactionary with respect to the acceptance of new technologies and new ideas. Military men may have pictured scientists up on cloud nine as men who really could not be trusted to involve themselves in matters that were basically of military concern. I remember this well. Many of you probably do too.

But now the roles are almost reversed. Today the common, if not the universal stereotype, is the precise opposite. Today I think many in the military world are thinking of the scientists and the

leading technologists as being very conservative, reactionary, and unreceptive to new ideas; whereas many of the scientists and technologists tend, sometimes, to think that it is the man in uniform these days who is up on "cloud nine."

All this affects the attitude, and is reflected by the attitude that is taken toward requirements. At the point where military people think that it is their job to write requirements in such a way as to stimulate the technological and scientific advance, it is clear that they are recognizing, as they should, their key role with respect to the scientific and technological community of our country and to the scientific and technological resources of our country.

But it also puts them in the posture of representing something different than military needs for an end product.

And I think that there are many who have become convinced that if you have enough money and if you have enough authority, you can get almost anything you want. And there is much evidence, based on the developments of the past several years, that that is, in part, true. In any case, we have arrived at the point where our military departments control nearly 50 percent of our national resources for research and development work. They have the power to direct technological events and trends as never before in history.

Now, this attitude toward requirements that says, "It is my way of stimulating you. It is my way of moving the Nation in this or that technological direction;" these attitudes and developments of the past decade or two have invited the outsider into camp. The scientists complain relatively little so far about what you might call the "military domination" of science and technology, or the "military impact" on science and technology, or military interference with science and technology. You do not read many articles about that. You do read comentators who note with varying shades of dismay or concern the scientific and the scientists' input to military requirements. And you are forever being told that more and more "the scientists" are getting into military affairs which they do not really understand and that scientists are really determining military requirements which are not their affair.

I think it is bound to be this way. Because if you shape requirements not only to meet your needs, but--knowingly or otherwise--so as to stimulate scientific and technological advances in a particular direction, you are inviting scientists and technologists to play

a major role in determining how you are going to go about filling those requirements, and hence what the requirements are.

What can be deduced from this disquisition? What is clear with respect to what we ought to do, or what our attitude or our actions ought to be, or in what directions we ought to move? I think the following, at least, is clear: First, we must fulfill our needs. We must be sure that we are furnishing modern, reliable, useful, and powerful weapons and supporting systems for the fighting man. That is what defense research and engineering is all about. And that is what your job is or is going to be. Even though it may be hard to define just what those needs are, and even though we may have to alter our notions of what our needs are and seize technological opportunities that arise unexpectedly, the thing we are really trying to do is fulfill our needs. That we must do.

Secondly, we must seize promising technological opportunities. Most of the really great developments; most of the developments that have really made a big difference in a short time, have come about that way. People have been alert to opportunity, have seized that opportunity and have hammered home a solution utilizing that opportunity. Merely planning for the technological future and putting blinders on with respect to opportunity will not suffice. In short, no doctrinaire approach to the evolution of requirements is going to solve, I think, in this era of rapidly evolving technology, the real problem of military needs.

I have seen a description of how at least one of the services says that it is handling or is going to handle this matter of requirement and their relationship to technology. I say "says it is going to handle it," because I don't really think they will. But it goes like this; they are going to evolve long-range plans--plans that extend 10 or 20 years into the future. They are going to evolve notions about what their doctrine and tactics ought to be in that 10- or 20-year future. And of course no one can quarrel that it is desirable to look ahead 10 or 20 years, and it is desirable to think through what your tactics and your doctrine ought to be or might be in the 10- or 20-year future.

