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THE EVALUATION OF MILITARY CAPABILITIES IN THE FORMULATION OF STRATEGY

by

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GENERAL [illegible]: This is my first opportunity to introduce a Dr. [illegible], so I am going to beat him to the gun and announce that he has received and read the outline.

We continue our examination of the strategic concept of operations with a talk today on "The Evaluation of Military Capabilities in the Formulation of Strategy." Our speaker brings to his subject considerable experience during the war in weapons evaluation, and he now occupies the important position of Deputy to the Director of the Weapons Systems Evaluation Group in the Office of the Secretary of Defense.

It is a great pleasure for me to welcome back to this platform, Dr. Philip Morse. Dr. Morse.

DR. MORSE: General Hull, Admiral [illegible] and gentlemen: I will try to live down my [illegible], and also try to mention, as few times as possible, how complex and imposing the subject is.

I am very glad to be here again, and to be able to take part in the activities of the War College, particularly in connection with the subject of this present series of lectures. The subject of grand strategy is, of course—in spite of my promise—an extremely important and complex one. It is one in which all parts of the nation must have their say and in which all phases of our nation's capabilities, military, industrial and scientific, must play a part. Basic decisions in this field must be made at the highest level, although decisions made by the services and by

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various parts of industry will have their effect.

Strategic problems are getting more complex as our technical development gets more complex. As the interreaction of the various parts of the social organism speeds up and as our technical advances accelerate, the need for flexible yet accurate answers to our strategic problems gets more and more urgent. A hundred years ago we could take our time about making up our minds concerning some of these problems and once we had reached a decision we could expect it to stay valid for several decades. This is not true any more. Situations can change over night and what is a good policy this year may not be next year.

The changes I speak of are ones of degree, however. The strategic problems, in essence, are still much the same as they were a century ago, or as they were several thousand years ago. Technical developments have changed tactics and weapons a great deal. The basic facts of grand strategy have not been changed. A major strategic problem for the military, in time of peace, is still to maintain a proper balance between the need to be prepared today and the need to be better prepared tomorrow. This constant race between preparedness and obsolescence of equipment, tactics and deployment has always been present. Now, however, it is streamlined and travelling with supersonic speed, so to speak.

It is particularly true of our form of government that complete preparedness for today may mean obsolescent equipment and lethargy five years from now. A crucial strategic problem is to estimate when to be ready, to plan our training, development and deployment so as to be ready at the right time. I have heard it stated by someone high in British war planning that England can be fully prepared for war only about once in each

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generation. Perhaps we can afford to be fully prepared more often than this but certainly not much more often.

In all such planning it is just as important not to overestimate our own and the enemy's capabilities as it is not to underestimate them. Before we start our ponderous development and production machinery in a direction which will force us to depend heavily on a given weapon, such as the atomic bomb, we had better be very sure it will do what we expect of it. Similarly, before we commit ourselves to a heavy emphasis and expenditure on antisubmarine weapons and craft we had better be sure that we are not overestimating the enemy's capabilities in this line and simultaneously underestimating them in other lines such as in naval mining for instance. Here again quantitative measure and correct scientific analysis is important.

These are not new problems, of course. Analogous ones have had to be considered ever since there were governments and armed forces. They're just more complex now. They are very much more intermixed with technical problems and they are much more in need of quantitative analysis.

All of these comments simply add up to the fact that we must make our over-all planning as realistic and as quantitative as possible, carefully balancing various alternatives and keeping in mind future technical limitations and possibilities. A miscalculation of the effectiveness of some measure by 20 per cent may be serious. A miscalculation by a factor of 3 may be crucial. Under such circumstances we cannot rely on hunches or make emotional decisions. Numbers, whenever they can be obtained, must play a part in the decision.

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The quantitative parts of a strategic problem are, of course, not the whole of the problem, nor do they give the whole of the answer. Added to them must come the political and other nonquantitative aspects, which are always present in such large questions. All that I am pointing out is that the alternatives to choose from are very much more numerous now than they used to be and that the quantitative aspect involved in our decisions is more important than it used to be.

