GRAPHIC METHODS IN REQUIREMENTS DETERMINATION

11 April 1947

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THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

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GRAPHIC METHODS IN REQUIREMENTS DETERMINATION

11 APRIL 1947

CAPTAIN WORTHINGTON:

The speaker this morning is Colonel Philip Schwartz. He is a graduate of Columbia University, 1917, and a graduate of The Army Industrial College, Class of 1929.

Colonel Schwartz served in the "Crossroads" Project. Upon his return to the United States he was assigned to the Fifty-eighth Bombardment Wing. During the war he was Air Ordnance Officer in the European Theater. At the present time he is Air Ordnance Officer of the Strategic Air Command, Andrews Field.

His subject this morning is, "Requirements." I take pleasure in introducing Colonel Schwartz.

(Applause)

COLONEL SCHWARTZ:

I will talk about peacetime procurement planning problems primarily. I have some statistics of World War II as well as a study on the quantitative phase of the problem before World War II. If lessons are learned from World War II experience, our new peacetime procurement planning methods should be better than they were before World War II. They should be more flexible and more realistic. This flexibility will be all the more necessary if war comes suddenly the next time. If we should be unfortunate enough to be on the losing side at the beginning, major changes in procurement plans may be suddenly necessary, and the maximum of flexibility will be needed if peacetime procurement plans are to be worth anything. If we practice flexible methods in peace, it should be possible to have similar flexible methods in war, but if we have rigid calculating methods with people handling billions of numbers, without realizing the limitations of accuracy of these numbers, we may suffer unnecessarily.

When war breaks out, one of the first problems encountered is the problem of shortages. This applies equally to men, equipment, and time. We know immediately that we want for our fighting forces more men, more equipment, and time to furnish the men and equipment. We must decide without delay the types of equipment and men which are wanted. This is not always too difficult. We want, of course, the best available types of men and equipment, and we want them in the least time, but when it comes to deciding how much of each kind of man is wanted, how much of

each kind of equipment is wanted, and the rate of production, we may have a problem which is more difficult than that of deciding on the types. Types may be found in T/O&E's and in Books of Standards. If the types wanted cannot be produced at the desired rate, the types may be changed in order that adequate quantities of second and third best types of men and equipment may be produced in the available time.

I do not expect to go into all of the ramifications of the requirements problem. During the next forty minutes I will talk about end-items primarily and will assume that the raw materials, manufacturing components, and spare parts problems, will be discussed at some other time.

In 1938 and 1939 I was a student at the Army Industrial College. At the end of my year in the Industrial College, I was of the opinion that the Industrial College was the best Army school course that I had attended. The most important impression which the Industrial College left with me was the necessity for flexibility in making war plans of any kind. This impression never left me during all of World War II. In 1939 and 1940, I was responsible for ammunition procurement war planning in the Office of the Chief of Ordnance. From 1940 to 1945, I was responsible for planning for the requirements for Ordnance equipment of all kinds, first for one Air Force in the United States, and later for all U.S. Air Forces in the European Theater. While on duty in the Office of the Chief of Ordnance in 1939 and 1940, I was interested in requirements because of the war production problems of the Chief of Ordnance. While on duty with the Air Forces from 1940 to 1945, I was interested in requirements from the point of view of the using combat organizations.

Recently I saw a copy of the record of a lecture which General Somervell delivered to the Industrial College last year. Because of his wide knowledge of the procurement problem, the following is quoted from his talk:

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"I just bespeak your courage in planning for the next war. The point in the last war which brings this up is that our mobilization was based on a set of conditions which did not turn out to be the conditions under which we fought the war."

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"It was not until after we were well into the war that the size of the forces we expected to employ was finally determined."

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"There are two conceptions as how to go about making these plans. One of them is that the Service Forces should supply whatever is necessary,

whenever it is necessary, and wherever it is necessary. * * * The other conception is that the strategic commander must gear his plans to the Service Forces estimates of his capabilities. * * * It seems to me that neither one of these plans is the best method; that the best method is for the strategic commander to have some Service Forces training."

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In a recent discussion before a Senate Committee, Vice Admiral Sherman said:

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"Translation of strategic plans to attain those broad objectives, into military requirements in terms of men, weapons, equipment, and supplies--this is a function of the Joint Chiefs of Staff."

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Mr. J. M. Hancock, a lecturer at the Industrial College in January 1946, said of World War I:

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"We did not know what kind of war we were going to have, not even remotely. The biggest Navy plan heard of, which I can recall, contemplated a Navy of 100,000 men. * * * It looked fairly clear, that the Navy would have maybe 500,000 men. We just figured we would use twice as much in wartime as in peace and with a Navy five times as large as previously planned, we added a zero to our requirements table. This is literally what happened."

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On 27 September 1946, at a seminar in the Industrial College, Mr. Silverstrand, the visiting speaker, is recorded as having said the following:

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"A British general officer of the Procurement Ministry visiting the United States in 1943, said that 'his general impression was that it would take about a year from the time the basic plan was conceived until the final requirement figure in terms of items was determined, and that if you worked real fast, it could be done in about six months. It ranged in that general area somewhere.' I think we (the United States) beat that a little, but not too much. He also made one very true statement, I thought at the end. He said that in the computation of requirements, after following all of their very carefully determined formulae,

when they got all through, they should double them."

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The following is quoted from the New York Times of 9 April 1947, two days ago:

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"But the War Department's concept was this: Our present strategy recognizes the overriding importance of strategic bombing. This concept has been developing with the technical perfecting of long range aircraft, but it has been confirmed and emphasized by the development of the atomic bomb, since the scale of destruction of this weapon has given the offensive such a marked advantage at least for the time being over the defensive. * * * It is our belief now that strategic bombardment either by piloted aircraft or by guided missiles of one form or another provides the single most important element of our military capabilities."

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On 10 April, yesterday, the New York Times carried another article in which the Navy is reported as not agreeing with the War Department's opinion on strategic bombing. Because the bomb has become so important in modern war, I will use it in requirements problems illustrations. Bombs are class V items, the prediction of whose requirements is considered to be quite difficult.

The 1937 test of the ability of Air Force bombers to hit the Utah, a moving battleship, is of interest in connection with bomb requirements and bomber aircraft. General Emmons, who had charge of the test, after considering the problems involved, asked that all available U.S. Army heavy bombers in the United States be used. All 50 of them were sent to him. They consisted of about 36 B-10's, about half a dozen B-18's, and about half a dozen B-17's. In this test we found that it was desirable to have on hand at airdromes many times as many bombs as were to be expended because of pipe line problems. We again learned this lesson about bombs after we went into combat in World War II. Compare the 50 heavy bombers available in the 1937 Utah test, with the figures for USAAF heavy bombers available during World War II - 2,000 in December 1942, 8,000 in December 1943, 13,000 in December 1944, and 14,000 in August 1945. It is difficult for peacetime planners to visualize or predict such tremendous expansions in new or advanced types of war equipment.

While a student in the Industrial College in 1939, I studied the bomb war procurement plans. In talking with one of the officers who was responsible for this activity in the War Department, I said that I thought the number of bombs in the War Reserve was not very large.

His reply was essentially as follows: "We have about 150 - 2,000 lb. bombs in the War Reserve. All the foreign battleships in the world total less than 150. Why do you feel that 150 - 2,000 lb. bombs are not enough?" In those days the Air Forces had not yet reached their present place of importance in the National Defense team and because of the usual shortage of funds, the existing War Reserve of about 8,000 tons of bombs was considered comparatively adequate.

During 1942 - 1945, I helped plan for weapons problems of the Eighth Air Force, the Ninth Air Force, and the First Tactical Air Force, while they were operating in England, France, and Germany. Just before V-E Day, we played nip and tuck with the bomb supply situation. There were many cables exchanged with the War Department on requirements, methods of calculating them, and justification of calculations. The War Department frequently questioned the bomb requirements submitted by ETO. In 1939, the total War Reserve of bombs amounted to about 8,000 tons. Congress had become generous and had agreed to procure another 9,000 tons during the next two years. Compare these figures with the figures which measure the expenditure of bombs in the ETO, during the one month of March 1945 alone - 118,000 tons. Yet during 1942 - 1945, we had periods of plenty as well as scarcity; an understanding of the situation which permitted a prediction of the quantities required for future operations could be obtained only by close study of previous combat operations, current operations plans, and the operational plans for the future which the A-3's were making. The combat situation sometimes changed so rapidly that only the Commander in the combat theater could see at all through the fog of war. For example, during December of 1944, when the ETO was expending bombs at the rate of about 50,000 tons of bombs monthly, General Spaatz, then commanding USSTAF, at one of his staff meetings, directed that plans for Spring 1945 operations be based on the dropping of 100,000 tons of bombs per month. Since the maximum expended up to that time in one month had been only 84,000 tons, this seemed like not too much of an increase. It is probable that more than 150,000 tons of bombs would have been expended in the ETO in one month before the summer of 1945, if the war had continued in Europe up to that time.

Here is some history of ETO bomb requirements problems. It is December 1942. The ETO has been asked for information concerning the desired ETO stocks of high explosive bombs for the next six months. We look at the plans for arrival of bomber aircraft, the palns for arrival of crews. We wonder how many of our bombardment groups and bombs General Eisenhower, who has just invaded North Africa, will want. We have already shipped many of our bomb groups and bombs to Africa. We wonder if those who are supporting the use of incendiary bombs will convince our commanders that we should use more incendiaries like the RAF does and less high explosive bombs. We wonder how the submarine menance will affect our shipments. We are told by the British that England is a small island, and that there is not enough space in England for too many bomb depots. Then we look at the figures for expenditure of bombs in 1942, and the requests submitted by the VIII Bomber Command.

We find that 700 tons was the maximum tonnage of all kinds of bombs expended in one month of 1942, by the Eighth Air Force. We estimate that we will expend a maximum of 10,000 tons monthly during the next six months, with an average of about 5,000 tons; we will need 30,000 tons shipped to the ETO during the next six months at the rate of 5,000 tons per month. How many of each of the six kinds of bombs will be used? Well, the 500 lb. size seems to be popular so let's get about one-third of these. The 1,000 lb. is also popular, the RAF swears by it, so let's get one-fourth of these. The sub pens are being attacked, so let's get more 2,000 lb. bombs (the largest that our B-17's can carry) say about 15 percent, etc.

Now let us assume that it is a year later. It is December 1943. The Eighth Air Force has grown in strength. The Ninth Air Force has appeared in the ETO. There is more than a rumor that General Eisenhower is coming up from Italy, to become supreme commander of a large force which will try to open a second front and obtain a foothold in Northern Europe. During 1943, we expended in the ETO a maximum of 10,000 tons of bombs in any one month, but the existence of radar bomb aiming equipment has increased our mission rate from six missions per month to eight or ten missions per month during the winter. Perhaps the number of missions per month will increase even more. We'd better notify the War Department that the rate of expenditure of bombs will probably go up, and we'd better ask for larger stocks of bombs. Both the Eighth and Ninth Air Forces are estimating much larger expenditures in 1944 than in 1943. We ask for larger stocks - much larger. The War Department asks for justification for these larger stocks. (Some of the bomb producing facilities had recently been closed because it did not appear that we would expend bombs as fast as they were being produced.) We send justifying cables to the War Department. We explain that D-Day is coming, and that we have blind bombing equipment; we furnish sheets full of numbers by air mail justifying our requests. For two months we exchange cables. Then we ask for permission to send someone to the United States to explain in person why we want so many bombs. The War Department says don't send anyone; we will send a committee to England (presumably they need a vacation from the Pentagon) to study your situation. The committee arrives. It studies the situation. It agrees that we have not asked for too many bombs after the members of the committee have personal conversations with General Doolittle of the Eighth Air Force and General Brereton of the Ninth Air Force. The committee cables the United States that we should be authorized more than the quantity of bombs we had previously requested, and someone adds some digits, selected at random, to the end of each approved quantity, so that the people in the War Department will believe that we have carefully calculated the quantities rather than guessed or estimated them.

Near V-E Day, when the air operations tempo was being increased and the enemy was retreating, there was a shortage of bomb quantity and not necessarily quality. In general, GP bombs furnished in World War II were similar to those used in World War I. Incendiary bombs and fragmentation

bombs differed in World War II from those of World War I, but they were less than 20 percent of the total tonnage dropped. What quantities of atom bombs or bacteriological bombs will be used in the next war as compared with the conventional high explosive and incendiary bombs of World War II? Who can even guess an answer to this question.