And then, they are going to try and say, "In order to fulfill these doctrinal and tactical concepts we need weapons systems to accomplish the missions we will have defined, and so we will not specify what those weapons and those weapons systems are. Then we will look to see whether or not it is feasible to develop those

weapons systems. If it is not feasible we will ask ourselves 'what do we lack?' Do we lack knowledge? If we do, we will establish a requirement to get the knowledge. Do we lack technology? If we do, we will establish a requirement to get the technology. Do we lack devices? If we do, we will establish a requirement to get the devices." And the notion then, is, "We will issue these requirements. We will harness people in laboratories, at drawing boards, on testing grounds, and the new knowledge, the new technologies, the new devices will come forth, and eventually the new weapons systems will roll off the line 10, 15, or 20 years from now, implementing these long-range plans and concepts."

What is wrong with that picture? It makes no allowance for the fact that the most important and the most dramatic evolution or developments that are likely to arise over the next 10 or 20 years are unplanned and unplannable. The most important actions that may have to be taken with respect to this process I have just described, in the next 10 or 20 years, will be to drop your other plans and go for a new one because there is a new technological opportunity that you did not know existed and nobody else knew existed, because it did not exist before.

Now this may seem obvious and it probably is. Perhaps I am belaboring the obvious, for which I apologize. But I want to make the point that it is clear that regardless of how we mechanize it--that is, how we mechanize the requirements process--technical opportunities must be seized and seizable.

A third point that I think is clear or which seems very clear to me, is that economical judgments must be made. Stated in other words: we are not ever going to be able to do just what we would like to do. Proper decisions will always be governed by economic considerations and trade-offs among alternatives.

Requirements have a great impact on this general area of consideration. So often we see requirements which say, "You will have such and such an accuracy, and such and such a range, and such and such an endurance," or whatever the parameters are of interest. You write these down and now you say to yourself, "Suppose I find that a 20 percent reduction in parameter "B" leads to a 75 percent reduction in the cost of doing the job. Will I or will I not be willing to make a change?" And the answer is not obvious. If it turns out that parameter "B" is the thing without which the weapons system is valueless, then you will pay if necessary, to

develop that parameter. Very frequently you will not.

Very often you will find that by making perturbations in the requirements, disproprotionately large perturbations will be made in the timeliness and the effectiveness and in the cost of the total job. These economic judgments must be made and requirements must not be considered as if they were inviolate and sacrosanct. They must be part of a dynamic process where each key element within it can be adjudicated and fitted to the desired end result, or at least to the wisest end result.

And finally, the lines of communication between all men with a voice in these products and decisions must be strengthened. The scientists and engineers must learn more about what military needs really are. Military people need to learn more about what science and technology are all about. The way in which we relate ourselves to one another, in uniform or out of it, in Government or out of it, needs to be steadily improved. The conversation between the groups, all of whom have a contribution to make, must be an on-going and expanding conversation. I think it has been growing in recent years and needs to continue to do so. Hopefully, this course which you are attending here and the others which you have been exposed to in the past and in the future, will assist in that process.

Thank you very much for your very kind attention.

QUESTION: Mr. Secretary, in relation to your remarks on requirements, what role does R. & D. play in the acceptance, rejection, or possibly even formulaton of requirements?

MR. RUBEL: Well, the answer is, we play no role in the formulation of requirements per se. Nor do we say that we think that this or that should not be done because there is no requirement, or that the requirement should be altered in this manner or that. All of our analyses and remarks, unless the Secretary asks for something special, are aimed at the questions "What is the feasibility, what are the relative advantages compared to other approaches?" Now, the Secretary does ask questions frequently which really are requirements-type questions, and gets opinions which really are almost the equivalent of requirements-type opinions. When the requirements include a great deal of technical substance, then our technical comments are really pretty indistinguishable from commenting on the requirements per se.

QUESTION: Mr. Secretary, you intimated that money, many of the times, is a predominating factor. Do we make adequate use of the research and engineering capabilities of our allies?