The need for technical and quantitative analyses as aids in arriving at command decisions has been appreciated by the services, both in this country and in England, and groups of scientific men with experience in military problems have been set up now in all of the services. The activity is called by various names—operations research, operations evaluation, weapons systems evaluation, and so on. The groups engaged in this activity have come to play an important role in providing the background necessary to reach tactical or strategical decisions.

During the last war operations research groups worked mainly at the tactical level. A group in the U. S. Navy, for instance, analyzed antisubmarine operations and was of help to the 10th Fleet in reaching decisions on the conduct of the battle of the Atlantic. Operations analysis groups, assigned to various air commands, analyzed various parts of the air war and helped these commands reach proper decisions as to the conduct of strategic bombing and air defense. The results of the studies of these groups were embodied, in part, in revised doctrine and in changes in weapon and equipment design. With the end of the war, the analysis of actual operations, of course, ceased and these groups turned to the evaluation of future tactics and weapons. Based on their wartime experience,

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they turned to the more difficult task of assisting the services in providing more realistic military requirements and force estimates for the future, so that future doctrine could be fixed and so that future plans and weapons requirements could be decided upon.

Each of the armed services in this country now has a group doing operations research. The Army has the Operations Research Office, which is located here at Fort McNair. The Air Force has two groups: The Operations Analysis Section, which is a part of the air staff and the Rand Corporation, at Santa Monica, which deals with broader questions, farther in the future. The Navy has the Operations Evaluation Group, attached to the staff of the Chief of Naval Operations. These groups, by their technical and quantitative analyses, assist the various staffs to reach decisions on tactical and strategic questions.

Groups in the individual services, however, are at a disadvantage in studying broader strategic questions. Therefore, to complete the analysis and evaluation setup, the Weapons Systems Evaluation Group (WSEG) was formed about a year ago. This is a mixed group, partly of military officers with broad operational background and partly of scientists with training in operations evaluation, set upin the Office of the Secretary of Defense. Its mission is to study the technical and quantitative aspects of those broader problems, which are not appropriate for the individual service groups, in order to aid the Joint Chiefs of Staff, the Secretary of Defense, and the Research and Development Board to reach over-all decisions concerning weapons systems and strategic plans. Attachment to the JCS and OSD is, of course, the correct level where quantitative and technical aspects of strategic questions can be studied.

It took most of last spring to get the group recruited and organized, and we have been at work only since last summer. In this time, however, we have gained some experience in the work and I want to spend the rest of my talk in outlining how the group goes about such studies and what its scope of activity can be.

In general, the WSEG studies weapons systems, broad activities or tasks of some part of the military organization assigned to carry out some major part of warfare. Possible subjects for study are airborne operations, antisubmarine warfare, strategic bombing, carrier operations, air defense, tank warfare and the like. A part of the group is assigned to study a given weapon system and its mode of employment. Various alternative ways of employment are studied, estimates are made of losses incurred against various opposing forces and of concurrent losses inflicted on the enemy. The interconnection, both equipment and personnel-wise, between various parts of the weapon system are studied with a view to finding possible critical situations. Eventually, if the strategic implications are to be obtained, the economic cost to us must be estimated, as well as the possible economic cost to the enemy. Comparison must be made with other possible ways of doing the same thing.

All the elements of such a study must be extremely detailed in order that we be as sure as possible of our quantitative results. A balance must be struck between the need for getting the facts before the Chief of Staff and the Secretary of Defense in time to aid in making a specific decision and the need for going into detail in order to insure accuracy of the results. Naturally the broader strategic parts of the picture come last, and many of these will take several years before they are completed satisfactorily.

