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ORDNANCE MODIFICATION

27 November 1946

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THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington, D. C.

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Ordnance Modification.

27 November 1946

GENERAL MCKINLEY:

Gentlemen, this morning General Christmas has favored us with his presence and will speak to us on ordnance modifications.

General Christmas is a graduate of Lafayette College in 1917 in mechanical engineering. In 1942 he obtained an honorary Doctor of Science degree from Lafayette. He was commissioned in the Regular Army in the Coast Artillery Reserve in August, 1917.

Practically all of General Christmas's experience has been in Ordnance, with his effort devoted to the designing, development, and production of tanks and other combat motor vehicles. Therefore he is wonderfully qualified to talk to us on that subject.

In 1942 all automotive activities of Ordnance were transferred to the Automotive Center in Detroit, later named Office, Chief of Ordnance -- Detroit. Here General Christmas occupied many important positions. He was Assistant Chief and Chief Engineer, and Deputy Commanding General and Chief of Field Service Operations. Then the following fall of 1944 General Christmas spent three months in the ETO and MTO as a representative of the Chief of Ordnance on all phases of Ordnance tank-automotive activities. In July, 1946, he was transferred to the War Department General Staff in the Service, Supply and Procurement Division -- G-4 to me -- as Chief of the Readjustment Branch, where he is now on duty.

I take great pleasure in introducing to you General John K. Christmas.

GENERAL CHRISTMAS:

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ORDNANCE TANK DEPOTS

1941 --- 1945

Gentlemen: It is a great pleasure for me to accept the kind invitation of your distinguished Commandant, General McKinley, to discuss with you one aspect of a subject which has always been dear to my heart, namely tanks. The aspect which I have been asked to discuss is the subject of tank depots, or, as you no doubt think of them, "tank modification centers."

It is necessary to go back a bit to the early days of 1940 to realize that our Army had at that time only two mechanized cavalry regiments and a few partly equipped infantry tank battalions, equipped with some 500 various tanks. However, in the summer of 1940, capitalizing promptly on the great success of German armored units in the battle of France, the War Department organized our Armored Force under the command of the famous mechanized cavalry officer, General Adna Chaffee, and started to organize for our Army modern armored divisions.

The demand for tanks, both in numbers and variety, to equip these armored divisions, as well as to assist our allies, was so large compared to any peacetime estimates that we were, in effect, confronted with starting a new industry both inside and outside the War Department.

By the autumn of 1941, shortly after the organization of a new and independent tank division in the Office, Chief of Ordnance, we began to obtain an increasing trickle of production of light and medium tanks. While a small number of these went to our newly organized units in training the great majority were shipped to Africa to support the hard-pressed British.

We must admit that we learned from our British Friends a great deal about the necessity of fully equipping a tank so that the crew could exist in it as a self-sustained unit. That is, the modern tank must carry rations, ammunition, radio equipment, first aid kits, tools and spare parts. We also learned almost daily that there was no such thing as a standard design, that the fighting man, as well as our proving grounds and troops in training, were constantly discovering the need for and insisting on the incorporation of many changes in design.

It was thus not long before we learned, the hard way, and the only way in which most of us seem to learn things, that:

- a. The tank producer was not the right man to be the distributor.
- b. That our own Ordnance field service was not equipped by previous training and experience to distribute through its then existing depots so complicated and varied an article as the fighting tank.

It was therefore decided to set up separate "tank depots" devoted to the exclusive mission of receiving tanks directly from the tank producers, completing them and preparing them for shipment to the ports of embarkation,

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or to troop units in the Zone of the Interior. There were the following specific reasons in existence at that time for doing this; but as time went on additional reasons developed corroborating the correctness of the decision of the then Chief of Ordnance, Major General C. M. Wesson.

a. The workers psychology: We soon found that as the number of apparently finished tanks accumulated in the tank producer's factory or yard there were psychological reactions on the part of the workers to the effect that we did not need the tanks as badly as we stated, and production slowed.

b. Engineering changes became so frequent that production was seriously interfered with, both actually and psychologically. These changes amounted in some models to as much as several hundred major changes per month.

c. Reserve requirements; because of the world tactical situation as well as on account of the shipping situation, it became necessary to create as quickly as possible a reserve of tanks.

d. Variations of theater demands; it soon became apparent that the various United Nations as well as the various United States theaters had their own requirements as to how a tank was to be shipped, what it was to contain, and how it was to be equipped. The situation also varied from time to time in one theater.

e. Installation of armament; it soon became apparent that the delivery of cannon and small arms from many factories different from those making the tanks could not be kept in absolute step with tank production. Further, the proper installation of armament with its complicated fire control was of itself a specialty. Scheduling was always a problem.

f. Installation of radio equipment; perhaps the biggest technical problem and the one having the greatest number of variations was in the installation of radio equipment for the various armies and theaters.

g. Self-propelled artillery; the introduction about this time (1941) of self-propelled artillery, a new item in our Army, in large variety, was achieved at that early date by the mounting of artillery on tank chassis. This new and quick improvisation was in part accomplished at the tank depots.

There was also an additional reason for the setting up of the tank depots in that there was created in the War Department a munitions assignment committee, which once a month studied the problems of the various agencies needing tanks and made a decision as to the allocation of that month's production. The decisions of the munitions assignment committee were, of course, predicated on the over-all strategic and logistic situation, hence the Ordnance Department did not know while the tanks were in production to which user they might be sent.

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The first tank depot was set up in the unused New York Central car shops on the outskirts of Toledo, Ohio, and was contractor-operated by the Electric Auto-Lite Company of Toledo, under a management contract. The principal reason for selecting Toledo was that it had a good rail net which could be fed from the tank factories in Detroit and Chicago, without backhaul for Atlantic shipments. I wish to call to your particular attention the fact that an existing facility was used and that the operation and management were by a successful concern in the automotive industry; that is, no Government depot was built and no Government organization had to be created except a relatively small Ordnance representation.

In outline the operation was as follows: The various tank manufacturers sent tanks when completed under the terms of their contract to the tank depot. It should be noted here that these contracts were not all alike either at that time or later, as it was necessary to vary the contracts with the different producers depending on a number of factors such as his facilities, his ability, the industrial situation at the time of making the contract and necessary variations such as type of engine used. Further, all contractors were not able to introduce engineering changes at the same time. At the tank depot was accumulated a supply of cannon, machine guns, tools and spare parts from other Ordnance contractors making such items and/or from Ordnance depots where such equipment was available. Supplies were also obtained at the tank depot from other technical services furnishing equipment for the tanks, that is, the Engineers, Quartermaster Corps and Chemical Corps.