MR. RUBEL: We have made a survey indicating that if we could enter into complementary arrangements with our allies, principally, of course, our Western European allies, that we could probably increase the effectiveness and the combination of the United States and our allies, by a very substantial amount over a period of years. We have estimated, for example, that the $7 billion we are spending now could, if we could make our programs more complementary with those of our allies, be increased by as much as 30 percent--perhaps even more--through a realistic program of complementarity. Through complementarity we would rely on another country for developments, and that other countries, in turn, would rely on us for developments in complementary fields or for complementary devices.

If we could do that, then we could greatly expand our efforts--we would bring more people to bear on our problems, because there are about as many scientists and engineers in Western Europe as there are in the United States. But we are not doing that now.

QUESTION: Sir, do you think that the military services are introducing far too many weapons systems into development? Specifically, are we making too many incremental improvements rather than breakthroughs?

MR. RUBEL: I think generally, yes. Breakthroughs may not be the word I would have chosen, but I agree with your thought. And I would like to point out something in this regard. I was out at one of the rocket engine manufacturer's places one time, and they were showing me with considerable pride a chart of the various engine developments they had been engaged in over a period of years. This one showed that the performance of an engine went up by a certain amount; then came the next engine; it went up by even more, etc. And they told me each one of these major developments cost about $50 million. Then I noticed that the zero was suppressed on the "y" axis. It didn't start at zero at all. And actually, the increments were about 10 percent increments in performance.

Now it only cost us about $50 million to develop the first engine. Then it cost us $50 million more to get the next 10 percent. And so, we asked ourselves the question, "Supposing we hadn't done that?

Suppose we had just said, 'Fellows, we are going to start with an engine that is two or three times as big.' " What would we have gotten then? And the answer seems to be that for comparable amounts you probably would get something two or three times as big.

So, I think that we have to be very careful about just what you have intimated. And I have seen from my personal experience, many occasions in which I think the desire to make improvements that are very attractive has really frustrated the basic objective caused us to end up with a system that really was not as good as if we had left the improvements off and just kept heading down the road toward the goal that we had in the first place.

QUESTION: How does the current DOD organizational structure assure that technological opportunities are received?

MR. RUBEL: I do not think it does. And I am not sure how you do that. That is a real problem. Organization probably is not going to do it; it is people that is the most important factor. We have made some innovations in the last year or year and a half that we hope will help. But it is awfully difficult you know, to give anybody a guarantee. One thing we've done is restructure the manner in which the research and development program is divided into categories, and then apply different rules to these categories. We have five categories now that apply to the hardware part of our efforts. There is a sixth category which is just the overhead account.

But counting the five categories, we have one which is called "Operational Systems Developments," and that, by definition, is a system which, where a decision has been made, you are going to put it into production; Minuteman is an example--Polaris is another example. Then, we have another class called "Engineering Developments," where you are going to develop a whole system but you are not sure whether you are going to produce it or not; it is still going to be a system. The B-70 and Nike-Zeus are other examples.

Now, many of these are very large systems; not all, but many of them are. We feel that the rules that apply in that area need to be different from the rules that apply to the rest of our program, with the objective of trying to bring forward these technological opportunities with greater certainty. Half our program is in these two upper categories of engineering and operations systems developments. Half of it is in research and exploratory development and

advanced development.

So, what we are saying is, we will support activities whether or not you can define an end-product need very clearly at the time you undertake them. We think that will encourage people to look for and to seize technological opportunities and to develop them far enough to see whether they are really worth carrying further. That is one technique we have used.

I have another comment. I have talked to a lot of people about it. It has to do with organization. Most military organizations evolved because of logistic and command requirements. And I think you will find that the organization of our military departments, even today, very heavily reflect these kinds of requirements. You have to deploy lots of people. You have to acquire and deploy lots of materiel. This is a tremendous organizational task. As industries get bigger they copy the military mode of organization.

But that is not a very good mode of organization for stimulating scientific development, for many reasons, but chiefly because individual genius, initiative, and creativity counts so heavily in R. & D. so much less so in production or operational undertakings.