It is probably worth-while to show in detail, by an example, how this works out. Most of the Weapons Systems Evaluation Group has been engaged for the past six months on a study of the strategic bombing question. Only a part of this study has been completed, the part concerned with the physical aspects of the problem rather than the economic, our ability to carry atomic bombs to appropriate targets, our losses in so doing, and the probable amount of physical damage caused by such bombing are the points which have been under study. These, of course, are basic for the broader questions of economic cost to us and economic damage to the enemy. The study has been extremely detailed and has involved the help of a large number of other groups in and connected with the services, in addition to the staff of WSEG itself. The first major report of this work is now in the hands of the Joint Chiefs of Staff. Naturally I cannot give you details of our conclusions and recommendations, but I can tell you how we went about the job and some of the typical situations which arose in such study.

We started, of course, with a consideration of the situation at present and in the near future. We investigated the nature of the forces we do have—the kind of planes, the airfields, our stocks of bombs, of gasoline and of spare parts, for example. There was the question of the deployment of these forces. For the present we have three types of planes capable of carrying atomic bombs—the B-29, the B-50, and the B-36. For the next few years the B-50 will carry the majority of the load, about half of the bombs to be delivered. The B-29 will carry another third, and the B-36 will only carry between a sixth and a seventh of the total load, although it carries those to targets which otherwise could not be reached. This means that the majority of bombs must be taken off from overseas bases. We had to look into the question as to whether the suggested bases were adequate and could be protected and supplied in case of war.

Next we had to study the ability of these planes and their crews to fly the requisite distances, from bases in this continent and overseas, to enemy targets. Not every plane can fly as far as the best plane and not every crew can make a plane perform at its top capability. Planes vary in weight, engines vary in efficiency and crew engineers vary in effectiveness with which they carry out cruise control. All available data on the three types of planes and on the ability of operational crews was collected.

The operation of the Strategic Air Command was very greatly appreciated in this part of the work. They made their files completely open to the group in order to study this part of the job. It was not sufficient just to obtain an average figure for operational range. We needed to know the distribution in range: what percentage of planes could go farther than a certain amount and what percentage could not go as far as this.

After all the data was in we were able to draw curves giving the percentage of planes and of crews which could exceed certain range performance and could draw bracketing contours on the map of Eurasia. These contours indicate, for instance, that only 10 per cent of our B-29's with crews could fly beyond some given line, under the best of conditions, and at least 90 per cent of our B-29's with crews could fly farther than some

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other line, even with opposing winds. By contour curves like this, based on actual operational data, we were able to obtain realistic figures on our capability of flying to the target.

On top of this, of course, were the figures on aborts--that is, planes which had something happen to them before they got to the target and had to turn back--aborts both of planes and of equipment such as bombsights. Again the operational data of the Air Command was extremely important and useful. In addition, data from World War II was also used. Studies were made of operational data, both from the last war and from training exercises more recently conducted, which gave us reasonable figures on aborts. Similar questions of maintenance and of the percentage of time a plane would be inoperable because of lack of spare parts were gone into, so that in the end we had a fairly realistic and quantitative picture of our own capabilities of carrying bombs to the target.

We then had to make a similar estimate as to the enemy's ability to defend against such a bombing attack. This was in two parts, the first being an estimate of the equipment and strength of the enemy air defense command and the second an estimate as to what this equipment and strength could do against our bombers.

Naturally, the first part of the question could not be answered with any degree of accuracy or of surety. Unfortunately it is very difficult to tell what the Russians have in some lines or what they would do. What has to be done in cases of this sort is to bracket the result, taking one set of values which are on the high side and another set which are on the low side. It is dangerous to choose just one set of average values even though they are the most likely values and are agreed on by

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everyone. If one assumes but one value for estimated enemy strength he is likely to forget that this value is only a probable one and to forget that it might be twice as great or three times as small. Whereas if one gives a pair of values, one on the high side and one on the low side, this pair is a continual reminder of the likely spread of possible values.

Moreover the resulting pair of answers serves to indicate the sensitive spots in our assumptions concerning enemy strength. If both the high and low assumed values give about the same results, we are more sure that that particular factor is less important; whereas if the final answer varies markedly between the high and low assumptions, it immediately alerts us as to the need for more information and occasionally suggests to us means whereby we can overcome this sensitivity. A few examples of sensitive items will be pointed out later.

