WARTIME DIFFICULTIES IN THE PRODUCTION OF COMBAT AND MOTOR TRANSPORT VEHICLES

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COLONEL CRANE: Gentlemen, today we start a consideration of production problems in various commodity fields. The first one for consideration is the problem of tank production. Your schedule does not show this, but the general scheme we have set up provides for the presentation of both the military aspects and the industrial aspects of these problems. Our speaker today will discuss production problems of tanks from the military point of view. Subsequently, we shall have a talk on tank production problems from the industrial point of view by Mr. K. T. Keller of the Chrysler Corporation.

Our speaker today is particularly well qualified to discuss the subject of tank-production problems, having been Chief of the Production Section of the Tank Automotive Center in Detroit, which afterwards became the Office of the Chief of Ordnance, Detroit. At the present time he is Executive Officer of the Tank Arsenal in Detroit.

I take great pleasure in introducing Lieutenant Colonel George White, Colonel White.

COLONEL WHITE: Thank you, Colonel Crane.

Captain Worthington and members of the Industrial College of the Armed Forces: I wish to humbly acknowledge the great honor of presenting to you this talk covering the combat and transport vehicle phases of production during World War II. Having been away from this production activity for about two years and having only recently returned, I feel it is a grand welcome to be asked to deliver such a talk. It makes me feel as though I am getting right back into the swing of the production activity as I left it in late 1945.

Any reference made in this discussion to specific manufacturers or specific activities is purely intended to bring out a point or to demonstrate a problem. I do not wish to leave the impression that any critscism or praise is intended with respect to any of these activities.

The information I present is based entirely upon my own experience. I offer you, therefore, my own opinions and observations. I have referred to certain statistical publications of the Office of the Chief of Ordnance for some data. I have also drawn some data from the book, "The Industry-Ordnance Team," written by Lieutenant General L. H. Campbell, who, as you know, was our Chief of Ordnance during this period.

The 1st of September 1941 was a memorable day to me. It was on that day that I actually came into this program. I joined the Tank and Combat Vehicle Division of the Office of the Chief of Ordnance on that date. The situation was essentially as follows:

The Ordnance Department was not then charged with responsibility for motor transport vehicles. The Tank and Combat Vehicle Division was a newly organized setup. Prior to this, these activities had been handled as an activity in the Artillery Division. However, the growing importance of tanks and combat vehicles made it necessary to establish a separate operation. The organization then consisted of three essential elements: engineering, production, and facilities. With minor modifications, these three elements were found to be absolutely essential throughout the entire program.

It is my observation that organization, while very important to smooth operation, is not nearly so important as the proper staffing of the organization. There certainly is no substitute for intelligence. The careful selection of capable personnel to manage and staff the organization is extremely important.

At this time the programs were increasing very rapidly, and the major job actually was to find additional capacity and new facilities. During peacetime lack of funds had prevented our keeping up to date with development. Consequently, there were no late designs ready to go into production. This meant that we had to go into production, do the engineering, and actually establish facilities all at the same time. Naturally, this led to many "crises," as we referred to them, which in turn meant many "blitz" operations in order to get production and keep up with requirements.

I would like to note here that automotive equipment is never static in design. The rapid strides always made in research of automotive equipment naturally cause engineering changes. It is difficult, therefore, if not impossible, to have a design sitting on the shelf ready in the event of a future M-day. However, it is true that, given sufficient funds to keep thoroughly abrest of all development changes, particularly in regard to components making up vehicles, we can keep up to date so that the minimum of time is consumed when actually going into quantity production on the latest types.

This period (1 September 1941 to 1 October 1942) saw the actual completion of the establishment of the basic facilities required for the combat vehicle program. New vehicle designs were put into production later which, in most cases, required the rearrangement of the basic capacities established, with a minor amount of additional new equipment.

During this period there was a great deal of pressure from many thousands of manufacturers (usually small ones, whose normal commercial business was disappearing from the scene) to get us to make contracts directly with them for the many thousands of components and items going to make up our vehicles. If we had done this, I am sure the entire production program for these combat vehicles would have failed. Obviously, we would have had to establish and organize a very complicated system of scheduling, expediting, and follow-up in order to get these components into the factories in time to be assembled into the vehicles. This was not feasible, particularly when we already had these big industries well-trained and thoroughly capable of doing that.