For strategic operations in Europe, the RAF Bomber Command used the number of bomber sorties and the tons of bombs dropped on the enemy as a yardstick of effort. The United States Air Forces adopted similar yardsticks, and for this reason, a study of bomb tonnage dropped may be used to give information concerning the magnitude of the operations of Air Force bombardment organizations.

We found in the ETO that determination of requirements was difficult if we had to add numbers of one kind of thing to numbers of another kind of thing. So in the case of bombs, we found that a ton of bombs was a much better yardstick than numbers of individual bombs of varying weights and types, and tons of one type could be added to tons of another type. At first the War Department was unwilling to accept our reports on bomb expenditure in terms of tons because they wanted the number of individual bombs rather than tons of each type. Ultimately, we convinced the War Department. This was probably another example of the work of partially trained people who did not fully understand the limitations of accuracy of requirements estimates, and who may have felt that their job would seem more important if they used astronomical figures in pounds instead of smaller numbers in tons, or used individual items instead of thousands or millions of the item. Later we found that for bombs the best yardstick for requirements for transmission to the War Department from the ETO, was a thousand tons of bombs.

During war, requirements may be calculated perhaps to two figures. For over-all procurement planning purposes during peace, one figure may be sufficient. In other words, over-all plans may be based in war on a 5.3 million man Army, and a 3.7 million man Navy, but during peace, it should be sufficient to plan for a 5 million man Army, and a 4 million man Navy. Can such a method be adapted to peacetime procurement planning? If it isn't, planning methods tend to become tremendously complicated because of the billions of numbers involved. If the method is followed, planning is simplified; time to complete a plan may be reduced by half or more, and graphs instead of long tabulations may serve most planning purposes.

Before World War II, the number of rounds of 75 mm ammunition required for 24 months of war was calculated to the last round. In other words to say that 15 million rounds were required for 24 months war operations was considered inadequate. It was necessary to make the calculations to many significant figures, reporting that 15,747,842 (or some such number) rounds of 75 mm ammunition were required for 24 months of war. This, as you can see, does not make too good sense, but,

if any of you, after graduation from this college, go into procurement planning work, you may stumble into such a situation. When requirements are calculated, the actual pick and shovel work is frequently done by clerks who fill in forms and who do not really know the limitations of the accuracy of the assumptions and the conclusions. The result may be requirements expressed in terms of many significant figures when one, or at the most two significant figures, are all that are warranted by the assumptions.

If we had only one kind of: man, officer, uniform, truck, aircraft, gun, bomb, round of artillery ammunition, radar, and radar set, the war production and training problems would be eased tremendously. However, each war brings new situations, and personnel and equipment must exist in sufficient types so that the needs of the war can be met. If these types have not been standardized at the beginning of the war, they may not be producible in sufficient time to be available during the war. For example, one eminent scientist has recently expressed the opinion that the fruits of scientific research during one war are likely to be of major value, not during the war when the research is conducted, but during the following war, a generation later. A large quantity of unimproved equipment may be used as a substitute for a small quantity of improved equipment. We may not like this procedure, but we may be forced to follow it. For example, we found it desirable to substitute masses of bombs for bombing accuracy during World War II because the war situation was different from what we had expected. This change in policy caused such an increased demand for bombs during the last year and a half of the war that the United States had much difficulty in satisfying the demands of the combat theaters. The Air Forces were able to accomplish much of their objective and help win the war in spite of this change in policy.

Men and equipment may be interchangeable. I first realized this when we began to use the word requisition in asking for personnel just before World War II. Up to that time I had seen the word requisition used to apply only to inert items. As the war went on, I realized more and more how the absence of quality or quantity in equipment may cause increased losses in personnel. The presence of quality and quantity in personnel sometimes made the presence of adequate quantities of equipment unnecessary because of the ability of the personnel to improvise. In general, commanders in the field recognized this equivalence of personnel and equipment, and for that reason asked that equipment quantities be held at a high level in order to keep personnel losses to a minimum. Although commanders preferred the highest quality in their equipment, they were frequently willing to accept lower quality in order to be sure to have adequate quantity.

I will now show you some charts giving World War II statistics, and I will then go into the methods of procurement planning which were in effect before World War II. Some changes in these pre-World War II methods appear to be desirable. As you know, there was a plan called

the Protection Mobilization Plan which was in effect during the 1930's. This plan called for mobilization of personnel by augmentations.

The charts were prepared before World War II, at a time when I was responsible for planning for ammunition production in war. During World War II, I was responsible for calculating Ordnance requirements for a theater, and my production responsibilities were small although not absent. The charts helped me to understand the production problem during the war as a result of which I felt that Ordnance requirements for the ETO Air Forces could be defended even from the production point of view.

Chart I shows the number of tons of bombs expended per month by each assigned heavy-bomber of the Eighth Air Force. The interesting thing about this chart is that the curve was below five tons in 1942, while at the end of the war in 1945, it was up to thirty tons. This change from five to thirty tons caused a big change in requirements planning.

Charts IIa and IIb show the tons of bombs received and expended in the European Theater. Chart IIa is a cumulative chart; the full line shows receipts; the expenditures are shown by the dashed line. The expenditures lag behind the receipts, which is quite natural. But Chart IIa is somewhat difficult to use for requirements analysis. Chart IIb gives the monthly expenditures of bombs, and shows that the ETO started with a small monthly rate of a few hundred tons and expended about 118,000 tons in March 1945. In Chart IIb the full line, which indicates receipts, was above the dashed line, which indicates expenditures, until the winter of 1943. This was the time when General Eisenhower was ordered from Italy to Northern Europe to start his Northern European offensive. At that time we were preparing for D-Day, and the expenditures of bombs showed signs of rising almost vertically. It was then that we started to send so many cables to the United States saying in essence: "We need more bombs." The War Department, being a little distant from the combat theater, asked for justification for the requests contained in these cables. In June 1944, the ETO expended 84,000 tons of bombs, which was a large quantity up to that time. Receipt of bombs again lagged behind expenditures at that time. As General Patton moved across France, he did not need ammunition; he wanted gasoline most; because we seemed to be winning, the rate of bomb expenditures went down. Another explanation for reduction in expenditures late in 1944 was the arrival of winter. Chart IIb is almost a temperature chart from this point of view. As the 1945 Spring approached, we increased bomb expenditures; again the receipts lagged. We sent personal cables from Eisenhower to Marshall again saying, "Please send us more bombs."

To show you that such curves are typical, Chart IIIa is a cumulative curve of the bombs expended by the Fifteenth Air Force. It shows,

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MONTHLY BOMB TONNAGE EXPENDED ON OPERATIONS
PER ASSIGNED HEAVY BOMBER AIRCRAFT OF EIGHTH AIR FORCE

CHART I

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ETO

HE BOMBS RECEIVED AND EXPENDED

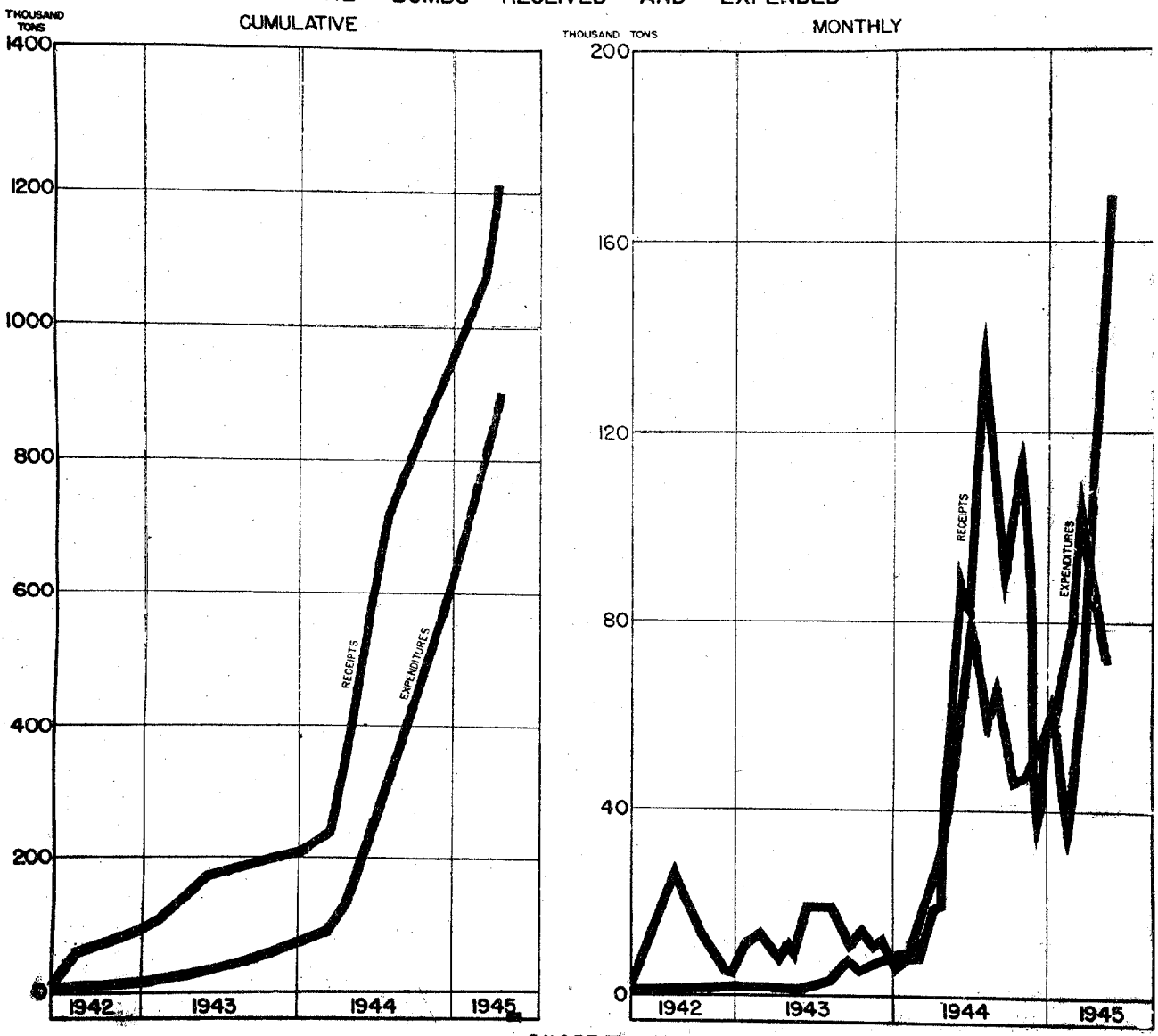

CHART II PAGE II

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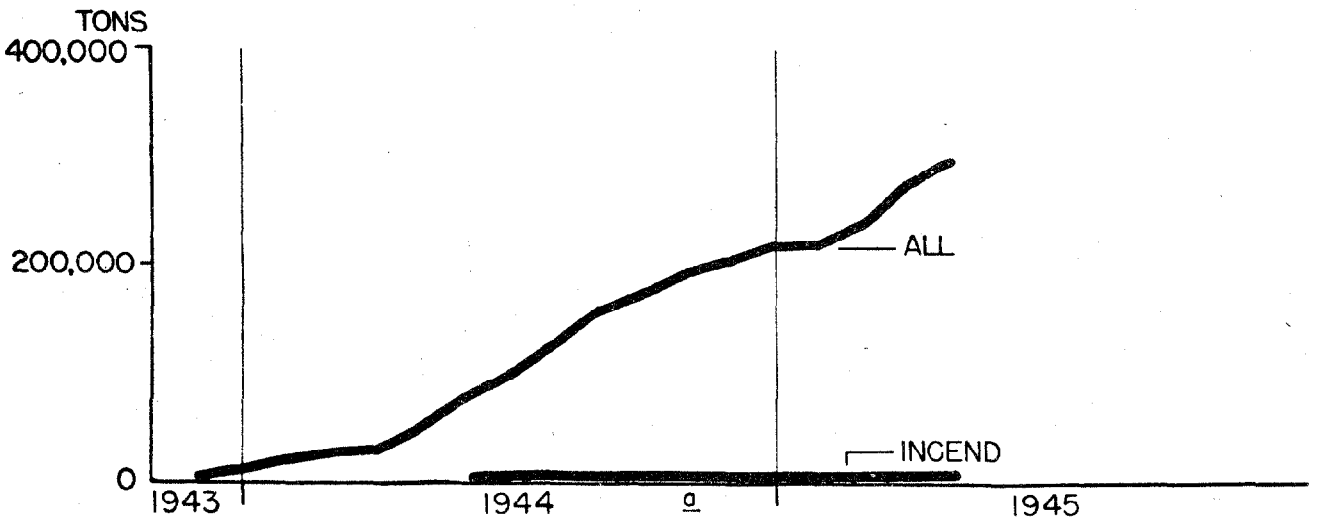
15th AIR FORCE