The biggest single activity in this line lay with the Signal Corps who furnished the complex radio equipment which varied not only as between the United States, Great Britain and Russia, but very considerably from tank to tank, depending on its tactical assignment. The Signal Corps sent specially qualified personnel to supervise and check the radio installations. Eventually this became a very complicated technical operation for which the Signal Corps is entitled to very great credit.

Our first tank depot at Toledo was soon such a success that we arranged to set up the following additional ones: At Chester, Pennsylvania, at the Ford Motor Company's Chester export plant, using their plant and their management; at the Richmond, California (San Francisco Bay area) Ford export plant under Ford management. Later Canada set up one at Longue Pointe. The original depot at Toledo soon became physically inadequate to its load and had the additional disadvantage that it was located in such a manner that anybody riding from Washington to Detroit on the railroad could see the stock of tanks in process, or awaiting shipment. It is a curious quirk of human nature, and worth noting, that as soon as people passing on the train saw a few hundred tanks accumulating at our Toledo depot we had serious complaints that we were over-producing tanks and wasting materials and manpower. Actually, of course, a few hundred tanks look like a lot of tanks to the uninitiated. There was actually only a very small number either in terms of our production or in terms of our needs.

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This may be better understood if it is realized that in the month of December 1942 we produced a little less than 6,000 tanks in this country, which in open storage would occupy at least 75 acres. Actually, based on our shipment, we usually, until 1945, had in the tank depots about a five weeks' supply of tanks. This, I believe, you will admit is not a very large reserve with which to fight a global war.

However, as a result of public reaction to the Toledo Depot as stated above, as well as due to its physical limitations, we took over an incompleated, but not needed, Government-owned gun-factory at Lima, Ohio, and completed it as a tank depot to be operated under the management of Universal Motors Division of General Motors Corporation, and when this depot was in full operation the Toledo Depot was discontinued.

With respect to the management of the tank depots it is to be noted that they were started by the Industrial Service of the Ordnance Department as a means whereby the Chief of Industrial Service was able to turn over a completed tank to the Chief of Field Service for shipping on requisition. The Ordnance Field Service put in the tank depots a Field Service Section, charged with the crating and shipping of the tanks but the tank depots remained under the Industrial Service as the latter continued to have much the major interest in the operations carried on there.

Some idea of the complexity of the operations of the tank depots may be gained from the fact that the typical Medium Tank M-4 or Sherman tank, by far the backbone of all United States and British tank operations, contained over 300 different items of equipment weighing in the neighborhood of 2500 pounds, exclusive of ammunition. Further, this "stowage" which we later came to refer to as "OVM" or "On Vehicle Material" varied with each model of tank, with every nation and with every theater. This equipment depended, as is obvious, on the size of the crew, the type of organization which was to use the tank, the theater in which it was to be used, and the language spoken by the soldiers of the receiving nation.

Tank depots also were given a definite inspection mission, inspecting all tanks as received in order, so far as practicable, to deliver to the troops a product of uniform high quality. It is worth noting that even tanks from the best producers sometimes arrived at the tank depots with critical shortcomings.

In spite of the various activities outlined above the greatest and most difficult mission of the tank depots lay in the application engineering changes. It takes, as most of you gentlemen no doubt know, from 60 days to 6 months to apply an engineering change to a complex article which is really in quantity production. This is particularly true in the case of a complicated item such as a tank, which is assembled from items furnished by as many as 500 sub-contractors and sub-sub-contractors. It is true that there are many engineering changes, such as inside an engine or a transmission which cannot be applied at a tank depot. However, the great majority of changes affecting the tactical use and or the tank crew can be applied by job shop methods in a tank depot.

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I have in mind such items as changes to a firing mechanism, a fire control instrument bracket, an ammunition rack or an engine accessory. Not only is it slow work to introduce such changes in the production line but their proper application there requires a class of skilled labor and supervisory personnel not generally available in production line factories.

As already stated, the tank depots were contractor-operated under management type Cost-Plus-Fixed-Fee contracts. The management of the contracts, from an administrative and day to day basis, was handled by the Ordnance District in which the tank depot was located. These functions included such things as the auditing of accounts, personnel administration of the Government personnel and local procurement. The reason for the local procurement was that the tank depots were continually and increasingly doing emergency procurement in small lots in order to make engineering changes directed at the last minute, or to make up storage equipment not obtainable from depots. This was done on an emergency basis to meet a dead line for a specific shipment of tanks. For example, I recall that the Chester Tank Depot spent Christmas day for 1942 shopping for lead in the Philadelphia area in order to make counterweights on certain self-propelled artillery to meet a dead-line shipment.

In the early days of the tank depots they were also set up to ship with tanks the spare parts going with the initial shipment, that is, not only the spare parts carried in the tank but also the sets needed in the theater to initiate the theater depot stocks. This system, in my opinion, worked very well but was later changed so that tank spare parts were shipped from separate Ordnance parts master depots. It is my recommendation that in the next emergency tank spare parts be handled by the tank depots, as they have a highly specialized knowledge and special interest in the tank program, both of which I consider essential to rendering really "good service." I have reference to the difference in service one gets say in buying a pair of shoes in a general store in the country and in going to a shoe store in the city. I have stated before that as the war went along additional duties were thrown on the tank depots. One duty which had not been foreseen was in the rebuilding (or major overhauling) of tanks before shipment overseas. Our tank production program had been predicated on our troop basis; plus 7% a month of wastage in the theaters (no wastage had been allowed for in the Zone of the Interior). Actually, our newly organized armored divisions received new tanks from the tank depots and used them quite properly but very severely in the realistic type of training set up by the Armored Force. This was particularly true in the final or graduate training in the Desert Training Center. This had the result that tanks after six months or a year of training were in such bad condition that field maintenance shops could not restore them to a condition acceptable for overseas shipment. Secondly, and perhaps more serious, was the fact that due to rapid tactical and engineering developments the tank that had been in training with our troops for six months to a year was already well on the way to becoming obsolescent or out of style. It therefore became necessary to send with the troops going overseas, or to ship overseas separately to equip units being shipped to the theater, tanks of the latest production. Then the Ordnance Department took back from the troop units before they sailed partially worn out and partially obsolete tanks; these

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tanks were then "remanufactured" for future shipment overseas or for issue to new troops in training.