Our assumptions concerning enemy capabilities had of course to be quite detailed. We had to specify, for the two levels, the general characteristics of their early warning radar nets, the characteristics of their gun control and their night fighter radars, the speed, ceiling and armament of their day and their night fighters and the deployment of these fighters, the quality, characteristics and deployment of their antiaircraft armament and many other things. This was not as difficult as it sounds, for we have information on a number of these items and, on many others, physical limitations of power and the contrariness of mother nature pretty well specify the maximum that can be obtained in many factors, such as radar ranges and the like. In the end most of the assumed values for high and low levels did not differ by more than a factor of two and the effects of the two levels were usually much closer together than a

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factor of two. In other words our results were not very sensitive to most of our assumptions. This happened to be true, for instance, of deployment of enemy fighters. There was very little difference in the results depending on the various assumptions of deployment as long as these assumptions were within reason.

It turned out that there were two major critical items in our assumptions concerning enemy air defense; the first concerning the number and characteristics of their night fighters, and second the number and disposition of possible high velocity antiaircraft rockets. In both of these sensitive cases we assumed a very low effectiveness for the lower number and an estimate assuming steady development and production progress since the end of World War II for an upper number. We know jet fighter speeds and we assumed that the enemy was at the best no better than we have been in night fighter radar and night fighter armament. In the case of the rockets, we assumed the characteristics of the German Taifun rocket which was nearly in production by the Germans at the end of the war. We did not assume for the Russians any guided missiles. In the case of both assumptions, the lower limit naturally gave low losses. Poorly equipped night fighters are extremely ineffective and normal antiaircraft artillery is likewise ineffective at the bomber altitudes considered. At the higher assumed levels of enemy competence in these two critical fields our losses were far from negligible.

The next part of the study was to combine the known characteristics of our own bombers with the assumed characteristics of the enemy defense to obtain estimated averages for our losses. This part was carried out in great detail and with the co-operation of a number of scientific

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groups, in particular with a group at Aberdeen which has concerned itself with the vulnerability of aircraft to gunfire and to antiaircraft damage. Groups at the University of Chicago, and a part of the Operations Research Office of the Army were also involved. The data from Aberdeen on vulnerability of planes was combined with data on accuracy of fire for various assumed tactics of the fighter and bomber, to obtain the probability that the bomber would be shot down on a single pass of the fighter against it. Calculations were made for a variety of altitudes and speeds, for different angles of approach of the fighter, and for different armament. In some cases, for example, when the bomber fires back at the fighter, there is a chance that the fighter is destroyed before its own shots take effect. The effect of this on the outcome of the duel was included in the studies. Such figures, of course, cannot yet be obtained by any set of tests. Tests will give parts of the figures, but at least in peacetime the only way of actually determining probabilities of kill is by taking these pieces from tests and putting them together on paper.

As this part of the study went forward, certain optimum tactics for both fighter and bomber became apparent. These were then checked against actual tactics employed as a continuing check on the realism of the calculations. In addition, the probable results of bomber-fighter duels for World War II conditions were also worked out and were checked against World War II data. We now have data from both sides on German-U.S. bomber-fighter duels in World War II. The comparison of our calculations with these data shows how important it is to take all aspects of the problem into account before the final result is arrived at.

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The first theoretical results of our calculations of the duel between the B-17 and the German fighter were of course equivalent to results which could be obtained in proving ground runs, with none of the complications of actual combat coming in. They gave probabilities of about 45 per cent that the bomber would be shot down in one pass of the fighter against it. The gunfire accuracies used checked the very voluminous German gun-camera data, which we have obtained on this type of duel. However, this same German data showed that operational results in actual combat gave a markedly different picture from proving ground results in that gross errors were present; in many passes by the fighter the aim never steadied on the bomber at all. Because of nervousness of the fighter pilot or to other influences, many runs occurred in actual combat where the fighter guns never actually got pointed at the bomber, and the shots fired were wasted. In fact, according to the German battle data, in only 1/3 of the passes by German fighters did the gun sights actually steady on the bomber target. In these cases, the proving ground results, predicted by the calculations, turned out to hold for actual combat with about the predicted accuracy and about the predicted losses per pass. In the other two-thirds of the cases, practically no hits were obtained and the runs were a complete loss as far as the fighter was concerned. Consequently in the case of World War II fighter-bomber duels, the operational figures on the probability of shooting down the bomber by a fighter in a single pass turned out to be 1/3 of the proving ground results.