EXPENDITURE OF ALL BOMBS CUMULATIVE



15th AIR FORCE

MONTHLY EXPENDITURE OF ALL BOMBS

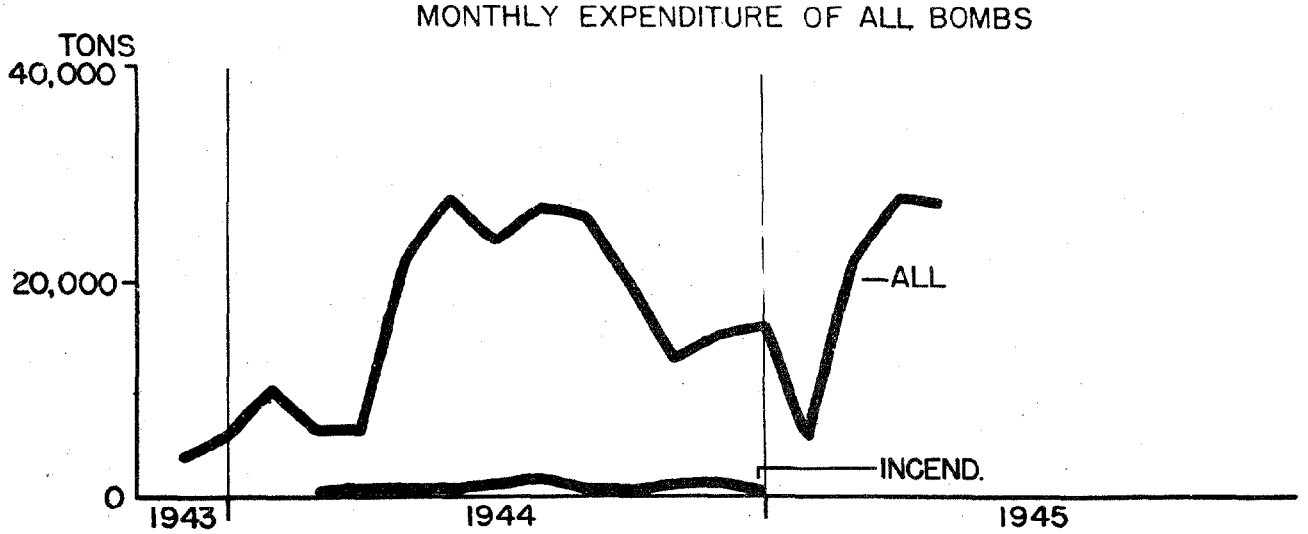


CHART III

that over the whole period of the war, the Air Force expended about 300,000 tons of bombs. Chart IIIb shows that the Fifteenth averaged approximately 20,000 tons per month bomb expenditure during most of 1944 and 1945.

Chart IVa contains a cumulative curve for the RAF Bomber Command expenditures; it shows that they dropped few bombs at the beginning of the war, and at the end of the war, there was a total expenditure of about 900,000 tons of bombs. In Chart IVb there is a picture of the monthly rate of expenditure; the average expenditure near the end of the war was about 40,000 tons monthly. The dip in Chart IVb at the beginning of 1945 is interesting because Air Marshal Harris, who commanded the RAF Bomber Command, had been using incendiary bombs largely during the early part of the war. Toward the end of the war he was rumored to have said, "We've burned down Germany with incendiaries, now we want to blow it up with HE". Accordingly, he began to use HE bombs in large quantities just as we were doing, and the supply of HE bombs became critical. He came to us for HE bombs, which the United States Air Forces in Europe shared with him.

Chart V contains curves which are of general interest in connection with the initiation of requirements calculations. Chart Va shows the tons of bombs dropped on enemy targets per bomber aircraft lost in action. Towards the end of the war we were dropping about 500 tons of bombs on the enemy for each aircraft lost in combat. Chart Vb shows casualties; we were averaging about forty tons of bombs, dropped on the enemy, for each casualty. Chart Vc shows we were expending on the average 120 rounds of machine gun ammunition per bomber aircraft per mission. For the B-17, which has about a dozen guns, each of the guns averaged about ten rounds fired per mission. In other words, they were just firing "warming" shots. In those days we had long range escort-fighters. What shooting was done, was by the escort-fighters. The guns on the bombers were of most value in the case of stragglers.

I have prepared a few purely Ordnance charts, too. Chart VIa contains a cumulative curve for manufacture of artillery, in dollars. This data was taken from General Campbell's book, entitled "Industry-Ordnance Team". Chart VIa shows that over the whole period of the war there were about four billion dollars expended. Chart VIb shows that the cost of manufacture per year went up to a peak and then came down. At the end of the war, the average was somewhere less than a billion dollars per year. I would like to invite your attention to the curve of Chart VIa which slopes up rapidly and is difficult to analyze from the point of view of what is going to happen in the future. The curve of Chart VIb is a much better curve for prediction purposes, even though it does bend around in a typical manner.

Charts VIIa and b contain similar curves for tanks and combat vehicles. The total war expenditure was about ten billion dollars as shown by the

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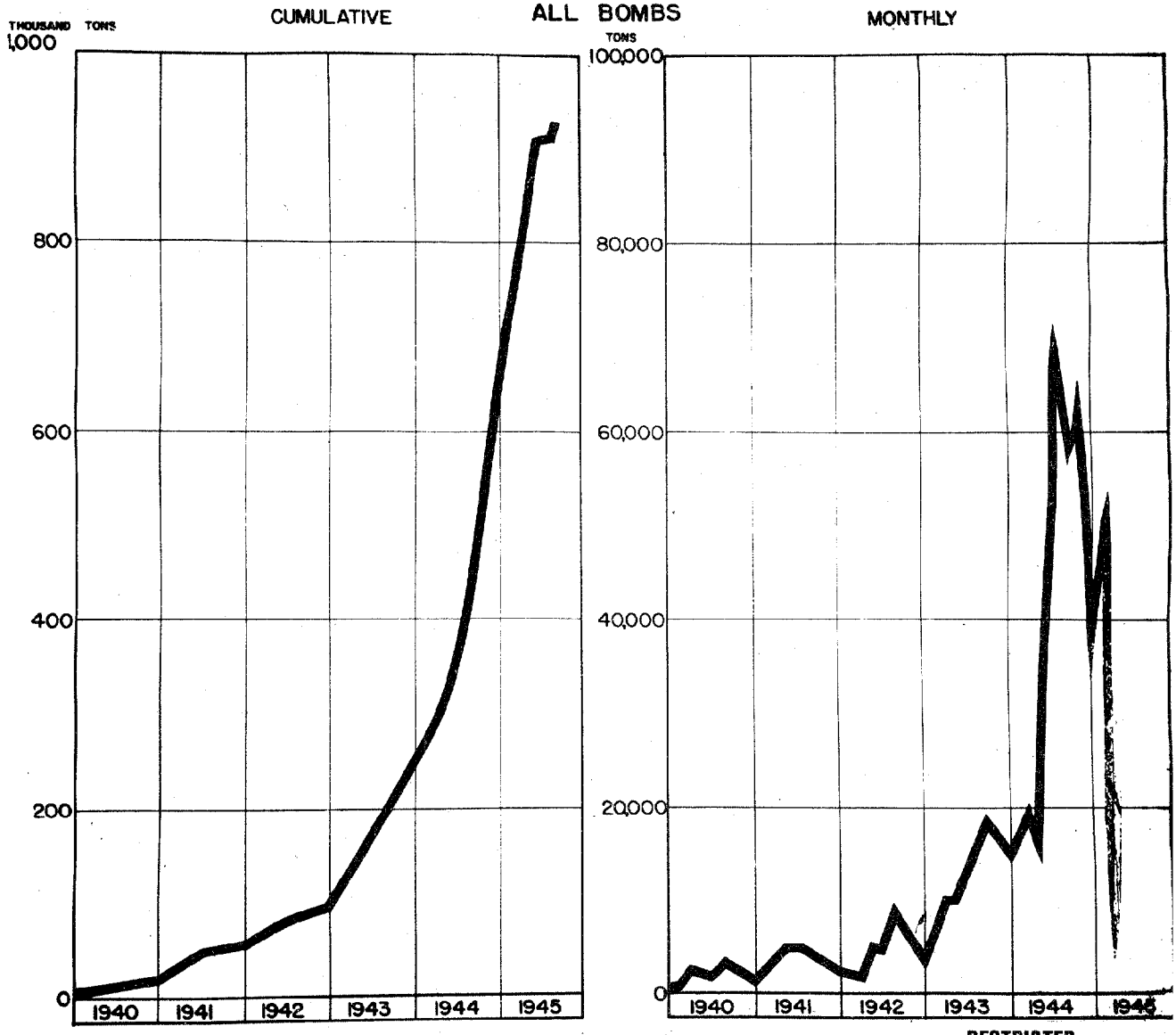
RAF BOMBER COMMAND
ALL BOMBS



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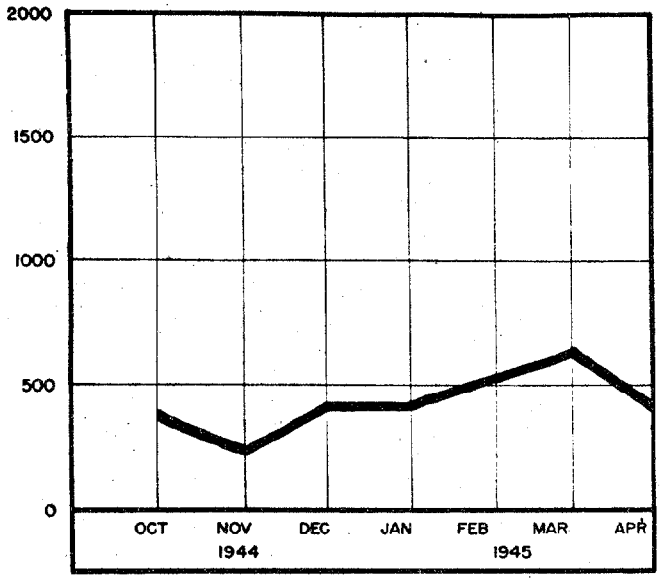
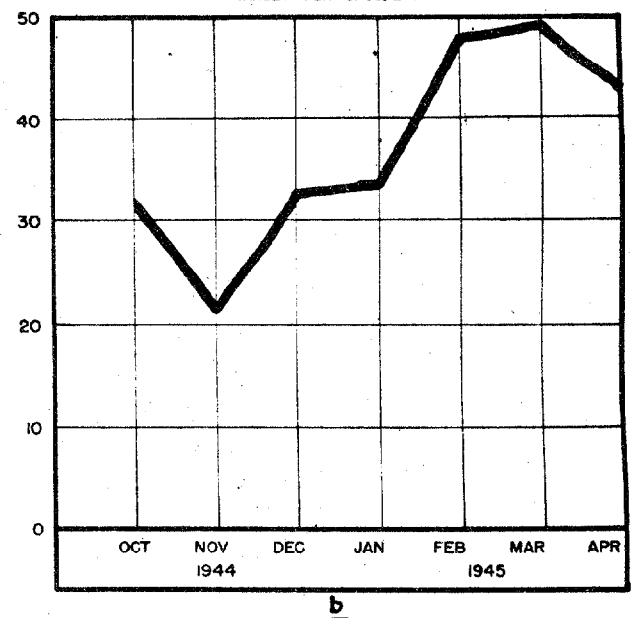
8 TH AIR FORCE
TONNAGE OF BOMBS DROPPED ON TARGET
PER BOMBER TYPE A/C LOST IN ACTION