Since these used tanks varied as to condition, had come from as many as eight different factories and often at different time periods, the remanufacture of these tanks was not an Ordnance field shop operation but a definite manufacturing operation. This remanufacture averaged in cost about 30% of the original cost, so was economical to us. It was not straight-line production and for these reasons it was decided to put this class of work in the tank depots, where it served also to fill in gaps in their work load. The correctness of this decision was borne out by the excellent results obtained by remanufacture in our tank depots of large quantities of such tanks, as well as of many other combat vehicles.

While these depots were originally set up to handle only tanks, as their name implies, as the war developed we not only manufactured a variety of tanks but a still greater variety of self-propelled artillery. We also made many auxiliary vehicles, such as tank recovery vehicles, tank bulldozers, and many varieties of armored half-track vehicles. Added to these was a large variety of other combat vehicles, such as armored cars and special fast tractors for mobile artillery. The result was that in 1944 our tank depots were handling in the neighborhood of 60 different major types of combat vehicles mostly combat. While their over-all supply of vehicles never went beyond approximately a five weeks' supply at critical periods, it is true that in certain types they would at times have as much as four or five months accumulation. This happened because the organization of new units had been delayed, a theater requisition for an item had been cut back or put at a low priority, or important engineering changes had to be applied before shipment could be made.

A few statistics on the operation of our tank depots follow:

The peak of vehicle receipts at our four tank depots was 17,500 in October 1943; peak shipments were 14,000 in May 1944; peak stock on hand, 24,500 in April 1944.

From January 1942 to August 1945 inclusive the four Ordnance tank depots received 331,523 combat and special vehicles, shipped 310,467, which left only 21,056 on hand when the war was over, or 3% of what had been produced.

The Chester Tank Depot in October 1943, a typical war month, had these operating characteristics.

|                                |      |
|--------------------------------|------|
| Total vehicles shipped         | 6159 |
| Percent tanks shipped          | 35   |
| Percent other vehicles shipped | 65   |
| Percent shipped to U.S. Forces | 75   |
| Total employees                | 5603 |

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Work on Medium Tanks M-4 (Sherman):

1116 vehicles handled

22 major operations performed on each

635 man-hours per vehicle

Major types handled: 58

From this brief sketch of the Ordnance tank depots I will now summarize what, I believe, is of the greatest interest to this college, namely, what we learned from these tank depots in this war:

First and most important, I believe, is that we must welcome new ideas. I wish you to know that these tank depots were not set up without a considerable and continuing opposition on the part of many people who later admitted the necessity of having them. It was necessary to fight for this new idea.

Secondly, since you are the Industrial College of the Armed Forces and dealing specifically with the procurement of equipment, I suggest that you do not lose sight of the fact that no matter what you are doing in a war you are first of all dealing with people. That, I think, is shown not only by the reaction of the workers in our tank factories to the piling up of tanks at the plants but by the reaction of the public to seeing tanks stored in our tank depots.

The third lesson which I draw from this experience is that on the working, or operating level, a commodity, or product-type, organization rather than a functional one is most successful. It was the business or mission of the management of the tank depot to deliver tanks to the ports on time and in the condition ordered by the Office, Chief of Ordnance-Detroit. This these depots did with magnificent success. In accomplishing this mission they performed many functions, such as engineering, inspection, procurement, manufacturing and shipping.

The fourth lesson I draw from this is the desirability of decentralization. These depots operated in a decentralized manner, receiving instruction from the Office, Chief of Ordnance-Detroit mainly in three categories, what to ship, when to ship it, and priorities of work.

Lastly, but not least, the desirability of reliance on American industry is, I believe, also shown by the speed with which these tank depots were put into operation and their great over-all success in a field of activity new to all. I think this operation shows that in an all-out effort to win a major war such home front operations as I have described can in most cases be performed in a private facility by private management under contract with the Army, with the Army supplying general policy and super-vision.

