SCHEDULING INTEGRATED WITHIN INDUSTRIES

9 December 1946

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CONTENTS

THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington, D. C.

SCHEDULING INTEGRATED WITHIN INDUSTRIES

9 December 1946

CAPTAIN BENSON:

Gentlemen, this morning we have Colonel Wilhide, of the Military Acedemy class of 1922. He was quarterback on the football team at West Point for two years.

After graduation, Colonel Wilhide spent two years in the Army, and then went to civil life, where he spent his time in the public utility industry. He was general manager of both the Portsmouth Gas Company and the Associated Gas and Electric Company of Ashtabula, Ohio.

He was recalled to active duty in 1942. Since that time he has been with Army Ordnance. He served as contracting officers' representative in the Chicago Ordnance District at the Gary Armor Plate Plant. Then he was transferred to the Detroit Ordnance District, where he became chief of the Tank Branch. Since then he has succeeded General Quinton as Chief of the Detroit Ordnance District.

He is back in the Regular Army now for good, having received his regular commission last July. Colonel Wilhide.

COLONEL WILHIDE:

It is gratifying to be selected to deliver the paper on this subject, "Scheduling Integrated Within Industry". I sincerely hope that the subject will receive the justice to which it is entitled. Others occupying a far higher level in the war production program could no doubt cover this subject from a much broader viewpoint. My entire time was devoted to programs in which the end result was tanks and armored vehicles; therefore, my paper will attempt to reflect the application of these items to the subject.

Any mention of specific contractors throughout this paper is not for the purpose of signaling out that contractor for special credit, but rather to illustrate an example of means taken to accomplish a result.

Selection of the manufacturers for production of tanks having been made from an over-all national study, I will treat this subject from the standpoint of securing a maximum delivery, consistent with A.S.P. requirements, from the plants available to the Tank and Armored Vehicle Division.

In the initial stages of the program, there were eleven producers of medium tanks, some of which also produced the heavy tank. By the end of 1943, these had been reduced to three main producers on which the Ordnance Department relied for the major portion of its medium and heavy tank requirements. The other eight were utilized for other war requirements; some were converted to production of other war materials, and some utilized for odds and ends production of small quantity items, components, and rebuilding programs. The three remaining producers were Chrysler Corporation, Fisher Body Division of General Motors Corporation, and Pressed Steel Car Company.

The light tank requirements were mainly supplied by the three firms, Cadillac Motor Car Division of General Motors Corporation, Massey-Harris, and American Car and Foundry.

The main factor with respect to decision as to what vehicles and in what quantities they could be secured was one characterized principally by open discussion and cooperation. The contractors and interested Ordnance Districts were called together by the Office, Chief of Ordnance-Detroit, and the requirements placed upon a blackboard before them. After much discussion and trading back and forth, allocations were fixed and the Districts would be given a production order to procure. As can readily be realized, in meetings of this nature it would be developed that end item commitments would be dependent upon deliveries of many critical components. The situation with respect to critical shortages and lead time necessary could be freely discussed; then would follow meetings with the various suppliers of these critical component parts, such as engines, transmissions armor castings, rolled armor plate, gun mounts, bogie wheels, tracks, etc. These meetings developed the real causes of delays, and solutions were suggested. Many of these suggestions were ingenious. Examples of action often times necessary to be taken are:

1. The construction of new buildings.

2. The raising of manpower ceilings.

3. The acquiring of additional machine tools and other facilities.

4. The transfer of dies to other sources.

5. The securing of an engineering deviation.

6. A change of some inspection specification.

7. A complete change of design, such as a change from a cast armor part to a rolled armor part.

8. The use of a supplier by one facility, which had been developed by another.

9. Securing of a higher W.P.B. priority.

An outstanding example of planning and integration within industry is illustrated by the performance of Cadillac Motor Car Division, Massey-Harris, and American Car and Foundry in the Light Tank Program. In this instance, Cadillac was the largest producer of the end item and the supplier of certain major components, such as engines and transmissions, for the two companies. Whenever a change in requirements for light tanks was necessary, the above three manufacturers would meet with Ordnance representatives. American Car and Foundry and Massey-Harris, the two smaller producers, would decide the quantities that they could handle within scheduled requirements, and Cadillac would assume the balance. Complete harmony was in evidence at all times.