Thus corrected for gross errors, our theoretical calculations predicted approximately a 15 per cent probability of shooting down the

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B-17 on a single pass by a German fighter, which checked remarkably well with actual data on the air battle over Germany. Such a detailed check with operational results for World War II gives us confidence in our predictions on future battles as long as we take into account the operational gross error factor which must be added to theoretical proving ground results.

Losses due to antiaircraft fire were worked out in the same degree of completeness and in the same manner as for the fighter-bomber duel. Here again certain critical factors showed up which strongly influence the results. It was found, for instance, that losses reduced markedly when bombers were concentrated over the target in a manner to saturate the antiaircraft defenses. If there were one bomber present over the antiaircraft defenses at one time, naturally all the guns would concentrate on it. If there were three present, the guns on the average would be spread and any individual bomber would have one-third the shots fired at him. This turned out to be true in practice in World War II data, as a matter of fact. So this brought out the fact of the need for the concentration of our bombers over the target. The results also show the great importance of evasive maneuvers taken during the bomber run. A very considerable diminution in losses occurs when the bomber definitely takes violent evasive maneuvers against a straight run. If our bombers are equipped with bombsights which will allow evasive maneuvers to be taken during the bomb run, our losses will be considerably reduced, particularly in the case of the assumption of higher Russian capability. This result is of considerable use in determining possible improvements in our bombsights and in our tactics. By going into this amount of detail,

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therefore, our study produces, as a by-product, conclusions of value to the development and materiel commands.

Finally, we analyzed the operation of dropping of the atomic bomb. A scientist member of the Weapons Systems Evaluation Group took the bombardier training course in order to have operational experience in running visual and radar bombsights. We studied the details of enemy targets considered for an atomic bombing offensive and the radar scope pictures for similar targets in this country. We studied the effect of training on bombing accuracy and determined the difference in accuracy between a drop made when the crew makes a run on a given target for the very first time and similar runs made by crews which have made several runs on the same target. This is quite important. Otherwise the data that one gets from training is likely to mislead one as to the accuracy of drops made on a strange enemy target later.

It became evident that the crucial element for radar bombing was not the accuracy of the bombsight, but it was recognition of the target on the radar scope. For some targets this recognition was easy and most bombardiers could carry out the task in time to make a fairly accurate drop. Such targets have easily recognizable points on them, such as a river with bridges, for instance. Other targets, however, have no easily recognized landmark on them. In this case it requires a certain amount of time and experience to sort out the rather confused picture on the radar scope and to recognize where the aiming point is supposed to be and if the radar operator in the meantime has to be fiddling dials, doing other things, he simply doesn't have the time at the last minute to make this necessary decision as to where the aiming

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point is in respect to the clutter on the scope and the resulting inaccuracies and gross errors correspondingly increase.

For the easy type of targets, with an easily recognizable landmark, our studies showed that the probable error of drop was somewhat less than the probable lethal radius of the present atomic bomb. For those targets which have no easily recognized aiming point, or landmark, the probable error is about twice as large, larger than the lethal radius of the present A-bomb, so that a number of our bombs would be missed. In other words, the critical point in the bombing operation is the question of recognition of target. Any improvement in our sets in that direction will help, whereas simple improvement in accuracy or putting in more accurate wind would have very little effect on improving our results. They also have implications with regard to training and tactics as well as implications with regard to future equipment.