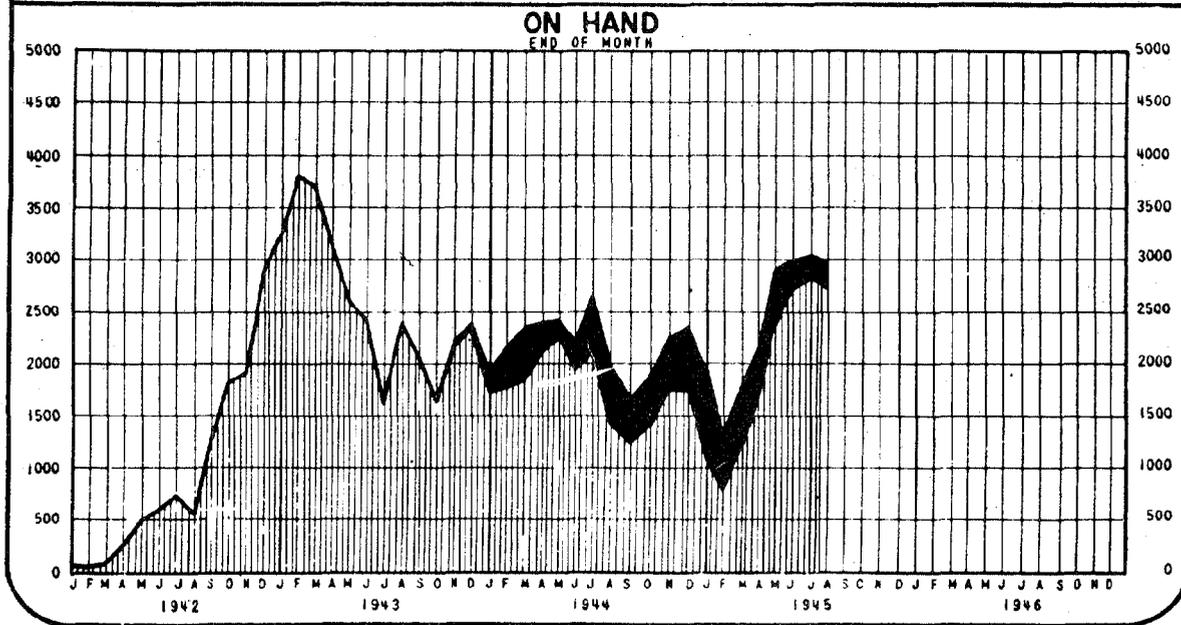
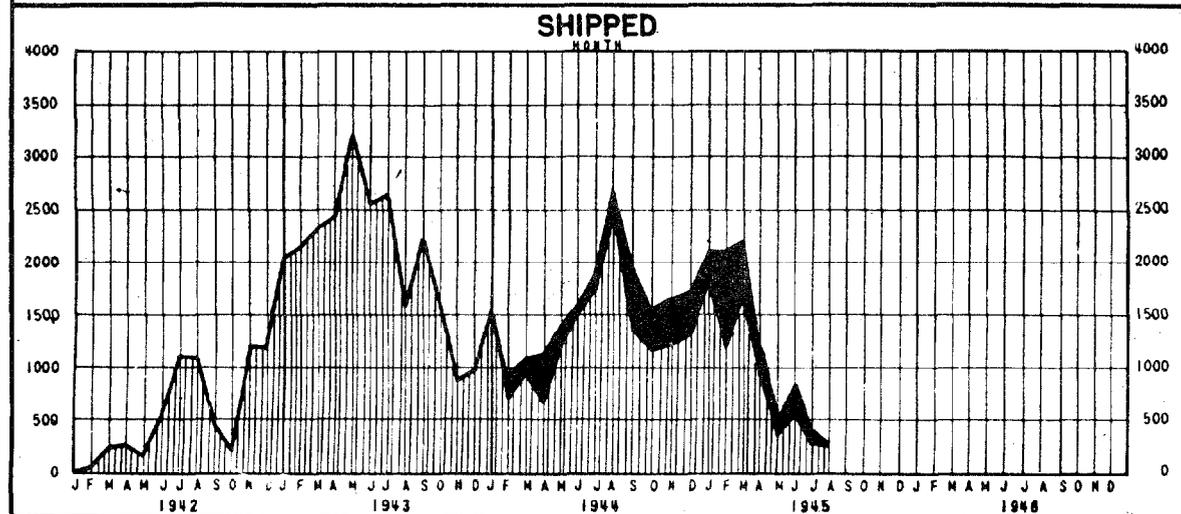
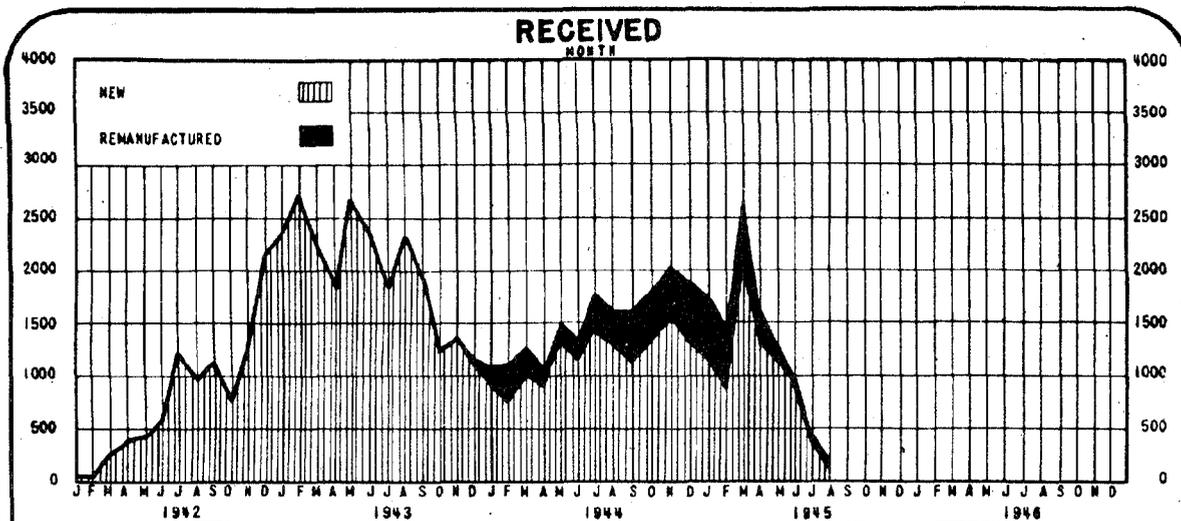
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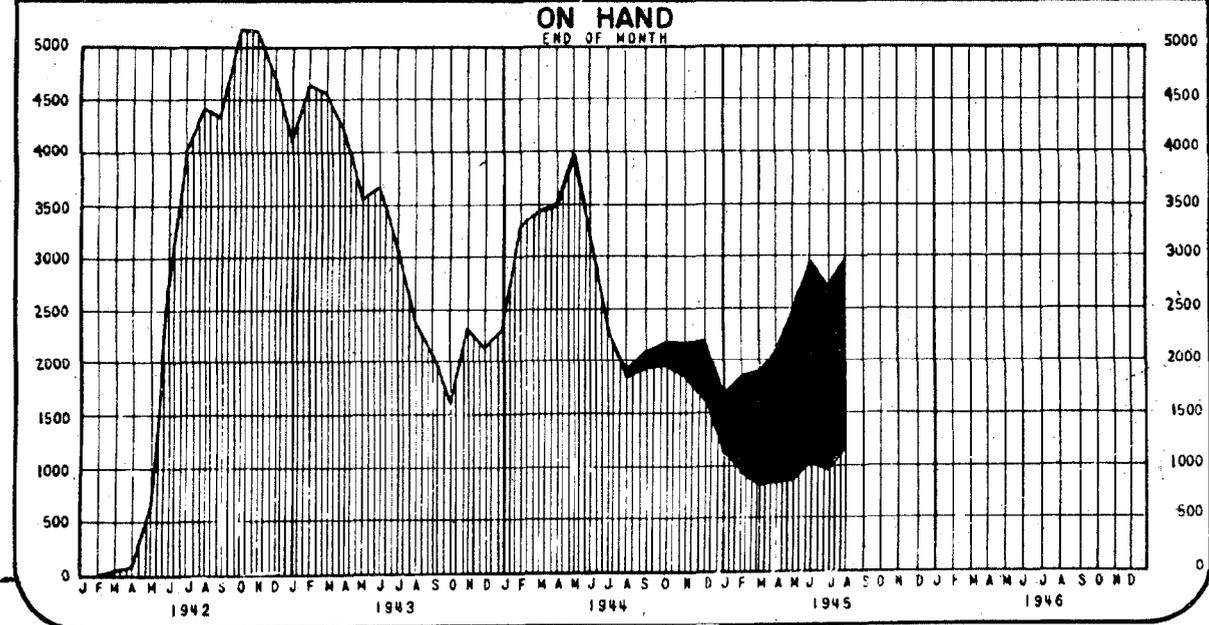
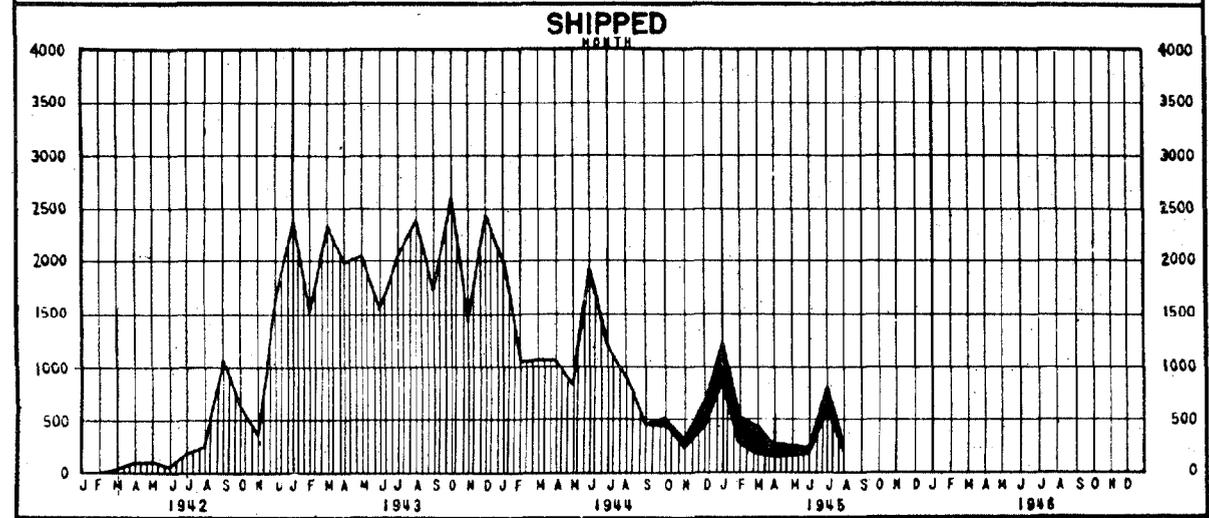
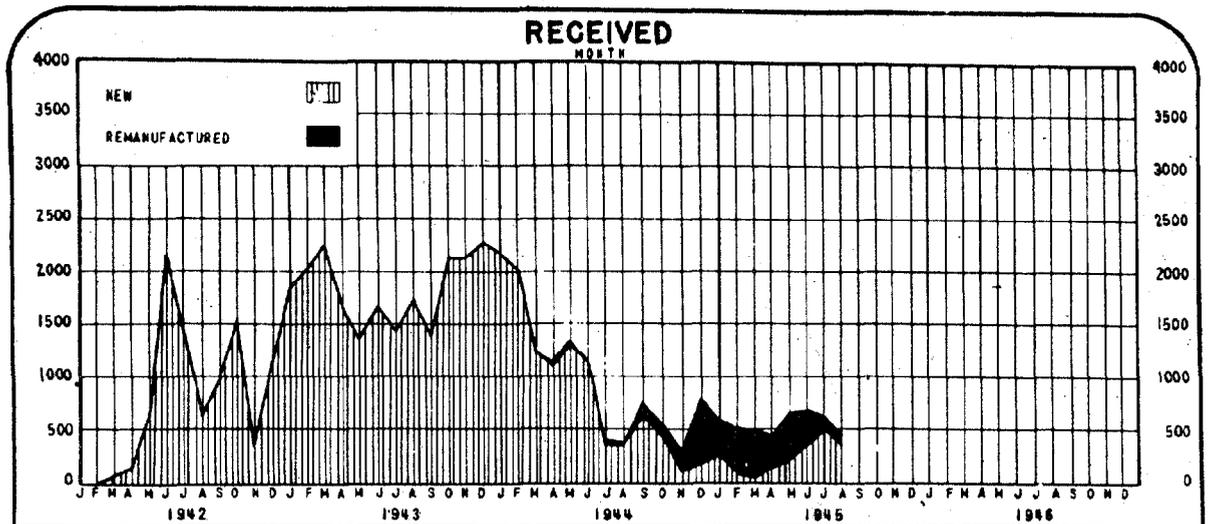
# MEDIUM TANKS