When you have a large-scale job to do you have to have organization and discipline, partly because you have to be able to use many ordinary people who may possess no more than mediocre or ordinary intellectual qualities and capabilities. But in science and technology you have just exactly the opposite requirement; where the man at the factory bench, or the rifleman in a platoon may be an average person and yet most useful, the scientist at the bench, the scientist at his desk, if only an average, ordinary person, is not likely to get anything done. It is there, at the working level, that you look for your creativity. In such activities, in the fields of science and technology it is often more useful to turn the organizational chart upside down; to say, the people who are normally shown at the bottom ought to be shown at the top. Those are the ones who are doing the work. Those now shown at the bottom are just furnishing the support.

Harold Brown, John Rubel, Brockway MacMillan, and the rest of us, cannot invent anything for anybody or think up any new ideas, or even understand half the things that are going on. But what we can do is create an environment, or help create an environment--and this is true all the way down the hierarchy--that will help those who are actually doing the work, do a brilliant job.

Now, there is an inconsistency you see between the way we ordinarily think about organization and the way you ought to think about organization in order to meet the requirements of science and technology.

I have talked about this to some of my friends in the Army relative to the new organization of the Army, after we had been asked to comment on the new organization of the Army for R. & D. A new Materiel Command has been set up in the Army, eliminating several of the technical services. The question is, "Is that going to make it any better? Is the Army going to be able to do a better job because of the reorganization?" I think the answer is not an unequivocal "yes." I feel strongly that what counts most heavily is not just how the organization chart is shown, but how the lines of real communication function between the people who make implementing decisions and the people who have the ideas on which one needs to act.

Now, in a military type and in an industrial type of organization you have to hold people responsible at every level for everything below that level. That principle is basic to the very concept of organization and command. So, if you assign a commander to a task and give him three, four, or five subordinate commanders, and if each of those has three, four, or five commanders under him, each one at every level is regarded as an autonomous instrumentality of command with full command authority and responsibility. Each one of those men will feel that he is not doing his job if he cannot be held personally accountable and responsible for everything that happens underneath him. One may ask: what could you mean by "command responsibility" that was less than or different from that?

Since many of these organizations become very large, most of the nodal points, most of the branch points on organization charts become equipped with staffs. You have a staff at Pentagon Headquarters; you have a staff at field headquarters; and at subfield headquarters; staffs are encountered all the way down the line.

Why staffs? Well, you have staffs so the commander can encompass his job. That is what it really amounts to; the commander's conception of his job requires staff help. And what do those staffs mean?

Well, they mean, among other things, the scientific worker far down the line must often hurdle half a dozen or a dozen staffs before he gets to the place where the final decision is going to be made. Why? Because at every point along the line the commander at that echelon feels that he must have total and full responsibility to the upper echelon of command. He, not the originator, must accept responsibility. He is an agent for action and command, not just support and communication. But I think that is wrong for the administration of research and development. This is an organizational matter which we haven't been able to do anything about in our military departments.

When I worked in industry we had a situation not too different than what you have in the military departments, only on a much smaller scale. I ran a laboratory that at one time included 2,000 people. A 2,000-man laboratory is a pretty big laboratory. We had departments with several hundred people in each. That is a pretty big department. The whole company numbered several tens of thousands. That is a pretty big company. But we were not allowed to have--I was not allowed to have--any staff. And I would not allow any of my department heads to have any staff either. I just would not allow it. The corporate staff was kept very small. If you really got into a technical matter that was important you finally found the general manager of the company not infrequently talking to the junior engineer who was the responsible individual.

Now, in my opinion, that is something we miss very badly in the military organizations. We get all mixed up and confused between the real facts of technical life and the real world out here. And you know, whether you're in the Army or whether you're in a particular command of the Army, or whether in the Air Force or the Navy, the technical facts of life are the same. Still, we finally end up with an "Army position" on communications satellites. We have an "Air Force position" on communications satellites. And it just turns out, from my limited observations of this, that these positions hardly ever help us get on with the job very much. But they usually stand in the way of the fellows who are trying to get something done down the line. They rarely clarify and often obscure facts and the objective assessment of facts. But facts are the essential substance of technical work.