Having completed the bombing accuracy part of the study it is then possible to compute an average pay-off figure. In this case the most enlightening form of the result is in terms of the ratio between the average damage caused to the target, per drop with the predicted accuracy and per cent of gross error, to the sort of damage that would result if perfect accuracy were obtained on each drop. This ratio between the damage which we would expect to actually occur and the damage that will occur if we are perfect as far as accuracy goes, is this pay-off ratio. In addition, we have to take into account the bombs that were sent off to the target but lost by enemy action or aborts, and we get a pay-off figure of the ratio of bombs that actually hit the targets to the total number of bombs sent off from the areas, and this is our pay-off figure. This ratio can be considered to be the fraction of atomic bombs which reach their assigned targets. It might be called the tactical pay-off factor whereas the fraction of bombers lost per mission might be called the tactical cost factor. These numbers, plus a discussion of the various sensitive factors entering into the operation, are the subject of the first report.

The results of our first studies are thus quantitative estimates of tactical costs and tactical results of a given operation, in this case strategic bombing, plus an enumeration of the factors which control most critically these results both our assumptions concerning enemy effectiveness and our own tactics and equipment. When the critical items are concerned with our lack of knowledge of enemy capabilities the findings point out targets for future intelligence investigation. When the items are things under our control they suggest possible improvements in our tactics or equipment.

A study of the sort I have outlined is of course only the beginning of the real strategic analysis. What must be tackled eventually are such broad questions as, "Is this the best way to use our bombers and our atomic bombs?" To answer these strategic questions we must go on to study the effects of the physical damage on the capacity of the enemy to wage war and to compare the effectiveness of this way of using atomic bombs with other ways of using the same bombs, with regard to cost to us and damage to enemy capabilities. These later, broader studies should again be as quantitative as possible. They must depend on detailed tactical and technical studies of the sort which has been carried out on strategic bombing, and they would again expect to find critical items, where small changes in our assumptions or in our capabilities produce large differences in the results. Such [illegible] studies will [illegible] after we have obtained background at the tactical level and when the Joint Chiefs of Staff require them as the ground for strategic decision.

[illegible] of the Weapons Systems Evaluation Group is going on to other detailed problems, to cover other weapons systems. We have before us the antisubmarine question or, to phrase it in its broadest aspect, the problem of overseas transport and the defense of this transport. We also have the question of air defense, which is the reverse of our strategic bombing problem. Another problem is the use of airborne troops, and so on. There are many such weapons systems which will require detailed study.

In each case our study will be at first quite detailed, going down to the fundamental operations involved and attempting to understand the scientific principles and ultimate limitations of the weapons used. In addition, we will have to understand and estimate the gross errors which in actual practice tend to reduce operational effectiveness below proving ground results. We must study past operations to see what quantitative figures we can obtain for these gross error factors. We must compute the details of the various tactics so as to check on optimum tactical doctrine, and so on. All of these details and calculations will then be put together to arrive at a tactical cost and tactical pay-off balance sheet, plus a listing of the sensitive areas where small changes in tactics or equipment will make large differences.

When enough of these studies of individual weapons systems are completed, we will then be able to tackle the broader questions involved in strategic decisions. Such questions as, [illegible] air defense can we afford? Can we supply [illegible] and at the same time carry out intercontinental bombing?", and so on, are questions which cannot be answered offhand but which must depend on detailed quantitative studies of the sort I have outlined here.

Naturally, broad strategic questions cannot be decided solely on the basis of the quantitative results which the group works out. As I pointed out earlier, strategic decisions depend as much on politics and other intangibles as they do on quantitative technical and tactical evaluations. It is not the job of a group such as the Weapons Systems Evaluation Group to reach decisions concerning strategic or tactical questions. We don't produce plans or doctrine, nor should we. Our job is to analyze those parts of major strategic problems which can be studied quantitatively and to present the results to the Joint Chiefs of Staff or to the Secretary of Defense, or the Commander in Chief, so that ultimate decisions on these questions can be made, with all the facts at hand to be combined with the intangible components--rather than by hunches and bursts of emotion.