The mass production of any complicated item, such as these vehicles are, must depend, for the most part, upon the large, well-trained, mass producers in our country. In our planning we utilized this principle. We attempted to channel these smaller manufacturers to the prime contractors so that the prime contractor could take advantage of any available capacities in their hands.

Taking data from numerous manufacturers, we found that about 30 percent of the total production of tanks was subcontracted; armored cars, 46 percent; the universal carrier, 44 percent; the cargo carrier M-29, 80 percent; the 1½-ton truck, 48 percent; the jeep, 48 percent. The average was about 50 percent. In some specific cases we know that our prime contractors had as many as four to five thousand subcontractors. Under those circumstances it was a terrific job to schedule, plan, and expedite the production of components going into a complicated end product and to train some of the subcontractors in such production.

The problem of utilizing smaller war plants, of course, was very important to our national economy. Many of these plants possessed critical equipment, and some of them possessed critical trained manpower. Not to have used them would have meant a definite waste. Consequently, we did procure directly from many of them items which were not going into the assembly of end-product vehicles and which were used for spares or various and sundry other purposes.

The principle of procuring a complete vehicle from a major manufacturer is very, very sound. We did find, however, that in many cases of major components, such as engines, transmissions, armor plate, armor castings, and so on, it was much more economical and faster for us to actually initiate the orders with the necessary manufacturers to provide the national capacity for all of the end-product manufacturers to meet their schedules.

In the early stages we procured vehicles less certain of these assemblies and attempted to supply these assemblies. We immediately ran into the same problem of scheduling, expediting, and trying to get into the

some cases these components were critical and for capacity on the end product or the actual assembly of the vehicle. In the case of heavy trucks, the requirements were many times over the capacity.

We also ran into a new thing here, and that was the normal competitive spirit of the industry. And, believe you me, it is a very jealous competitive spirit. Often the highest type of coordination was required in order to get manufacturers to give and take where it was necessary and desirable to accomplish the final end result to the best advantage of all concerned.

The facilities cost for the transport vehicles plus the combat vehicles was about $850,000,000 for that part procured by the Government. We know that many of the manufacturere, rather than go through some of the complications of the government contract for facilities, actually went ahead and spent their own money for facility expansions. That was particularly true in the case of those manufacturers who could see that these facility expansions would be of great benefit to them following the war. With the exception of Detroit Arsenal, which has been made a government-operated facility permanently, most of these facilities have gone into the war reserve of machine tools or have been absorbed by postwar industry.

During the period up to VJ-day we continually progressed in the development of our various procedures, and it became more or less the refinement phase. When VE-day came, we had certain cutbacks; basically, the production job had then been accomplished. We laid plans, of course, for the final terminations. Finally, when VJ-day came, we were able to cancel almost immediately. Of course, there is a long period following the terminations in the settling up of contracts, but, basically, the production phase had been completed.

So far, I have mentioned only the problems that came up in connection with giving to you this brief history of the period. I shall now try to discuss some of the major difficulties encountered and the possible solutions.

Integration can best be illustrated by this chart. Say we have three companies, "A," "B," and "C," involved in the production of a common item, the same item. Let us say there are four parts making up this item. The capacity of each company is represented by these figures on the chart. You will notice that the maximum capacity of company "A" to produce the complete item is limited by the production of the lowest subassembly or subitem. In this case it is 20; in the second case, 50; in the third case, 26; which gives us a grand total production of that end product of 96. If we get those three companies together or provide a means whereby they can exchange some of their extras, we come out with this picture: The total of part 1 made by all three companies is 112; part 2, 116; part 3, 120; part 4, 127. The total of the end product that could be manufactured

in that way is 112, as against the 96 we would get if each of these three companies worked entirely on its own. Therefore, if we get them all together and put that information on the table, we can, by juggling these parts around, come out with the higher production of 112. That basic fact led to the formation of what we called "industry integration committees."