Now, what can you do about that? I have talked to the men working on projects subject to such constraints and they have said the same thing: "In the last analysis I am going to please my boss because

he fills out my ER and I have to please him. I have myself and my career to think about. But personally I think the system is wrong."

I think we ought to have a way of working in this environment which supports us to get things done, but have lines of communication that go around it. I believe in that very strongly. You have to change a lot of attitudes before you are going to get that put across in the military departments. You have to get a lot of people to change their attitude toward command in this field, and toward themselves, their superiors, and their subordinates. At several points in the chain, commanders must be willing and able to say to their superiors, "Sir, I do not know what this man is talking about. I gave him a lab to work in and he asked for some test equipment and I gave him that. He has a couple of technicians to help him and we have written some contracts here, but he is the expert; let him tell you what he has on his mind. Don't ask me because I don't know. And I am not going to hire a staff man to tell me what that fellow said. Just let him tell you himself. I have seen his work, I have confidence in him, but he is the expert."

Now, if we could just get that kind of a way of operating in a military department, which alters the concept of command when it comes to R. & D., I would think you had made a lot of progress.

The Air Force has come very close to this on some of their major projects known as "Designated Systems." There the project officer down the line--maybe 5 or 10 echelons down the line--he has a line right up to the Pentagon, to somebody else who has the ear of the Secretary of the Air Force. He does not have to go through all those echelons for everything that he does. At least not according to the regulations.

Standing off here on the side are thousands of men who have been hired to do a job on the staffs that are trying to erode that red line. You cannot blame them for it or anybody else, because that is their job. They are trying to do a good job, not a poor job. But the point is, you have a concept there which I think is a splendid concept, which says that you have to have many command echelons to provide support for people so they can do their job, but you do not have to have an equal number of command echelons to filter the communications.

I have, from time to time, asked that the memoranda which I write be transmitted without alteration to the lowest echelon where the work is to be done. If anybody wants to add anything to it that is

just fine. They can say, "We think he is wrong, or only partly right, or has not presented a complete picture." That is their privilege. But at least let the man responsible for action know what is on our mind.

And I think the reverse is true. In the Designated Systems business it works that way. When a Project Officer sends something up the line they cannot take his paper out of the pile. Now, maybe they take it out anyway, but it is supposed to be in that pile so that when it finally comes up to the top the top man can see that though there may be 50 people along the line who want to introduce alterations, this is what the man who is doing the job has to say.

Now, I think you just have to do that on R. & D. generally. Otherwise you are never even going to know what these new ideas are; they will be contrary to somebody's staff-position somewhere along the line. And so, they will get killed.

QUESTION: Mr. Secretary, you said in your talk that there was a need for the military to learn more about science, and for the scientists to increase their knowledge of the military, yet, in the Army, for generations actually, we prided, or used to pride ourselves on our development of soldier scientists and soldier engineers, to specifically break this gap. And the other services have done this to a greater or lesser extent. Yet we find today that when the Department of Defense needs the kind of combined advice at the top levels to make decisions, that they have had to turn essentially to the scientific community for their key people. Where did we fall down on the job in the services in developing the kind of men to provide this advice?

MR. RUBEL: That is a very good question. In the first place, I would like to comment that we are using quite a few military scientists in DDR&E right now. Some of them are our key people. One is Cliff Duncan--Commander Duncan--from the Navy. As far as I am concerned, he is the match of anybody in the field of guidance, control, and space technology. We never go beyond him; we do not know of anybody who knows any more about the subject. We have complete confidence in him.

Another is Colonel Ray Gilbert. Ray is a terrific person, and he has just been invaluable in a lot of things. Major Walt Pennington, is another. We have several of these people. They happen to be in uniform, but they have been trained scientifically, a lot better than many of us have. They are outstanding and we use them. I do not

think you have fallen down. I just think that we need to do more.