During those few months immediately preceding Pearl Harbor, news had been circulating that automotive production would soon be suspended. Standard Steel Spring, being a substantial producer of springs and bumpers, became deeply concerned over the far-reaching consequences. Developments in the national and international situation gave unmistakable evidence of the trends in the United States to a general conversion to war production. Standard Steel Spring, like many other companies, began to study the situation to determine how its facilities could best be utilized. The immediate problem confronting this company was to select an item vitally needed in the war effort which would completely and efficiently utilize the company's facilities and personnel and the plants of many smaller companies allied with it in the spring and bumper business. In view of its know-how and its long and excellent record in the spring making industry, Standard Steel Spring felt that it should be able to fabricate armor plate, which is primarily a delicate and precise operation in heat treatment. Up to this time, the production of armor plate had been treated as a deep and mysterious secret. Most prospective armor plate fabricators feared the thought of going into armor plate production because it was felt that unless a concern had inherited the process and know-how, it could never hope to produce armor plate. Few people outside the Government arsenals had any experience with it, and to make matters worse, pre-war armor, including naval armor, had been highly alloyed, particularly containing large amounts of nickel, soon to be prohibited in the production of armor plate.

The situation as it developed was a natural one. The steel mills could supply the rolled plate, while Standard Steel Spring, with the approval and blessing of the Ordnance Department, undertook the risk of furnishing the missing link in the chain of tank production by fabricating armor plate. The proposition was particularly appealing to the Ordnance Department because here was a concern which, with the least expenditure of time and money, could convert to the production of armor plate at once. Working in close cooperation with the Ordnance Department, Standard Steel Spring lost no time in immediately proving that it could produce acceptable armor plate. Plates of low alloy steel rolled at Great Lakes Steel Corporation were obtained

and heat treated by Standard Steel Spring and submitted to the Proving Ground for tests. After these plates were accepted by the Army, Standard Steel Spring became a recognized qualified armor plate producer, and it soon negotiated a contract to supply Cadillac Motor all of the armor plate required for its new light tank.

The conversion of Standards's Coraopolis plants was accomplished at once. All sorts of makeshift and temporary expedients were employed to get out the production. Furnace loading and unloading doors and tables were remodeled. Heat treatment cycles and hardness ranges had to be developed for bettering the ballistic qualities of the plate. Manufacturer of various types of flame cutting equipment were of great assistance in setting up the rapid burning torches for cutting the steel plate into the proper shapes. By ingenious means and methods, dies were developed to straighten armor plate with existing presses, while polishing heads and wheels which formerly polished bumpers now effectively and efficiently ground the plate to the desired dimensions. In less than six weeks after the curtailment of automotive production, a great deal was learned about all phases of armor plate manufacture, and Coraopolis had already produced some of the vitally needed armor plate for our fighting tanks.

The Ordnance Department was pleased with the accomplishments and achievements of this company, which had produced ballistically acceptable and satisfactory armor plate in a plant which was readily converted, with minimum expenditure of time and money, without any delay for new plant construction, and without the necessity of any new critical machine tools, already drained off the market by other companies converting to war effort

At this time, the Army's demand for armor plate had reached astronomical proportions, and the situation on the battle fronts was such that tanks in large quantities were needed at once. This requirement presented the Ordnance Department with a black and dismal picture when it set out to accomplish the seemingly impossible. The situation was not hopeless, however. The Ordnance Department reasoned that since Standard Steel Spring was able to produce armor plate so quickly and efficiently, it should therefore be possible to effectively bring into production its brother companies engaged in similar peace-time activities. The Ordnance Department further reasoned that since Standard Steel Spring was already producing and had acquired some technical skill and know-how, it should be set up as a leader of a production team, heading a satellite group, and coordinating their activities toward the common goal of producing armor plate. In addition, the Ordnance Department felt that by allocating specific parts for processing to the various subcontractors, these subcontractors would be able to employ methods of mass production and produce the part assigned to them more rapidly than if they had attempted to produce an entire set of parts for the tank.