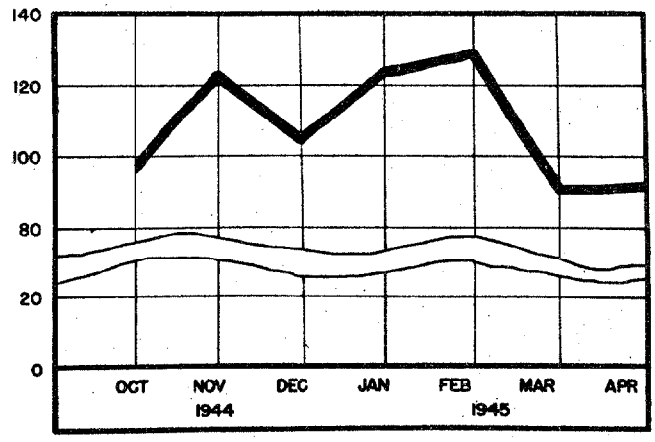
a

8 TH AIR FORCE
TONNAGE DROPPED ON
TARGET PER CASUALTY



b

8 TH AIR FORCE
ROUNDS OF CAL. 50 EXPENDED
PER AIRCRAFT PER MISSION



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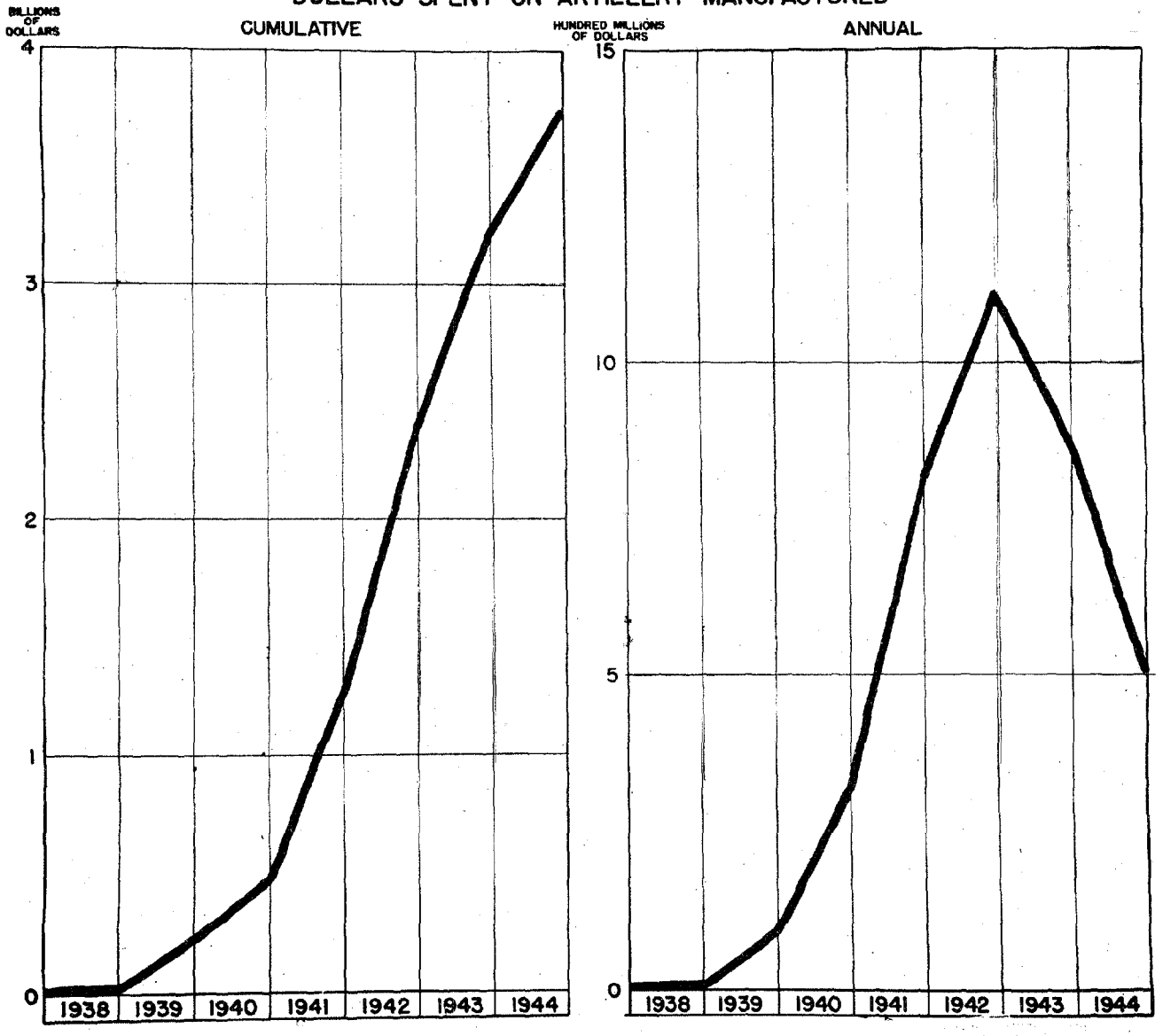
DOLLARS SPENT ON ARTILLERY MANUFACTURED



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DOLLARS SPENT ON TANKS & COMBAT VEHICLES MANUFACTURED

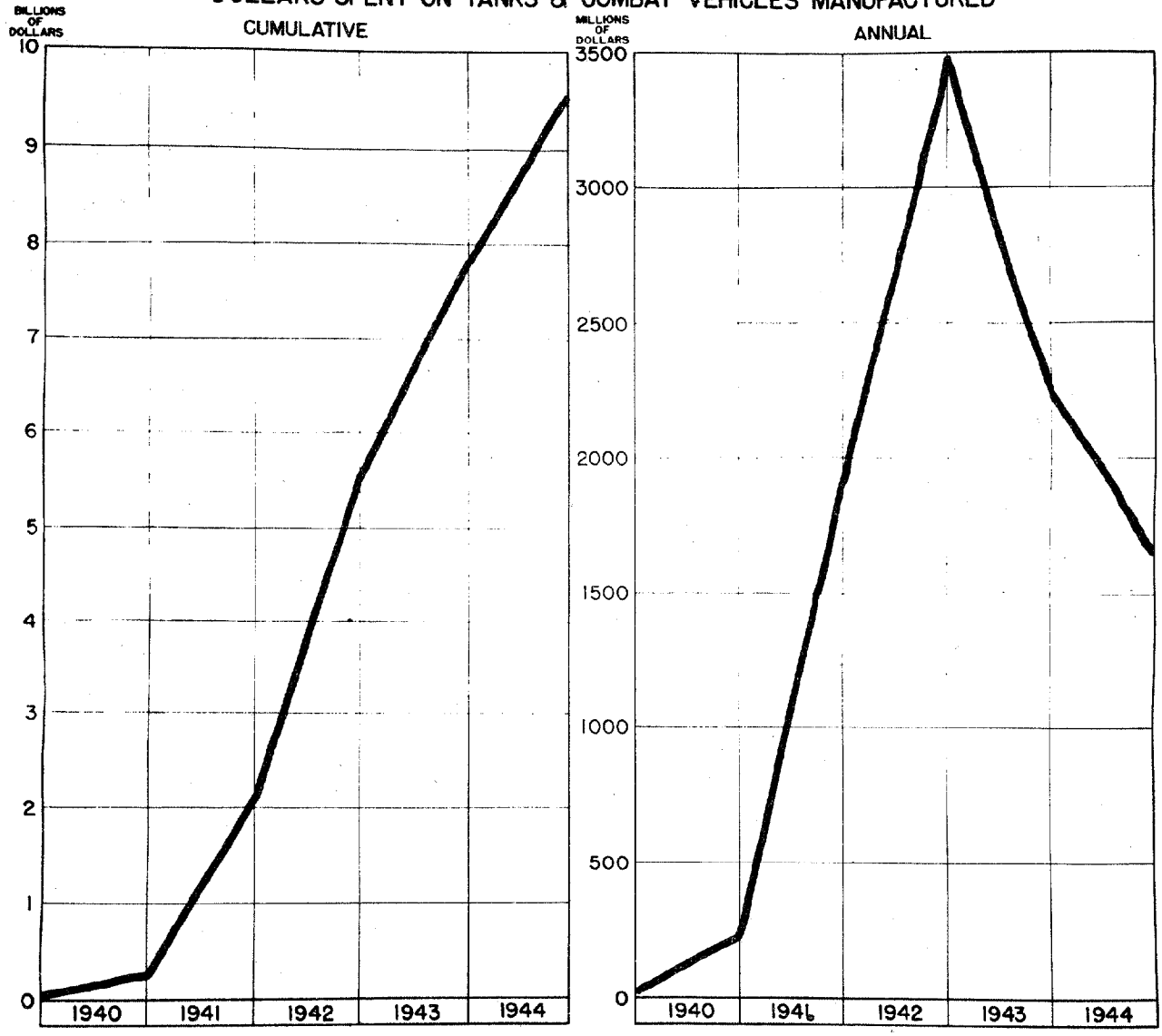

CHART VII PAGE 17

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curve of Chart VIIa. Again the annual curve (Chart VIIb) goes up to a peak and then drops off.

Here is something which we know more about - trucks. There were about nine billion dollars expended, cumulatively, for trucks, by the War Department as shown by the curve of Chart VIIIa. Again, the curve for annual expenditure went up to a peak and then dropped off as shown by Chart VIIIb.

The curve of Chart IX is different. It is not a very good curve, but it is all that General Campbell had in his book on this subject. It shows the estimate, in million pounds per month, of the capacity of explosives plants in the United States. The capacity goes up initially and then levels off. When it is decided that there is too much ammunition, the capacity goes down. When it is decided that there isn't enough ammunition, such as when General Eisenhower cabled the United States, "Please send me more ammunition," the capacity goes up again. This chart shows two things: first, the difficulty of predicting ammunition requirements. Second, whereas on the previous charts the rate line goes up and then comes down and stays down, in the case of ammunition, it goes up and is more likely, if properly planned, to stay up. If it stays up, shortages such as occurred in 1944, should not happen.

Now I am going to talk about the charts which were prepared before the war, when I was a procurement planner. I was trying to find out if there was anything basic about the quantities involved in procurement planning - anything common to all kinds of items. These charts are not really quantitative; they are primarily qualitative, and are designed to give some idea of the relationship of requirements and production to time. There are three kinds of items plotted in these charts; first, personnel because that is always first. Second and third, two kinds of equipment; one kind which the Army calls Class II, and the other kind which the Army calls Class V. Class II items are items like trucks and tanks. I assume ships are included in the same category. Uniforms may be included, too. Other items, which are expendable, are considered in Class V. Ammunition is expendable in an unpredictable manner. Gasoline may be considered an expendable item.

Chart X has personnel as the ordinate, and time after M-Day as the abscissa. There is a peacetime army as shown at zero time. For the sake of flexibility, there are shown five different plans for personnel mobilization.

On the curve of Chart XIa, the requirements for guns start at zero time, at a height sufficient for the peacetime army. We want one rifle for every man. We start mobilizing our personnel; but they require training. The Rg (gun requirements) curve does not go up rapidly at first, but by the time the personnel have been trained, some time after M-Day, the requirements increase rapidly. After everyone has a rifle,