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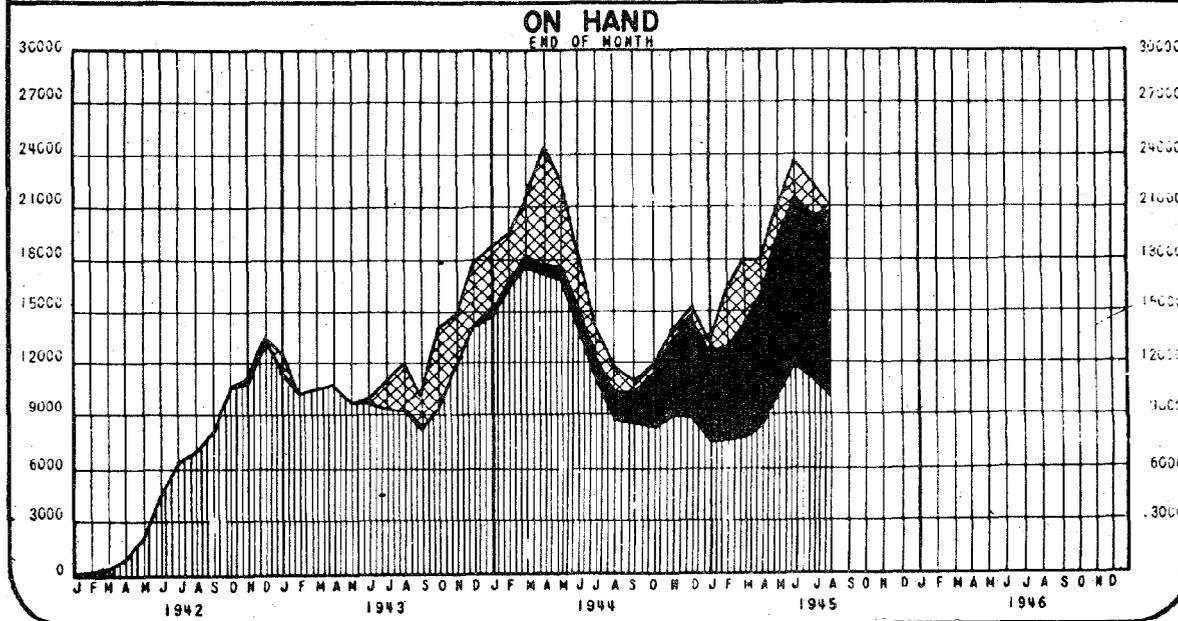
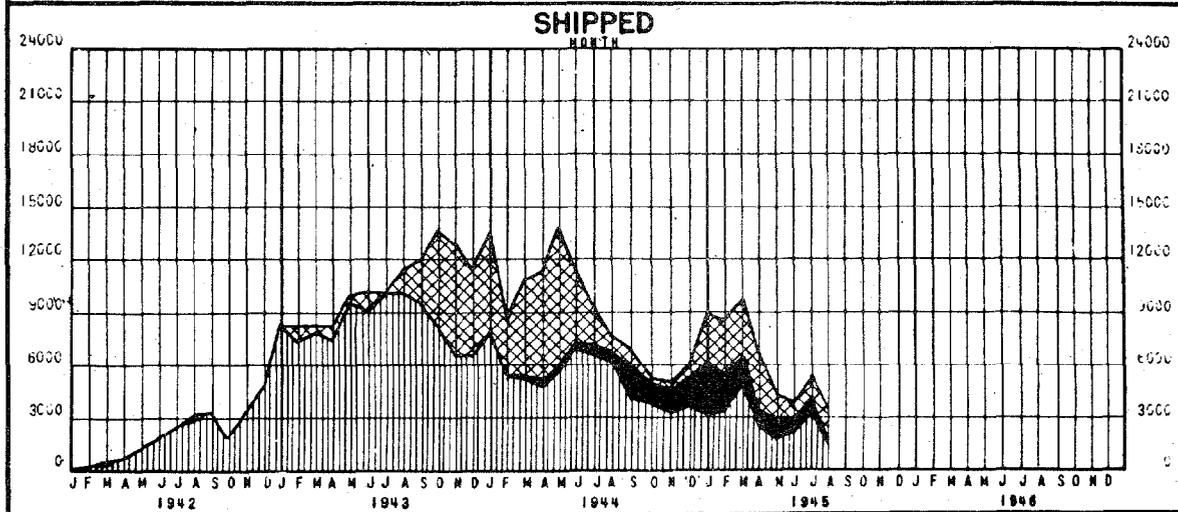
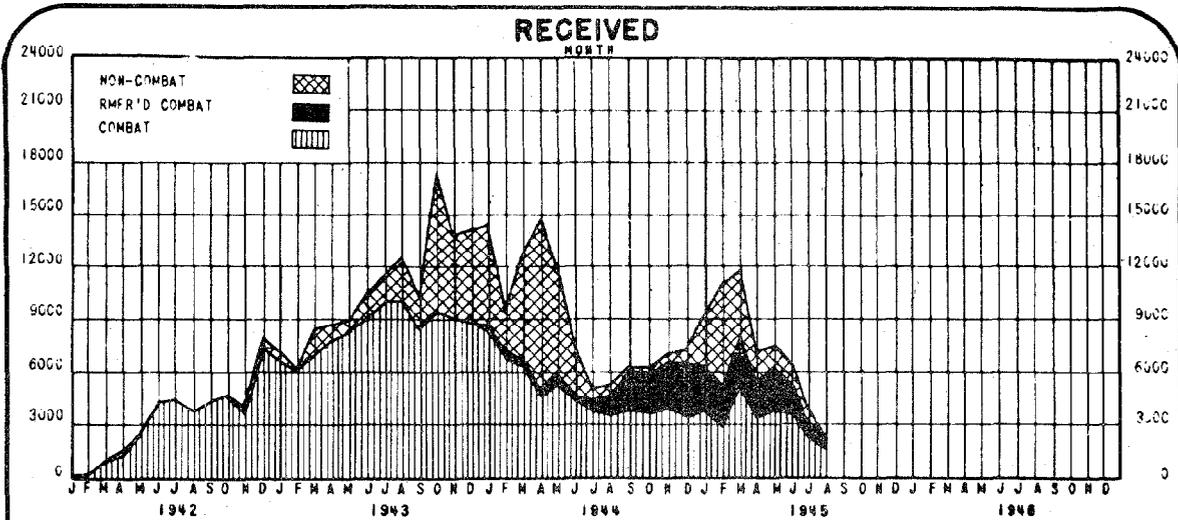
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ORDNANCE MODIFICATION