Now, there is one area in which I think the military departments have a long way to go, and this is going to be tough too, because you are not even sure of how to do it right, but that has to do with career development for officers with this training. What is his future in your service? I think the services will have to figure out better ways to make sure that a man can choose a career in this vital area and still have good chances for promotion and for making a major contribution not just in his field but in other areas too. That is happening, but perhaps not as rapidly or on as widespread a basis as we would like to see it happen.

I think one of the problems has been that some of the very best people have become discouraged because of the limited opportunities for some of them to move forward, even though they have developed these very special skills.

QUESTION: Is this new organizational structure essentially threatened by change in the political environment so that it loses continuity?

MR. RUBEL: Excuse me. Are you referring not to the breakdown of the budgetary categories that I referred to first? When you said "organizational structure" I did not follow what you meant by the question.

QUESTION: I am speaking of key personnel in the organizational structure.

MR. RUBEL: Perhaps if you would explain a little bit more of what you have on your mind. I do not think I quite understand it.

QUESTION: Well it would seem that the program requires a long continuity, and a change in the political environment would make the key people in this program subject to--

MR. RUBEL: Oh, I see. Well, yes, I think that has been a problem. The turnover at all levels, I think is a problem. We have a turnover at the military level just due to the normal policies of rotation. I think it has been excessive in many cases. You get a fellow who has been really doing a job, and then about the time that he reaches maximum effectiveness he is replaced by somebody else. And that is bad, especially if he has demonstrated outstanding

performance. You have to find a way, and it is not easy, to make a fellow not only feel, but make it really true that if he stays on his job from the cradle to the grave and really does an excellent job his chances for promotion and advancement are going to be better, not worse.

That has been a real problem in the past, because often a fellow feels that the best way to advance and get promoted is to get off his current job, get on another one, so that his record will show a diverse background of good experience. And some times it is easier to look good for two, three, or four years, than it is for four, five, six, or seven years. I have even advocated that it might be good policy, especially for major projects, to say that a good project head must stay on the project until it is finished. I think we would get a lot of projects finished in a more timely way. We would have fewer "improvements" that way.

Now the political level is a different problem. The Harold Brown level--my level--the group just below us in the organization; that is a real problem. There has been a terrific turnover at that level. I have been there 3-1/2 years and I am practically an old-timer. In fact, Dr. Charyk, Dr. Wakelin, and I, are almost contemporaries and we are the three longest-term civilian appointees in the whole Defense Department. While that is not long compared to the normal tour of duty for a military man at the Pentagon, it is comparable to that of many.

Now, one of our big problems here, of course, is that we have made it almost impossible to hire anybody in the Government anymore. We have just priced ourselves completely out of the market. We have given CPFF contracts to companies and then when we wanted to get going faster we have given them still more money. And we have just upped the salary level so that men like myself and the others I mentioned have to make a terrific financial sacrifice to come into the Government. You can argue you are making a sacrifice if you are there and have not left, but it is a lot harder to go the other way than to give up not going out.

That makes it very difficult to get people into the Government. We have now in DDR&E about 20 men whom we have acquired from industry and universities to come down to Washington and help out. If we can get a fellow to agree to come for two years we think we are doing pretty well. We have several of them--vice presidents of companies--almost every one of them was making on the order of

$40,000 a year. They come in for $19,000, and you just cannot expect people to stay for very many years on that sort of basis unless they have a lot of money of their own, and most of us do not.

So that, just replacing those people when they leave--and they are going to leave, most of them, in a couple of years--is a major problem. And I do not think there is a solution to it, frankly, until the pay bills begin going through the Congress and we raise some of the levels a little bit so that we can bring some of these people in for longer periods and keep them. But even that will be frustrated if we do not run our business so that on the outside the opportunities do not become correspondingly more attractive.