DOLLARS SPENT ON TRUCK MANUFACTURE

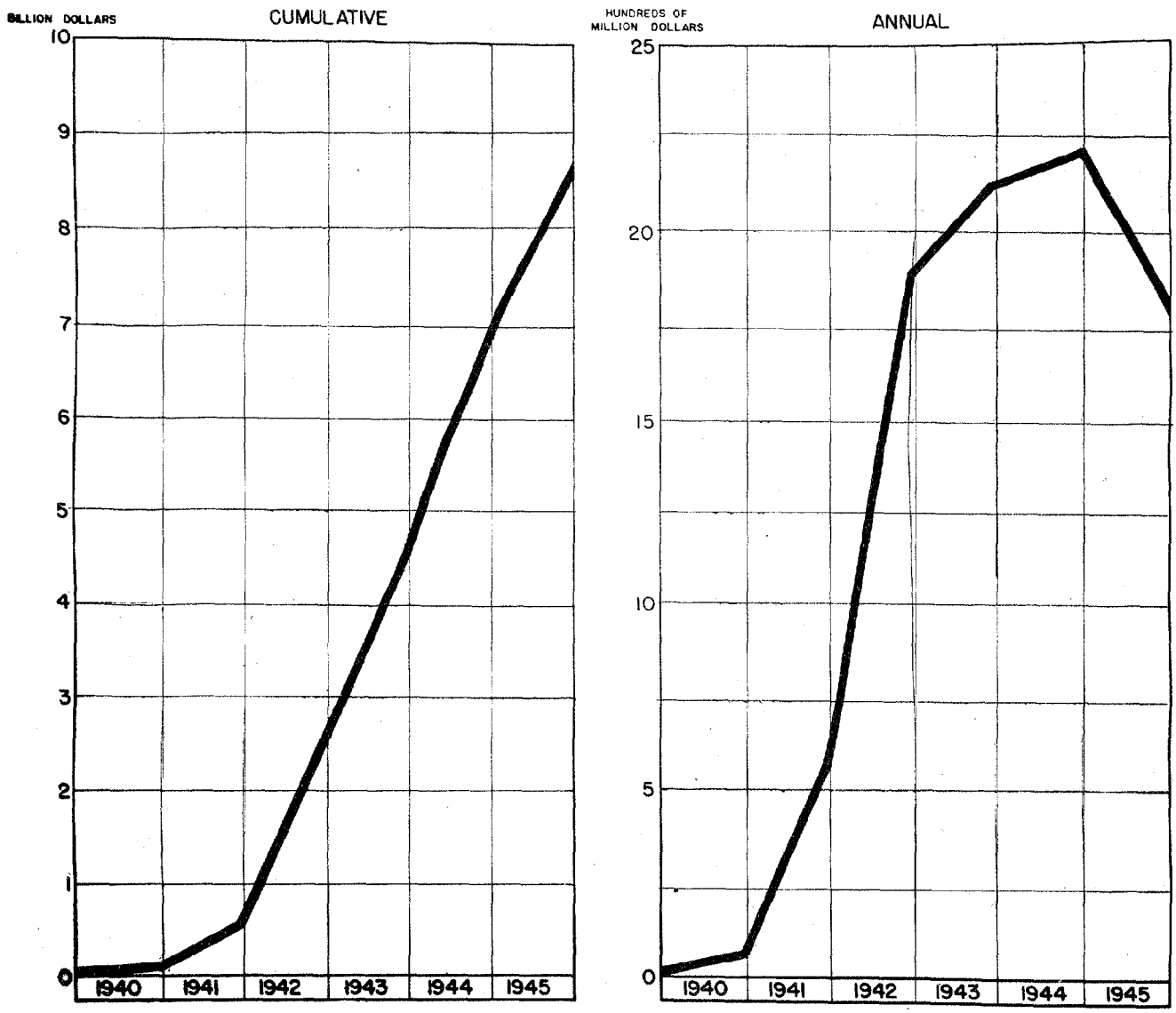

CHART VIII
PAGE 19

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MONTHLY HIGH EXPLOSIVES MFR CAPACITY

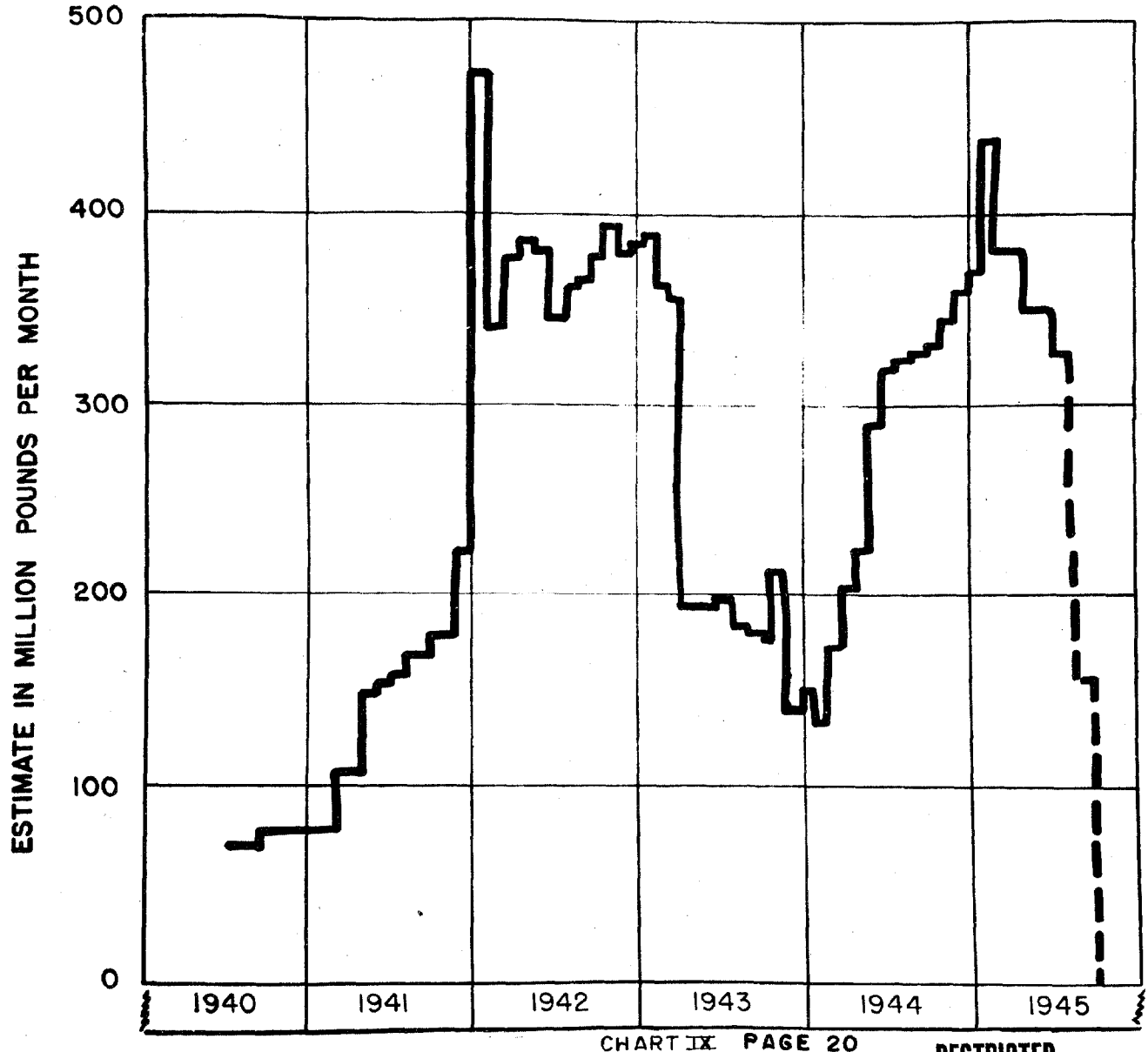

CHART IX PAGE 20

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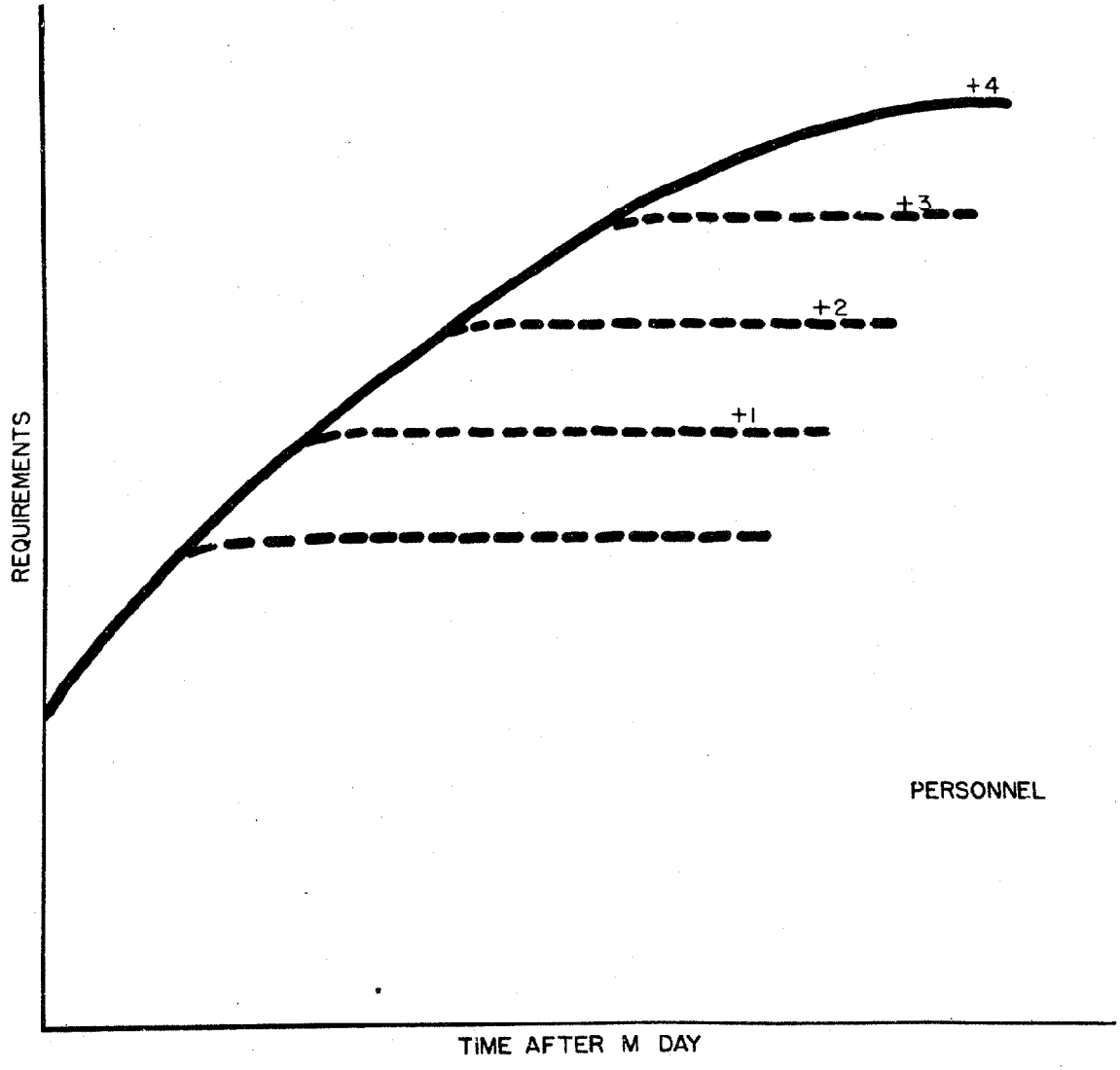

CHART X
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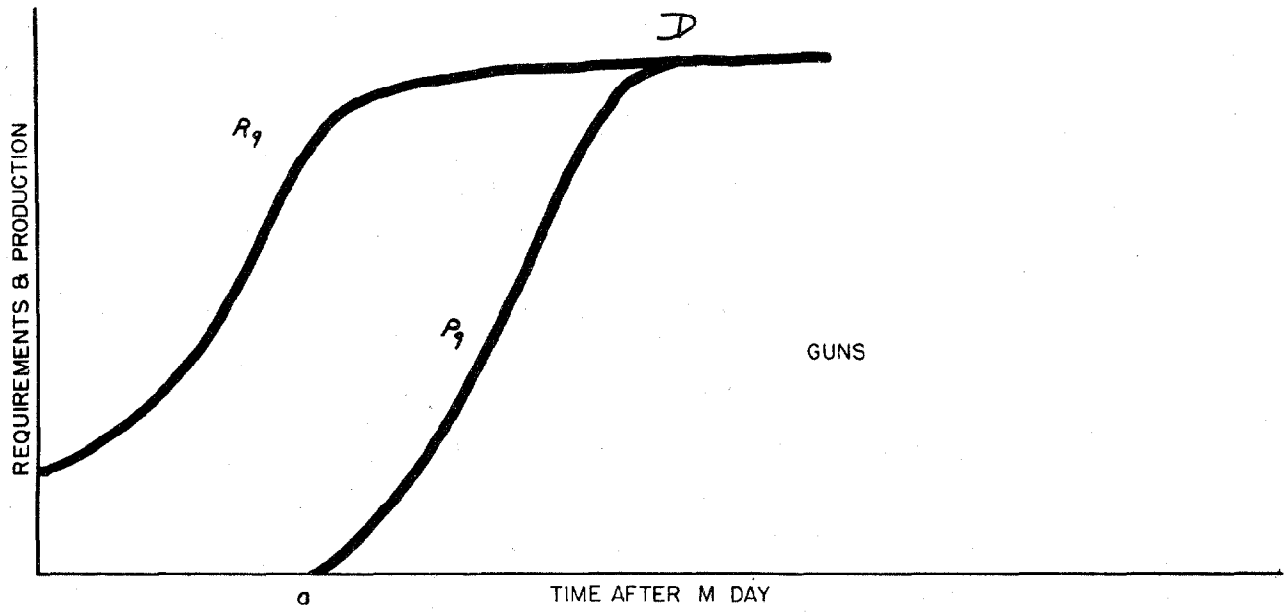