27 November 1946

SPEAKER -- Brigadier General J. K. Christmas, Chief of  
Readjustment Branch, Service, Supply and  
Procurement Division, War Department  
General Staff

(SUPPLEMENT TO ABOVE LECTURE CARRYING DISCUSSION FOLLOWING MAIN TALK)

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A STUDENT: General Christmas, would you discuss the use and value of the ordnance experts, civilians, who were overseas with the tactical units in connection with tanks?

GENERAL CHRISTMAS: I think it was necessary for the Ordnance Department to send over in uniform service engineers, technicians and other experts from the various tank factories as technical observers for the Ordnance Department. They went out with some of the combat units to obtain knowledge of new equipment being used by the troops. I think they did a good job in every way. I know of one fellow in North Africa who was recommended for the Legion of Merit because he did such a good job with combat units.

The method was not wholly satisfactory. First of all, there were not enough of these experts. I believe we could improve by learning something from our sister service, the Navy. When they build a ship, they send part of the crew up to the shipyard to stay there until the ship is built, so that they will know her from bow to stern. I think that system could be used in our tank factories.

My personal observation of these men overseas was not over a long enough period to give complete knowledge of the value of their work. From what people in ETO and the Pacific have said, however, I should think they have proven their worth.

A STUDENT: I have six big questions that I would like to submit. First, the over-all effect on production of major engineering changes in design. Would you tell us how you initiated that?

GENERAL CHRISTMAS: Let us take what we called "subject No. 1"--the pistol ports on the turrets. First we must obtain drawings. Then, since the turret is made of molten steel, we must make a wooden pattern--a difficult pattern to make. The pattern shop will have to incorporate this change (for which they must be paid). It might take a week to change the pattern, which is then shipped by air or truck to the foundry. The foundry must make such things as core boxes and cores, which are molded in sand, and the castings are made. When the casting is taken out, it is cooled and heat-treated. The foundry may spend about three days working on this. It is cleaned and sent to be machined, which may necessitate another shipment by rail.

The whole setup has to be changed simply because we put pistol ports in this turret. Profiling machines have to be used to machine that little

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hole. Doors must be obtained and hinges put on. If you are lucky, in a couple of weeks or a month it may be ready to be shipped to the tank factory, where they will put all of that complicated gingerbread inside the turret.

Then suppose we find that somewhere along the line a mistake has been made. Perhaps when the pistol port was put in, the bracket which holds this spare sight was not moved over. This means further delay. Eventually the turret is remodeled and installed on the tank.