I think you can get a lot more continutiy than meets the eye, providing some of the key people will stick around for a long time. I think one of the reasons I have stayed for twice as long as I expected to is because I really felt that it was important, and I have done it, I think, partly for that reason. Harold Brown will probably stay for at least four years. Well, that is pretty good. Once you get that kind of overlap you can begin to smooth out a lot of the ripples. Jack Ruina is another one who has already stayed almost four years. He is the Director of ARPA.

So, we have even had some success in keeping people for a longer time. Yes, I think you can have some continuity in the program, but it is much more difficult than it would be if better people would stay longer.

QUESTION: Dr. Rubel, Tuesday night you said one of the most interesting aspects of all of the studies we have been doing in the Department of Defense was that there were no new ideas of the military applications of space since Sputnik. Do you consider this a commentary on the inability of the military services to come up with new ideas? Or, do you consider it an admission by the Administration, and particularly the scientific inability within this Administration, to pursue new ideas other than the previous Administration.

MR. RUBEL: Well, I think I know what you mean by your question. What I said in my talk went along the following lines; that there were no really very new ideas for military applications in space that had evolved since Sputnik I; that we had expended tremendous efforts to study the possibilities of such new applications. And I cited--maybe you read my talk--what we have done. For you information in this audience, I tried to find out how much money we have spent

on these studies, and I have not been able to get an accurate figure. That is why I said "Tens of millions of dollars" have been expended directly or indirectly for such studies in the last five years.

Actually, I am convinced that the number is well over $100 million in the last five years. These studies have been conducted in many places. In the Answer Corporation there have been about 30 or 40 men working for about four years on nothing but that subject. The STL and later the Aerospace Corporation have had substantial numbers of people doing the same thing. The SR program of the Air Force that began in 1956 harnessed a large number of scientists and engineers in industry studying military applications of space. I think it would be almost impossible to ever come up with a number as to what that really represented in terms of man-hours and dollars, because the Air Force gave "need-to-know" clearances to many companies and paid them nothing, and the companies came in with so-called "free" studies, and in great volume.

We have had in-house studies. The Scientific Advisory Board of the Air Force came together for long periods. We had the Gardner Committee Report. General Estes recently had a study that involved between 400 and 500 people for a period of between three and six months, of both military and industrial personnel and aerospace personnel, studying this problem from A to Z. This goes on all the time. But if you will read the correspondence that took place between the Air Force and the Department of Defense as long ago as 1957, and just look at the list of projects that the Air Force had then, and look at the list of projects we are still talking about today, you will find that it is essentially the same list.

You may ask what this proves. And, as I said in my talk, it really does not prove that we are not going to find new applications. Nor does it prove that all the decisions we have made have been right or wrong either. It does not prove that having started so many of these programs, which we have, or having not started so many of these programs, which we have not, was the right thing to do. It does not prove that either.

But I think it does prove that the rate at which we are doing the development work certainly does not lag behind the ideas. We have more work going on than we can see clear application for. To that extent the ideas are not the problem. The work is not the problem at all in this area.

I went out to SAC a few years ago--it must have been about 1959--and visited the Requirements Section at SAC. They have "requirements" for many space systems. And if you want to prove that there was a requirement for a manned reconnaisance satellite, that is easy. SAC had one that was written before 1959.

If you want to look for a requirement in an early warning satellite, that was written ages ago. And I think the operation date when I came to the Pentagon was to be calendar year 1961 for Midas.

Well, I think the point then, that I was trying to make only was that after you have spent several thousand man-hours over a period of five years without coming up with a really unique idea, even though there are variations on old ideas, I think you can conclude that there just is no very great likelihood that a new idea is about to come.

COLONEL BEALL: Mr. Rubel, on behalf of all the members of the College we thank you for your very stimulating talk and taking time from your busy schedule to be with us this morning.

(25 Feb 1963--2)H/rd:dm