On the face of it, this is a very simple operation. It appears obvious. However, in our transport and combat vehicles, we had many more complications. In the first place, all of these vehicles are not interchangeable completely. In the case, of course, of a large program of one type of vehicle involving numerous manufactures, that can be done. But frequently our programs were of such a nature that we might have only one manufacturer involved in one item and only one or two other manufacturers involved in a second item. We had to be very careful, therefore, in the setting up of our committees to be sure that we grouped the manufacturers who were making items that could be integrated to the maximum extent.

Not only can we integrate actual parts, but we can also integrate capacities. This chart is labeled "Components Problem." We assume these capacities are basic for the end product manufacturers, the prime contractors, and that, if left to their own devices, these manufacturers would normally place orders with sub contractors, as indicated on this subcontract outline. For example, here is a requirement for 1,000 items. He goes down here and gets 800 of his need from this subcontractor. He goes over here and places the other 200 with this middle subcontractor. The "500" man gets his 500 here from this same subcontractor. Why? Simply because the subcontractor, desiring to retain good will, says, "Sure, I can make them." The same thing happens over here. The "200" man gets 100 from one place and gets 100 from this same subcontractor. The net result is that it suddenly develops that we cannot get the total end-product production.

Now, if you put these three people together and let them come up with this picture, they will know what the situation is and will say, "Okay, we need another facility to get this total production." In some cases there was sufficient capacity among the subcontractors; but because of the loading in their normal commercial relationships, one facility was not loaded to capacity, whereas others were overloaded. These committees were effective from the standpoint of juggling those capacities or coming up with the fact that additional capacity or new facilities were necessary.

You might conclude from these remarks that we should standardize everything. That is easier said than done. Productive capacity is the actual controlling factor in many cases so far as standardization is concerned. It may be a more intelligent approach to a problem to use a second engine if there is an engine plant with complete facilities to make it than it would be to go out and build a brand new plant from the ground up in order to get additional capacity of an adopted standard-type engine or any other component, for that matter. That is especially true if you want immediate

production or production in a shorter time than the usual nine to twelve months involved in a new facility.

Getting back to the integration committee, we found that the most important factor in making the committee work effectively was the very careful selection of the committee chairman. He was, of course, a representative of industry from one of the member companies, and he had to be a natural leader and outstanding individual. If the selection was not on that basis, the companies would never have gotten together and done the job. Initially we experimented a little, but we finally recognized that fact and carefully selected the committee chairmen thereafter.

Many agencies were involved in motor transport vehicle production during the war. These were the Office of Defense Transportation, the Navy, the War Production Board, the Army with its various activities, the Air Force Ordnance Engineers, and so on. Generally speaking, we were procuring about 80 percent of the total requirements of all of these agencies.

In about the middle of 1943 the War Production Board desired to put into the program additional straight commercial types of vehicles in order to maintain the so-called home front war activity. The WPB called meetings of all the agencies involved. The first thing that developed was that the total requirement was far in excess of the capacity available. It seems to me that the logical thing to do would have been to assign to one agency--it does not make any difference which agency--the complete job for the procurement of a common item or a comparable item. In this case a committee was established with top representation of all the activities concerned. It became known as the Automotive Production Committee and had responsibility for the entire national wheeled-vehicle program for 1944. The program was finally firmed in November 1943.

That is very undesirable from the standpoint of lead time. Lead time is one of the most important things connected with the efficient production of any item in quantity. Lead time might be defined as the time from the release of a program to the actual realization of production. This time varies considerably with different conditions. Where brand new facilities are required it will probably run around a year. In the case of existing facilities that are being given additional orders, it usually runs from six to nine months. In this case the program was firmed in November 1943, which meant that the maximum production for 1944 had to come out of the last couple of months of 1944. That, in turn, meant that an extremely higher rate per month had to be established than should have been necessary.

This brings us to the subject of requirements. In many cases during the war requirements were increased one month, then decreased immediately, increased again, and so on, all over a period of a few months. We all recognize that under war conditions it is impossible to anticipate all

connection. In my opinion, the combat vehicle phase was not nearly so difficult in spare parts as the transport vehicle phase. That was probably due to the volume of motor transport vehicle parts both in kind and quantity.

In the initial phase of combat vehicle production, we placed orders for a percentage of capacity actually greater than that required for vehicles, an arbitrary percentage, because it was not possible to establish the exact requirements of spare parts without some sort of experience. After a short time, however, certain experience was developed, and it was then possible to place spare-parts orders for new-type vehicles based upon comparable types for which there was experience.