But there is still a time lag because the factory in Detroit has a 60-day supply of the components on hand, which come from about seven hundred different suppliers. The suppliers, including the men making turrets, have a backlog of parts because rather than lay off men they keep them working through slack times. During the war, if you lay off men you never get them back. So when you make such a change as this pistol port, it might be five months before you get it on the tank.

These delays did not result from indifference on the part of manufacturers to wartime requirements. These people were working hard to win the war. You must understand that quantity production of complicated articles is like one big machine where you put the raw material in one end and the completed item comes out the other.

The pistol port is just one example. I could cite several of them. Such changes are made because people like yourselves thought they were advantageous, or because mistakes in design must be corrected, or for many other reasons.

General Stilwell asked me once what could be done to make these changes come through faster. I was ashamed to tell him that I did not know.

A STUDENT: You say you had to keep the factories going to keep the labor there or you would lose a lot of it. Would not that cause too much production if you kept your labor running on through?

GENERAL CHRISTMAS: The consideration was not only the labor. The materials were also short in this country, and we did not like to waste any. If we had five hundred turrets, and turrets like that would be worth about four thousand dollars, that would mean a lot of labor and material coming out of the supply in the country. We did not like to just burn them up.

A STUDENT: There is a lot of information on the stockpiling of destroyers and other naval vessels. What about preserving Army Ordnance items?

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GENERAL CHRISTMAS: There were a number of tank contracts put out in the last days of the war with various firms and some arsenals for preserving tanks. The most successful method involved the use of large oil storage tanks, some of which we got from the Navy. About two dozen tanks would be placed in the oil tank, the air would be exhausted and a breather put in. That is being done now at places that look like oil-tank farms, where there are big oil reservoir tanks full of fighting tanks in storage. The method used on artillery, which the Navy practices widely, was to spray a sort of cobweb on the pieces. However, this was not found practical for preserving tanks.

A STUDENT: How far does the Office of the Chief of Ordnance in Detroit go in scheduling government-furnished equipment? Do those people go down to the subcontractors for the components?

GENERAL CHRISTMAS: No.

A STUDENT: Was that left to the prime contractor?

GENERAL CHRISTMAS: The prime contractor did his own scheduling, for two reasons: That was his bread and butter. Anyone who is successful in the automobile industry must be a master of scheduling to get quantity production. Secondly, we would have needed trained teams to schedule components, but we did not have them.

In the early days we scheduled all engines, all transmissions, and all armaments. For a while we scheduled the ball and roller bearings, because they were under control, or allocation, by the War Production Board. Later on in the war, about 1944, we scheduled certain engines; for example, the Hercules engine, which is used in about a dozen American trucks, was scheduled. Also, the Fuller transmission and axles produced by Timken. Later on, the Ordnance Department stepped into the scheduling of such items as tank transporters or DUKW's only to the extent that certain components were short and there was a necessity for control.

A STUDENT: I am on a committee studying expansion of facilities for the production of munitions. Could you give me any references located here in the city that lay out the program by which the tank production factories were selected, established and put into operation?

GENERAL CHRISTMAS: You will find that pretty well written up in the Ordnance Historical Section over in the Pentagon Building. That is one place from which you could get it. You mean how they were selected?

A STUDENT: I mean the over-all control agency that created the policy and which allocated the money and space to the factories.

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GENERAL CHRISTMAS: Those are in the library. If you want to go into it in detail, I will be glad to talk to you about it.

A STUDENT: On the smaller war plants--I realize that a lot of the utilization of those was always a headache. What part did they play other than subcontractors in the tank-automotive vehicle industry? What part did they play as subcontractors?

GENERAL CHRISTMAS: In our business they were the ones with which we had a large headache. Congress passed a law, the Smaller War Plants Act. In the implementation of that act we were allowed to favor the smaller plants to the extent of 15 percent price differential.

That worked all right where the men really had something to make but in those cases they ordinarily had been energetic enough to have already gone out and obtained subcontracts with General Motors or Chrysler, because in peacetime they were making some item, perhaps seats, for passenger cars. Now that there were no passenger cars being manufactured, they wanted to make seats for tanks. Those fellows very quickly went out and got themselves jobs in the old historical American way.

But there were a number of people who, by the impingement of the war upon them, were put out of business. We were directed to place the work with them, and we did it in very good faith. In many cases it was an administrative headache to them, because they had no engineering personnel to help them and the parts were new to them. I recall one man that we had making wooden bodies. He had been making ukuleles or piccolos, or something like that. We sent him the lumber for truck bodies, cut like "mechano" toys with holes in it, so he just put the pieces together. That was perhaps an extreme example.

I do not say they did not do the country any good, because they did. Too many small businesses in small towns were in bad condition. But I think we can prove that it was an administrative headache. However, after a while, like most things in the war, we got used to it. The manufacturers had a clause in their contracts, in addition to the pressure from above, compelling them to take on these people. They were very good about it. So, like most of these things, we got over it. It was certainly very difficult at first. We had in the office of the Procurement Officer a representative of the smaller war plants who passed on each purchase.

A STUDENT: They were not placed with the prime contractor?

GENERAL CHRISTMAS: We did not place them with the prime. Get one of my colleagues down here who dealt with many small firms and he will explain it better than I can. I am not really a good one to ask about that. Perhaps one of the Quartermaster Corps men can tell you.

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A STUDENT: General Hardy will be here.

GENERAL CHRISTMAS: Get him. He will be a good man to ask.

A STUDENT: Were you able to accomplish all the modifications that were desired in the field? I mean by that, by the time the tank arrived in the field, in the theater of operations, was it successful, or did they want additional modifications after they received it?

GENERAL CHRISTMAS: Will it be all right for me to be quite frank about that, General McKinley?

GENERAL MCKINLEY: Yes.

GENERAL CHRISTMAS: These things happened. Sometimes tanks got to the theater and the fellow that asked for the modification had gone somewhere else, had become a general, or come back to the states, or the situation had changed because of the lapse of time. Then, of course, we might get a complaint from a theater in cases where a standard change had been applied to all tanks, perhaps on the recommendation of a committee. The change might be advantageous in the European theater and detrimental in the Pacific. That is why it was really better to make different shipments to different theaters.

Take as an example steel or rubber tracks. It takes about eight months to change a factory over from one to the other--that is, for good people like Firestone and Goodyear, not fellows working in a back yard. We changed all the rubber tracks to steel. Complaints would come in, and I would go to Army Service Forces, who were our superiors, and ask about it. Finally we made both types and the tank depot people put the type of track on according to the latest knowledge they had before shipment.