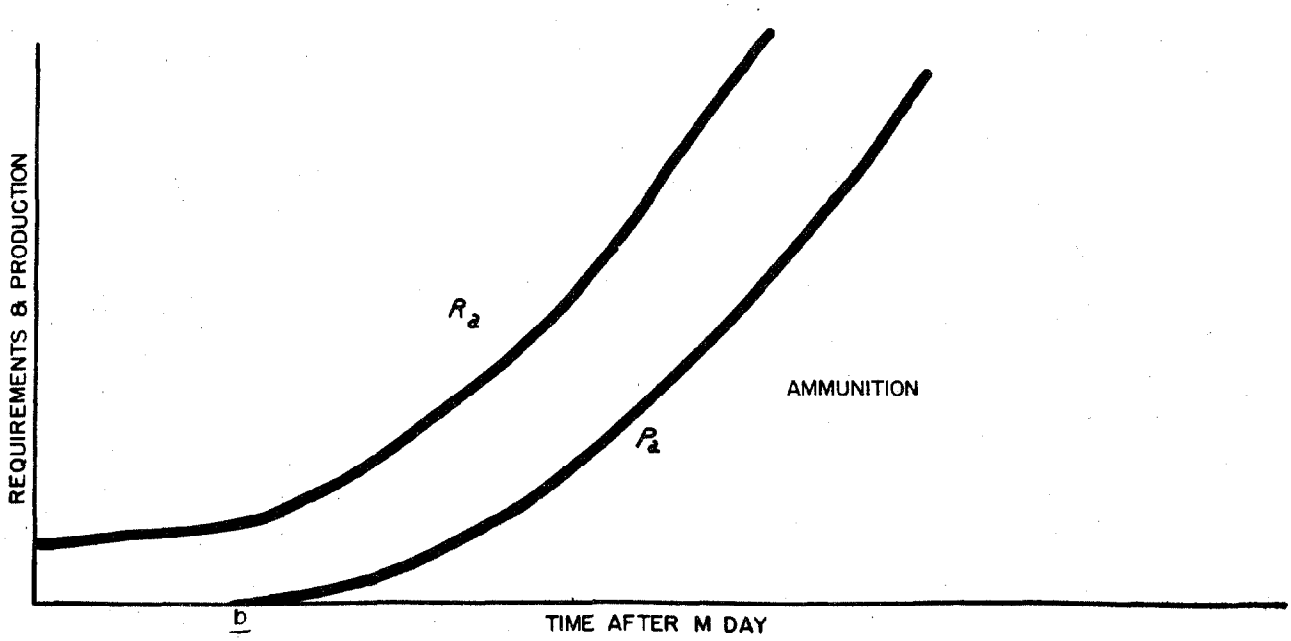

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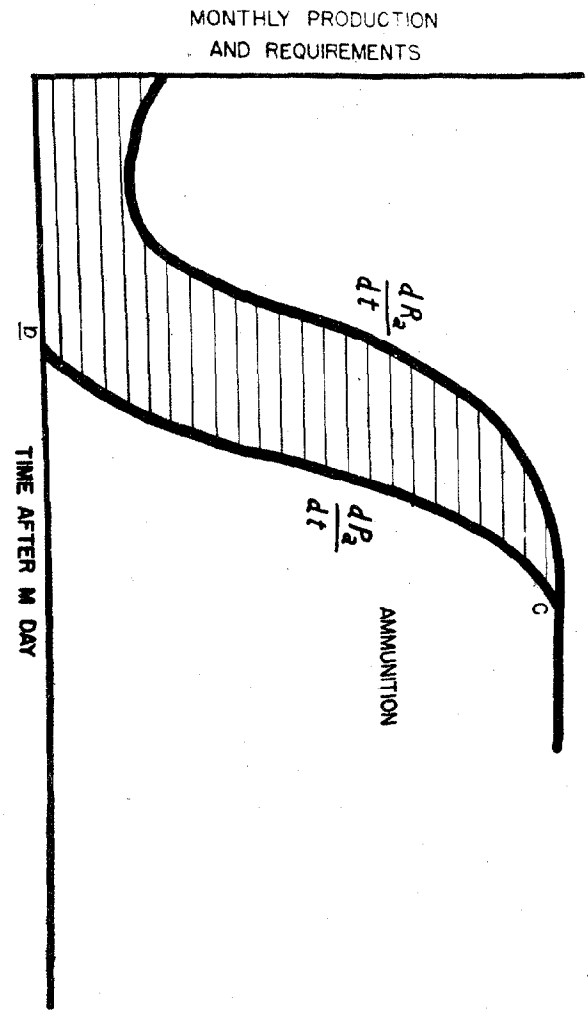
there is needed only a small amount in addition, equal to the wastage rate. We also know that factories take time to get started during war, expecially for items like guns. The factory production starts late on the Pg curve (gun production), but the factory production ultimately catches up with the requirements. At the point D, every man has a rifle. Up to this point, there had been a shortage. The shortage could be measured by the area between the two curves. On the other hand, an item like ammunition is consumable. If you have sufficient trucks, and if the war is not too destructive, the quantity will remain adequate except for wastage. But in the case of gasoline, you continue to consume gasoline steadily. The ammunition requirements (Ra) remain high. The combat units may expend ammunition day after day, and the curve must rise rapidly. The same is true for the ammunition production (Pa) curve. If production starts late, the curve starts late. When it becomes parallel to the requirements curve, the rate of production of ammunition is equal to the requirements rate, and the quantity expended equals the quantity produced. Please remember that Chart XI contains cumulative curves. I am going on now to another type of curve. More information can be obtained from another type than from the cumulative curves.

Chart XII contains curves which show monthly production and requirements for guns and ammunition. Again the abscissa is time after M-Day. For guns, monthly requirements start at zero time on M-Day on the Rg curve of Chart XIIa. Then during the initial training period you don't need too many guns for actual combat, and the curve dips down slightly. As the initial training period ends and personnel go to the places where they will do some good in combat or final training, the requirements go up. Finally, when all personnel have been trained and are in combat, requirements for guns will go down. The Rg curve goes down to a point equal to the number of rifles lost, the number of trucks lost, or perhaps the number of ships lost - I don't know much about the Navy, so I will say "perhaps" when it comes to ships. The production of guns may start late. Instead of going way up, the Pg curve of Chart XIIa levels off. We do not like to have factories open up and then close rapidly, so the curve of production becomes horizontal. At the point A, we have a maximum shortage of trucks, rifles, and items of that kind. Production remains above requirements for a time until the horizontally shaded area is equal to the vertically shaded area. When those areas are equal (at point B), the overage is equal to the shortage. For ammunition, there is a different type of curve. The monthly requirements for ammunition (Ra of Chart XIIb) should rise to a maximum and remain there. After you have all your guns, you may shoot ammunition out of them every day; that is why the Ra curve remains high. The monthly ammunition production curve (Pa of Chart XIIb) starts late; it catches up at Point C, but the horizontally shaded area of Chart XIIb, which measures the shortage, cannot be made up, whereas the gun shortage area is made up by the gun overage area of Chart XIIa. If ammunition isn't used today, it cannot always be used next month. The enemy and the target may be gone next month. But up to point A on Chart XIIa, some of the Infantrymen may have used broomsticks in their training. At point B of Chart XIIa, every Infantryman


MONTHLY PRODUCTION
AND REQUIREMENTS
D
TIME AFTER M DAY
$\frac{dP_2}{dt}$
$\frac{dR_2}{dt}$
C
AMMUNITION

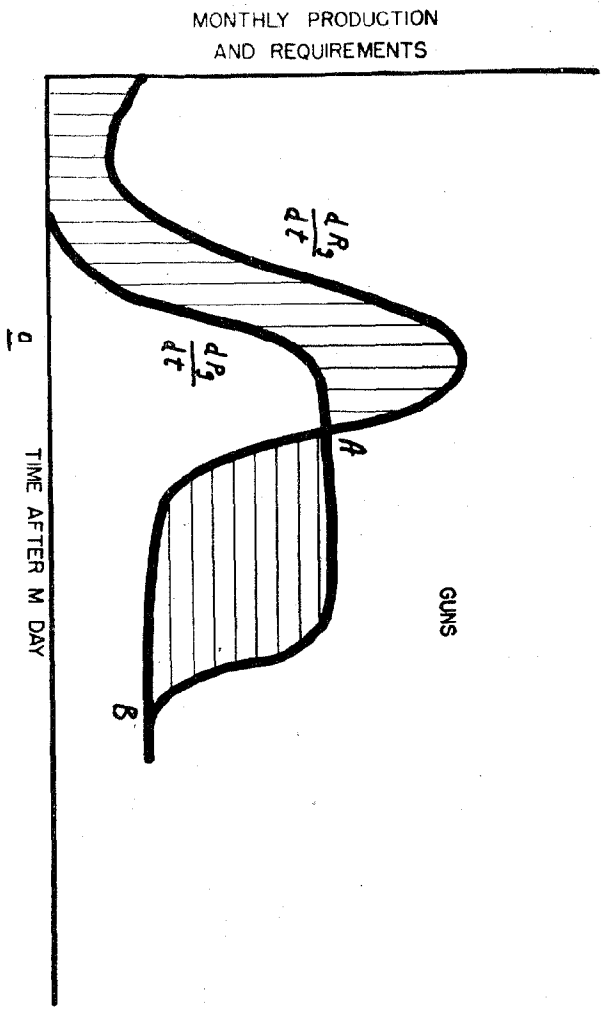
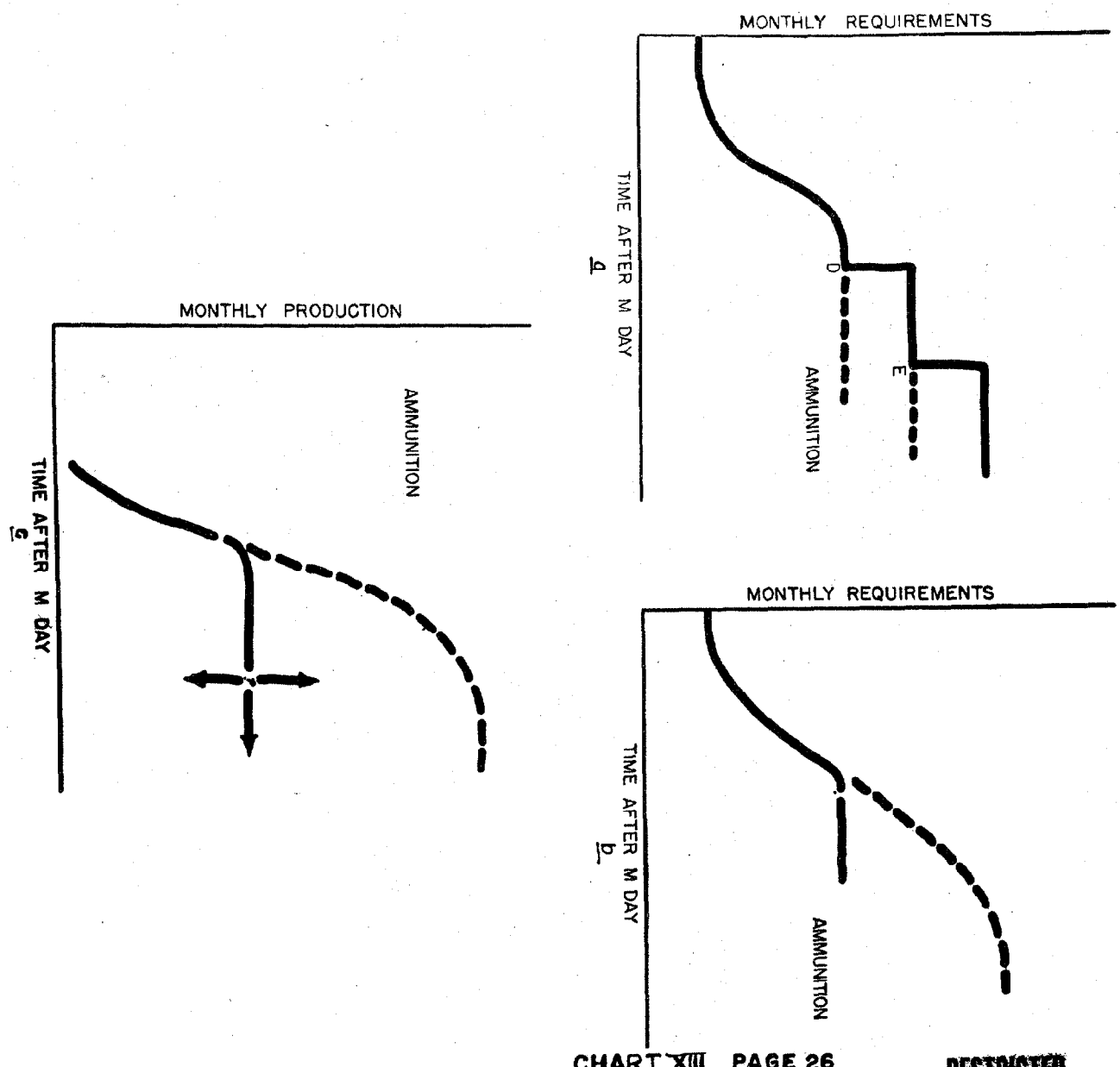

MONTHLY PRODUCTION
AND REQUIREMENTS
O
TIME AFTER M DAY
$\frac{dR_2}{dt}$
$\frac{dP_2}{dt}$
A
B
GUNS

CHART XII

has his rifle. But in Chart XIIb, if the soldier didn't have gasoline or ammunition two months ago, it's difficult for him to consume two months' supply of gasoline or ammunition when there may be no place to go and no enemy to shoot at.