It is most important to place spare-parts orders at the time the vehicle is ordered. In that way, capacity is established for later orders for replacement parts and for the continuation of spare-parts production.

I shall now give you a brief summary of the points I have covered.

Educational orders are of great value on combat and motor transport vehicles, particularly when they can be placed closely in advance of desired mass production.

Organization is important to smooth operation but not nearly so important as the careful selection of intelligent personnel.

Sufficient development funds are mandatory if we are to keep abreast of development and be ready quickly to go into production on modern design.

Decentralization of procurement by areas is highly satisfactory, and there must be over-all coordination.

A dealer-type depot system is of great value for combat vehicles, especially as a modification center.

All combat and transport vehicle production in great volume must be built around the efficient management of large, experienced producers.

The pool order must be carefully studied to determine a more satisfactory means of quickly establishing additional capacity, with particular reference to cost differentials.

Mass production is not flexible and cannot be turned on and off at will. A new program requires from nine to twelve months from its release to the actual realization of production.

after it has been completed or even as it is being worked up and to help us interpret the mass-production angle into that design.

QUESTION: Would you enumerate some of the difficulties encountered in inspection and comment on how they were handled?

COLONEL WHITE: I can give you something on that, although it was somewhat outside my personal experience. The ordnance districts, of course, were responsible for the conduct of inspection on all of our contracts. The thirteen area districts conducted the inspection. As I saw it at a distance, there was a great deal of difficulty in the initial stages primarily because of the lack of trained inspection personnel. Each of the districts had to set up schools for training inspection personnel. Occasionally our own engineering activities were called into the picture by the districts from the standpoint of, in some cases, waiving inspection; that is, changing the inspection to the degree that the vehicle would still be thoroughly acceptable as a fighting vehicle but possibly allowing substitutions of various types of either materials or other items.

The inspection problem, I know, was great. I saw it at such a distance, however, that I cannot give you a detailed comment on it.

QUESTION: Of what value is the facility survey in (1) determining the probable item to be assigned to that facility and (2) estimating the capacity of the facility, if the latter is possible?

COLONEL WHITE: In the case of combat vehicles it is impossible, I believe, to survey any facility and actually say how much of any combat vehicle they can manufacture. There is no industry--at least this was so during our war experience--that, using its existing facilities, can manufacture a tank. Our experience was that the existing facilities had to be supplemented by additional facilities of one type or another before they could actually produce a tank. However, I think it is of great value to survey these facilities continually during peacetime from the standpoint of knowing generally the types of machinery they possess so that if another program comes along requiring quantity production, we shall know essentially what facilities can most readily be supplemented to produce a combat vehicle.

In the case of motor transport vehicles military production is almost directly related to commercial production. The total capacity for military production can be determined, but a careful study must be made to be sure that there is such capacity. The production of military vehicles requires more capacity per thousand units than the production of commercial trucks does; we always have extra axles, and a greater machining capacity is required for that material.

as I mentioned in the lecture, the first facility to come into the picture. They built up to a production of approximately a thousand of those vehicles a month. Suddenly we were told the program called for 40,000 light tanks, let us say, for next year. Immediately we had to have additional capacity. Now, a program of a thousand a month on that type of equipment is a pretty big undertaking for any industry. So we felt that the solution was to bring another type of manufacturer into the program. We had Cadillac analyze that tank and brought them into it, with a completely modified vehicle for one reason, and that was that we had to have additional capacity for engines and transmissions. The existing capacity in the M-3 light tank was not enough, and it would have meant a long delay to set up brand new facilities for those two components. Cadillac had an engine and transmission that everyone felt would work. We placed an order for light tanks with Cadillac which required it to establish a capacity, I believe, of a thousand a month. That was later increased to 1,500 a month. We also gave Cadillac a development contract to completely engineer that M-3 light tank into the version it would produce.

Our development work was spread all over the industry, so far as I saw it. I think that we probably utilized industry to the maximum extent. We could not do much ourselves, so we had to do it that way.

COLONEL CRANE: Colonel White, in behalf of the College, I want to thank you for a very interesting and instructive talk.

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