Such things cannot be helped, but I personally believe there were too many changes.

A STUDENT: The Army Air Forces developed government-furnished equipment and used it with considerable success with instruments like bomb sights and carried it all the way across the board. The Government would actually let the prime contract and then furnish these things through the Services. Among other things they did that with ball bearings. What would you say to a plan of having the Government set up a table of requirements for all munitions and ball bearings, allocating those through the ball-bearing manufacturers and actually buying bearings themselves through claimants and prime contractors?

GENERAL CHRISTMAS: That is an easy one for me to answer. I am against it. I am against it because it would be so difficult to ad-

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minister. The Technical Services are going to be cut back. You will not find enough people in the Services who know a ball bearing from a string of pearls. How then, are you going to organize and staff this thing? The manufacturers specialize not only in antifriction bearings, but some of them devote their time to roller bearings and some to ball bearings. It is a specialty and they are much better informed on the subject than we are. I do not think we can lick them at their own game.

A STUDENT: It is not a question of licking the bearing manufacturers at their game. At the start of the war the ball-bearing manufacturers did not know whether they were going to have to make quarter-inch bearings or those one-eighth inch in diameter. The Requirements Department, which was then charged with setting up the requirements, could look ahead and see what types of equipment were needed. They would get the prime contractors, the end product manufacturers, to put in bills of material with the bearings used in them, enough to make a complete compilation. Then they would provide the manufacturers with a list of what they would have to make.

GENERAL CHRISTMAS: I would not be in favor of doing that. I think it would jam the whole thing up. I am speaking from my own experience. It is hard to rewrite historical things afterward. But I think we can prove that that would be a bad thing. I am only speaking from my own line of work. Remember, there was no tank industry in this country. We had to rely on what we had here. There was an aviation industry.

A STUDENT: General Christmas, if the allocation of controlled material was insufficient to meet the contract in its entirety, was the contract reduced, or was it continued in its original number in hope that you would be able to make more than the allocated materials justified?

GENERAL CHRISTMAS: We ordinarily cut down the rate of production, but we did not change the contract. I would just call the contractor up and say, "Cut it down to 150 a month" until we could get more material for him. That seemed to work.

A STUDENT: Did that mean that the schedules of accessories were continued at the original contract rate?

GENERAL CHRISTMAS: We did not have anything to do with accessories unless they were critical. We would call up and say, "We can use only 150 next month instead of 500," referring to the end product. They might be getting their bearings from the bearing division of General Motors, and they would just cut down their order from them.

A STUDENT: There was criticism of that practice of failing to cut back components for two or three days, because of the waste of

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controlled materials. They gave as their reason that there might have been a waste of manpower and materials or minor items.

GENERAL CHRISTMAS: Of course, we could theoretically have taken some manpower out of there. But, as I said before in my talk, the factories would employ these people on something else. They did not want to have people sitting around doing nothing, as that manpower would be lost. You cannot just move manpower around as you do marbles. People living in Detroit are not going to move to Podunk, Iowa, just because some colonel tells them it is a good idea. They are still Americans and they will tell you where to get off.

A STUDENT: I wonder if you could comment on where your major difficulty was in attaining your production goals as between the overall facilities expansion, your machine tools and equipment, or perhaps raw materials or manpower.

GENERAL CHRISTMAS: The greatest single trouble in the first two years, in all of 1941 and well into 1942, was machine tools. Specialized tools were not nearly so difficult to obtain as were some regular tools. In other words, a boring mill is not a special tool. That boring mill that you needed for machining tank turrets is so large that there are few of them in the country. Yes, machine tools were by far the greatest difficulty, because there were many manufacturers in this country who could have put them to use if they could have gotten them. Machine tools were our first bottleneck.

As to the steel foundry capacity for heavy castings like turrets, there were only a few people, like Eddystone, who could make such things. There was no demand for manufacturers to build up their capacity in peacetime.

I would say that those are the three things to worry about most: machine tools, special tools, and heavy castings. Later on antifriction bearings became a national shortage. Perhaps the great number of bearings shipped as spare parts might have had something to do with that.

A STUDENT: I would like to ask you an elementary question to find out the difference between your way and the way we have in England. When a tank leaves your depot and it is going into the Zone of the Interior, does it go to some other depot before it gets to them, or how do you distribute it from the depot before it actually gets to the field?

GENERAL CHRISTMAS: In the Zone of the Interior, if you were sending some tanks down to Fort Knox, they would be received down there by the Ordnance officer. What they did then depended on the local unit. In some cases they took all the equipment off and put it in a storehouse so it would not be lost and let the men train with more or less a bare tank. In some cases where the men trained with the

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equipment, it was scattered all over and had to be replaced later on. It was no mean job to keep that stuff supplied. There were some items that were just a nuisance. The most experienced people took them out and stored them in the local warehouse while the men were in the early stages of training. It did not make any difference, because the troops did not go to war with these particular tanks. We had to remanufacture all these training tanks.

A STUDENT: Would you clarify one point for me? You mentioned the fact that the depots put a lot of government-furnished equipment into the tanks. I was under the impression that the tank works manufactured this government-furnished equipment and put it in.

GENERAL CHRISTMAS: It was necessary to do a great deal of improvisation. When someone wanted six of a special type of tank, they would be changed in the depots. I remember in the early days we wanted a 105 howitzer self-propelled. We just took some medium tanks, took the turrets off, and installed howitzers in each of them. Those were the "Priests" used so well by the British in North Africa. It is that type of improvisation that I am talking about.

All those types, like the tank recovery vehicle, or the tank bulldozer, eventually got into production in the factories. But sometimes it was necessary to get off an order in a hurry for a special job--for example, those waterproofed tanks that did such wonderful work, were done at Chester Tank Depot, Pennsylvania. The ETO demanded some waterproof amphibious-type tanks, and sent a British colonel and an American colonel to Chester. It was very secret at that time. A lot of the work was done at the Philadelphia Ordnance District and at the Chester depot under supervision of our Detroit office. I think you have an Ordnance man in your class who could tell you something about that.

GENERAL MCKINLEY: General Christmas, I want to thank you very much for coming down here and giving us this down-to-earth talk. Most of our speakers have been from the higher echelons. I think the students appreciate having someone here who really did something.

GENERAL CHRISTMAS: I appreciate this opportunity. I am talking on my favorite subject, as you can readily tell.

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