These charts were prepared in January 1940. Perhaps they should have been brought up to date. I felt that, if you thought I had sufficient confidence to bring them here, even though they were prepared before the war, there must be something in them which makes them still of value. Chart XIIIa is supposed to show diagrammatically what happened in World War I. The coordinates are time after M-Day and monthly requirements. After the war started, the requirements, which had previously been planned to follow along the dotted line at D, were raised and levelled off on the E line. I think in July 1918 or some other month in 1918, they were raised again. The requirements which are set at the beginning of a war are likely to be changed shortly after the war begins. Chart XIIIb is supposed to illustrate what happened to the French in World War II. They had gone to war in 1939. Instead of having the Germans go westward, they went eastward. The French thought there was a "phoney" war going on. During peace they planned on requiring ammunition as shown by the dashed line, but they were not consuming the ammunition. Their depots were full. The French said in effect: "We will cut our ammunition requirements." Instead of producing according to the planned dashed line of Chart XIIIc, they cut it off to the horizontal full line. However, some of the French were worried about what might happen in 1940. Having reached the point where the question mark is shown, they were wondering whether they should go down or up or continue at the reduced production rate. The matter of increasing and decreasing production is a continuous problem during war. I remember hearing General Campbell (Chief of Ordnance during World War II) talk about turning the tap off and on for 20 pound bomb production.

Chart XIV is designed to show something about the ammunition war reserve. Monthly requirements and monthly production are shown. If we assume R1 requirements (small) and P1 production (early), then the expected shortages may be measured by the vertically shaded area. With small requirements and early production, shortages may not amount to much, but suppose we have large requirements R2 and late production P2, then all of the shaded area, both horizontal and vertical, becomes a measure of the expected shortages, and we may have a very large shortage at the beginning of hostilities. In the United States, in the past, we have assumed that the vertically shaded area is good enough for a war reserve. We have been lucky so far. We have always been able to depend on someone else at the beginning of hostilities. If we change our policy and assume that in the future we won't have someone else to depend on, we may need the whole shaded area for a war reserve. The horizontally shaded area may be ten, or twenty, or even fifty times the little vertically shaded area.


MONTHLY REQUIREMENTS
TIME AFTER M DAY
d
D
E
AMMUNITION
MONTHLY PRODUCTION
TIME AFTER M DAY
c
AMMUNITION
MONTHLY REQUIREMENTS
TIME AFTER M DAY
b
AMMUNITION

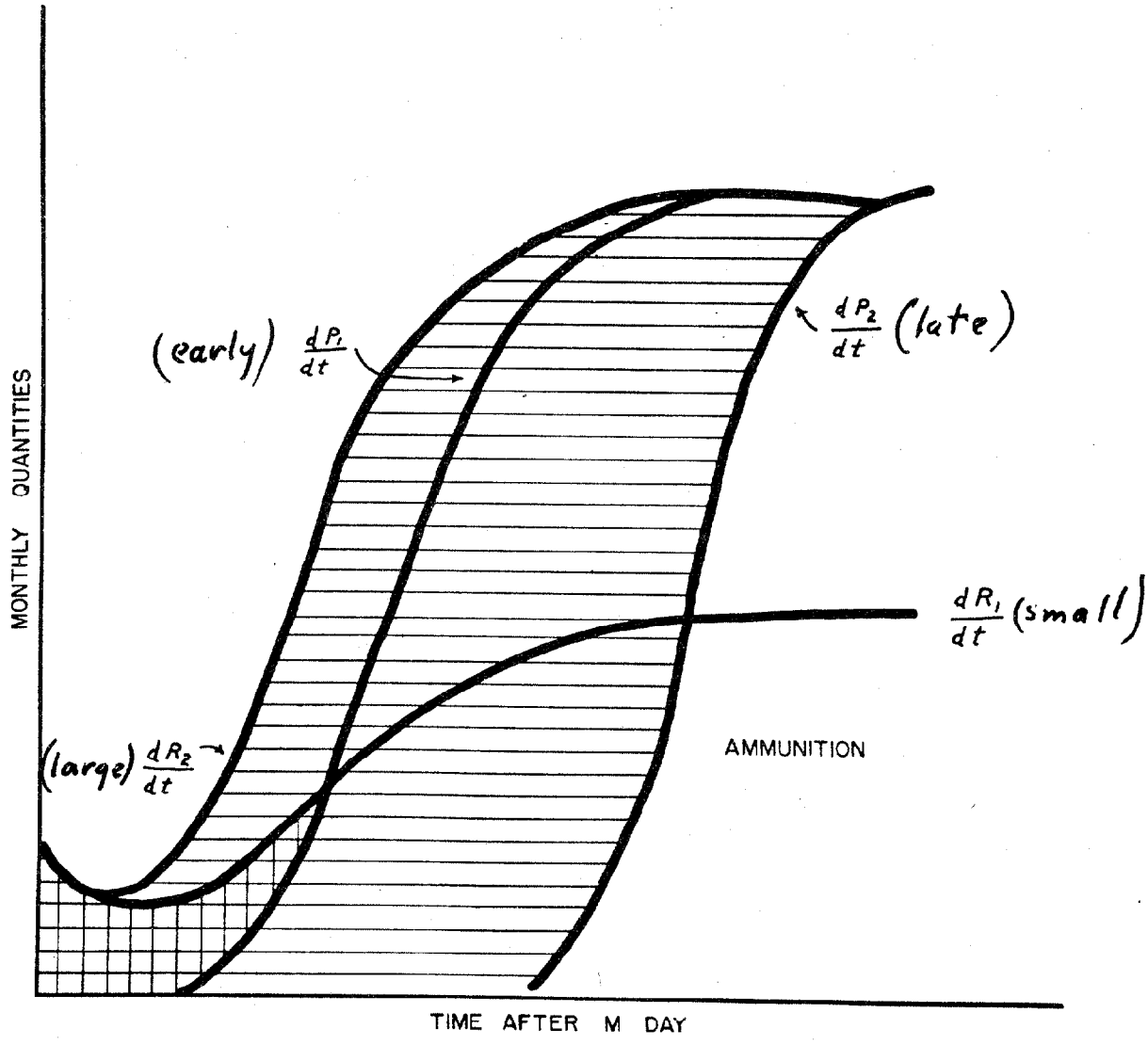
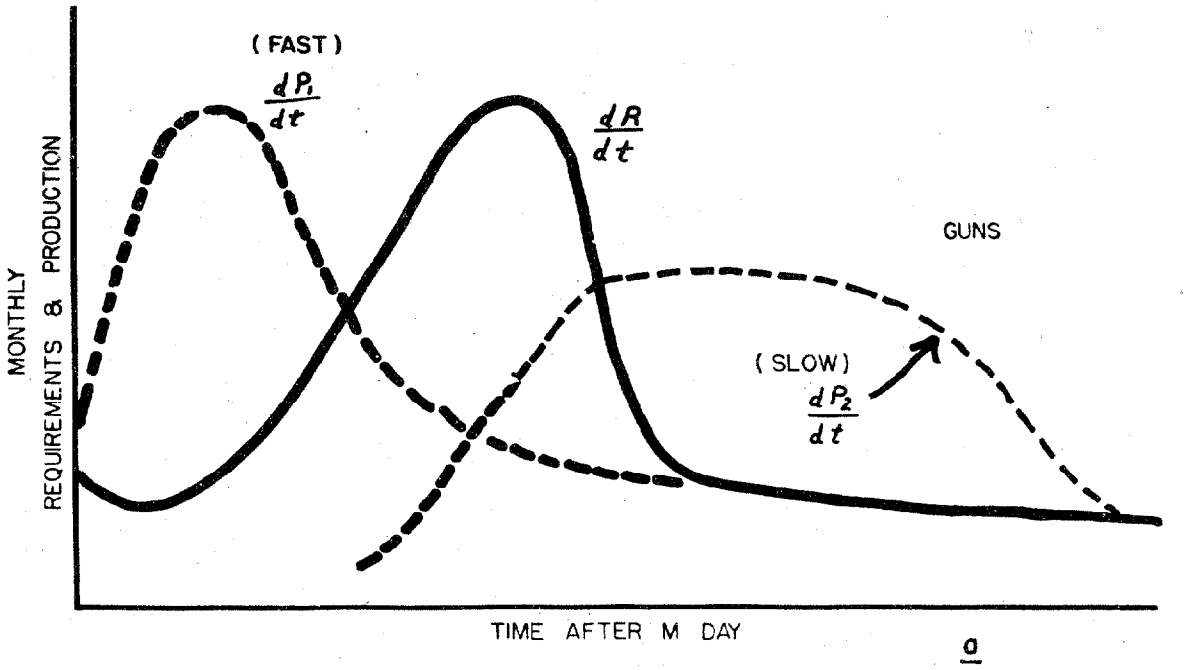

MONTHLY QUANTITIES
(early) $\frac{dP_1}{dt}$
$\frac{dP_2}{dt}$ (late)
$\frac{dR_1}{dt}$ (small)
(large) $\frac{dR_2}{dt}$
AMMUNITION
TIME AFTER M DAY

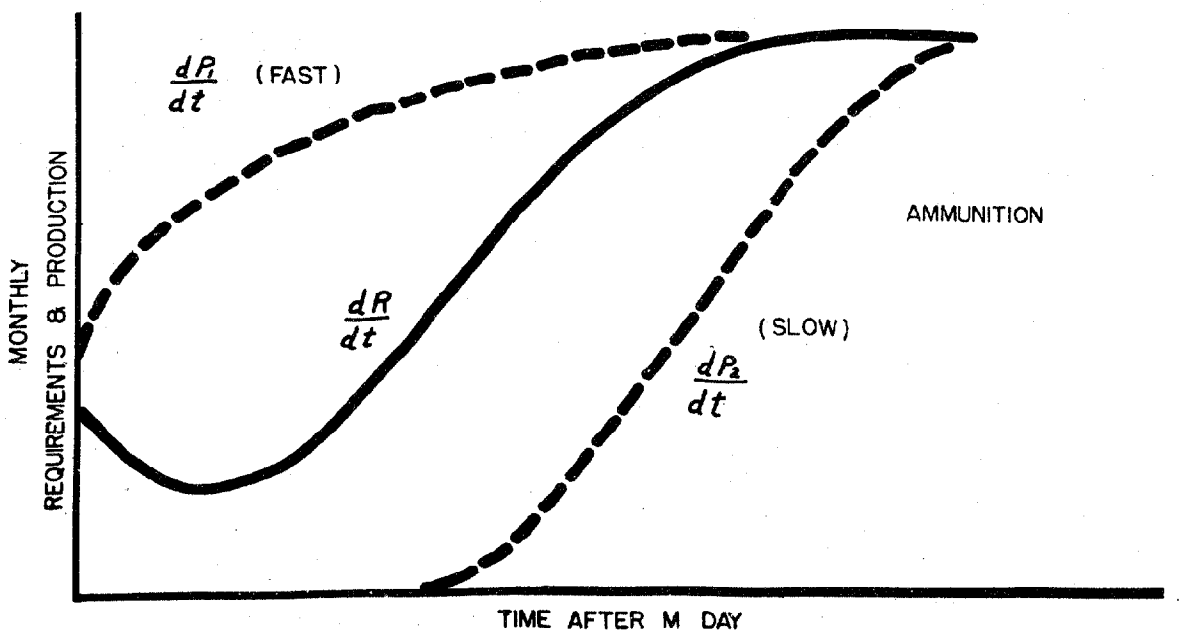
CHART XIV

Chart XV is designed to show under what circumstances a formal procurement plan should be adopted in peacetime. Suppose, for the sake of argument, you have requirements running like the R curve of Chart XVa for items such as guns, trucks, or ships. If for any reason it is possible to produce rapidly, like the P1 fast curve of Chart XVa, then production would always be above requirements, and it should not be necessary to worry about a formal procurement plan; but if production is going to be late, as in the case of the P2 slow curve of Chart XVa, then it should be desirable to have a formal procurement plan. In the case of ammunition, Chart XVb, the curves are somewhat different. Here R is the requirements curve for ammunition. If ammunition can be produced according to P1, fast curve, a formal plan is not of too much value. This might apply to shotgun ammunition. We may use more shotgun ammunition in time of peace than we do during war. In England, during the war, the British stopped making shotgun ammunition, and when we went to England and wanted to do some pheasant hunting, they were glad to let us use our own ammunition because they had none. If ammunition production is expected to follow the P2 slow curve, then a formal procurement plan should be desirable.

Chart XVI is designed to show how to determine how many factories are needed for ammunition production. Some of the curves start early, and some of them start late. Some of them have a low maximum production rate, and some have a high maximum production rate. If the R curve gives the total monthly requirements, then the sum of A plus B plus C plus D must be equal to E in order to have monthly production equal monthly requirements. The reason for the production curves rising in the manner shown is well known to those who have studied production in time of war. The location and slope of these curves may be due to a shortage of personnel, shortage of tools, shortage of raw materials, or shortage of facilities. Curve A may represent a peacetime factory which was able to produce promptly. Curve C may represent a factory which did not exist in peace, and which had to be constructed after war began.

I was trying to look into the future in 1940 and prepared Chart XVII. I looked back on what had happened in World War I. In April of 1917, on the outbreak of war, our requirements went up promptly. In 1918, they went up again. Production lagged behind requirements. The dotted line on the chart is monthly production, and the full line is monthly requirements. When the war stopped, requirements dropped off suddenly. The factories, of course, could not stop that fast, so they lagged behind. During the peace after World War I, we had no money for war production. We produced almost no war materials. The requirements were above production. We were living on the fat of World War I during the 1920's. As time went on, along in the 1930's, Congress began to appropriate money for educational orders. Congress was worried about what was going on in Europe. We began to produce a little. I judged that we would probably be in about the same position if and when war broke out again as we were


(FAST)
$\frac{dP_1}{dt}$
$\frac{dR}{dt}$
GUNS
(SLOW)
$\frac{dP_2}{dt}$
MONTHLY REQUIREMENTS & PRODUCTION
TIME AFTER M DAY
a


$\frac{dP_1}{dt}$ (FAST)
AMMUNITION
$\frac{dR}{dt}$
(SLOW)
$\frac{dP_2}{dt}$
MONTHLY REQUIREMENTS & PRODUCTION
TIME AFTER M DAY

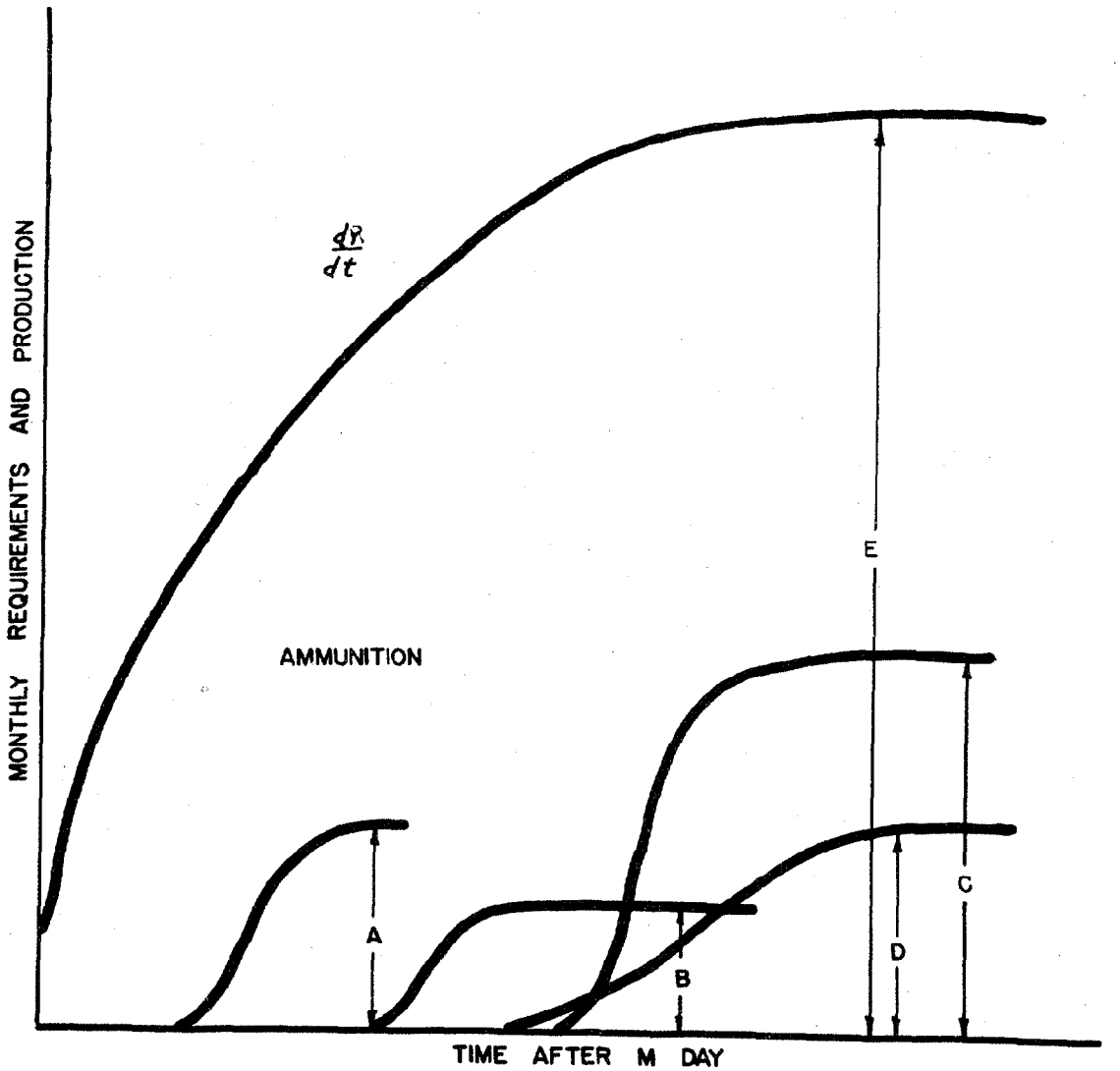


CHART XVI

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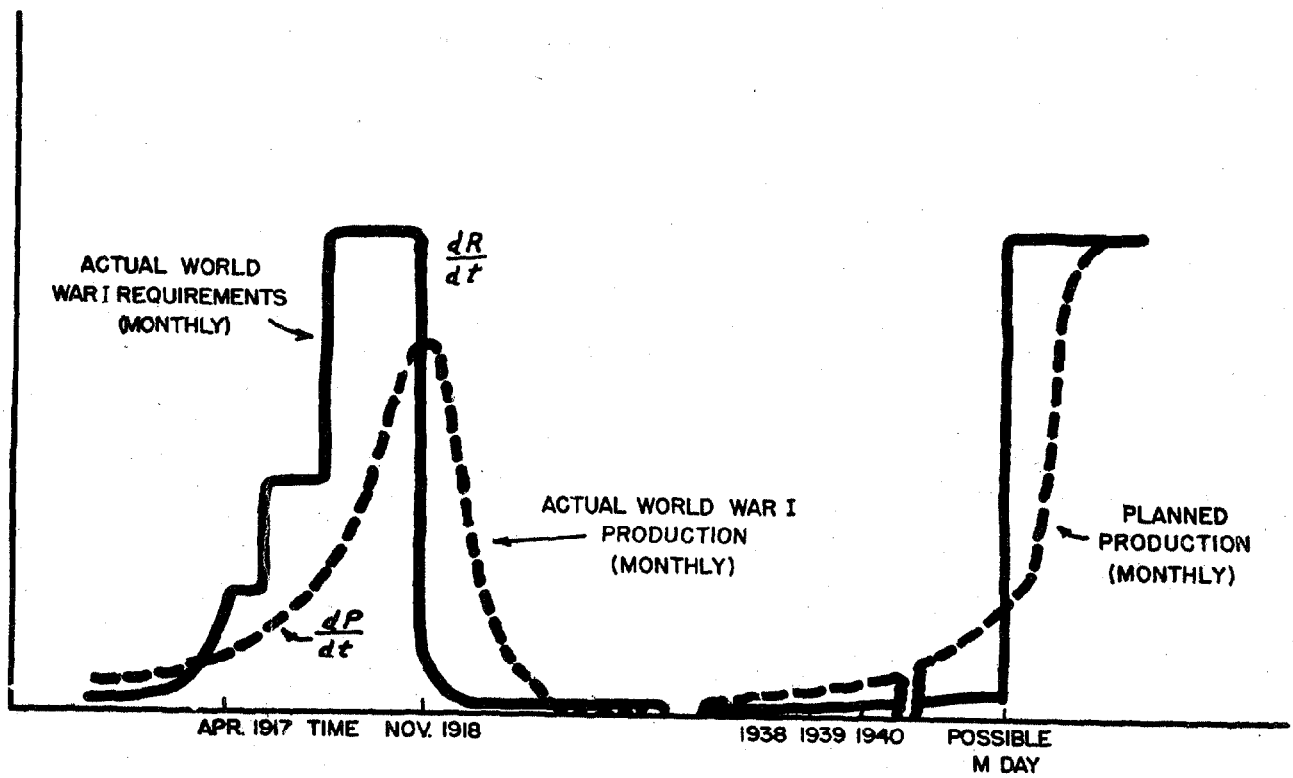

ART XVII

PAGE 31

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in 1917. Requirements would rise quickly, and production would lag.

A single set of requirements figures for ammunition for the first six months is of questionable value because we cannot predict who the enemy is to be and the kind of warfare which will result. It is probable that such requirements figures will be radically changed a few months after war begins. If the requirements figures for the first six months have little accuracy, those for the second and following six months periods must be even less accurate. Accordingly, it should be recognized that requirements and production figures are adopted for these later periods for planning purposes only, and that every one expects that these figures will be changed within a few months after we enter war. If recognition of this fact is adequate, much overplanning will be eliminated. If this fact is not properly recognized, many unnecessary burdensome calculations will be made and much misunderstanding of procurement planning problems will be broadcast. In addition, many planners will feel that there is something sacred about the requirements figures, and they will believe that a fixed plan has been adopted. Such beliefs will lead planners away from the flexibility which is so necessary if planning is to have any value.

In the fog of war not that side necessarily wins which does its job in the most efficient manner. That side often wins which makes the smallest number of mistakes. For example, you may not have a situation where the winning side carries out 90 percent of its operations correctly as compared with the losing side which carries out only 80 percent of its operations correctly. Instead the situation may be more like this: that side which does 80 percent wrong will win the war if the other side does 90 percent wrong. In other words, the winning side may be right 20 percent of the time, and the losing side 10 percent of the time. The winning side is then right twice as often as the losing side. This is an example of the kind of mathematics which must be used in war as well as the result obtained by looking at the same thing first through the eyepiece (factory) end of a telescope, and then through the objective (target) end of the telescope.

CONCLUSIONS:

a. The graphical method of presenting the results of procurement planning should be used more generally.

b. Tabulated values and graphs of monthly requirements and monthly production frequently have much more value than do the corresponding cumulative values and graphs.

c. Graphical analyses of monthly requirements, production, and desirable war reserve of such items as guns (Class II items) and ammunition (Class V items) show that planning methods for these items are not and should not be the same.

d. Procurement planning methods which require a year or more merely to complete paper work should be replaced by simpler methods.

(2 June 1947-350)TP