Although the scheme was considered radical and unorthodox and full of problems yet to be solved, the elements opposed to this plan soon realized that in winning the battle of production, decisions with a certain amount of risk had to be made, just as a field commander does in any campaign or battle. After carefully evaluating the risk involved, the Ordnance Department authorized the Standard Steel Spring Company to proceed with the plan. The Ordnance Department promised its full support and cooperation in carrying out the plan. No time was lost in getting the program under way. The group leader immediately contacted the various companies involved and held an initial meeting in order to acquaint the members of the team with one another and to introduce the proposed Ordnance plan. It was explained at this meeting what had been accomplished in six weeks with existing equipment and facilities by Standard Steel Spring. It was now generally conceded that under proper leadership, other companies in the group could succeed. The group leader started immediately to visit and inspect the plants of the prospective members of the team in order to analyze facilities, equipment, organization, labor markets, transportation, and location. In the amazing short period of eighteen days, fourteen companies were organized into a group of subcontractors which could fabricate armor plate under Standard Steel Spring's supervision. Later this group was increased to thirty-one subcontracting plants. This included nine spring and bumper companies, six stove companies, furnace manufacturers, producers of enamel products, brick and ceramic wares, wire, automobile frames and stampings, farm tools, saws and tool steel products, automotive and plumbing hardware, structural steel parts, railroad equipment, and even a former automobile retail dealer was included. The plants of this odd association of companies were located in the territory covered by seven of the thirteen Ordnance Districts. Effective administration required the establishment of a central office in an area which had the largest concentration of armor plate subcontractors and tank builders. Detroit was the natural selection. Through this office, the leader was able to supervise and control the engineering, steel purchasing, facilities, production control and planning, inspection, metallurgical engineering, process engineering, traffic and reports, and accounting of all of its subcontractors. In general, it acted as a central clearing house for all information and activity pertaining to the program. In order to facilitate transactions, the Detroit Ordnance District was designed to administer the contract. The important results of this integrated activity was the fact that this production team supplied 50% of all armor used on tanks and armored vehicles throughout the war, and during the peak produced at the rate of 11,363 tons per month.

Any paper attempting to depict scheduling and production methods productive of best results under war-time conditions would be deficient if certain extraordinary accomplishments of industry were not mentioned. To best illustrate the ingenuity and cooperative effort displayed by manufacturers, I should like to mention a few of the more outstanding examples.

1. Delivery dates of boring mills large enough to machine turrets were so far distant that there was a good possibility that the war might be over before we could ship any worthwhile quantities of tanks. Fisher Body undertook to manufacture a number of these boring mills, a product with which they had had no previous manufacturing experience. The resourcefulness and aggressiveness on the part of Fisher enabled them to build 150 of the 100 inch and 110 of the 112 inch Betts boring mills and to get into quantity tank production many months earlier than would normally have been possible.

2. A similar example to the above was accomplished by Carnegie-Illinois Steel Corporation. A great need existed for additional armor plate and a large armor plate plant, known as the Gary Armor Plate Plant, was under construction, to be operated by Carnegie-Illinois Steel Corporation at Gary, Indiana. Travel-Graphs, specified for the speedy and accurate cutting of armor plate, were manufactured solely by the Air Reduction Corporation. Delivery dates were so far distant that manufacture of any Travel-Graphs for this project by Air Reduction was out of the question. Under the supervision of an Air Reduction Corporation engineer, Carnegie-Illinois Steel Corporation agreed to manufacture its requirements of these highly intricate machines in the machine shop of its sheet and tin company subsidiary. Without this remarkable performance, armor plate from this plant would have been delayed two years.

3. Inability to secure sufficient castings for suspension arms reduced the available quantity of bogie suspensions to such an extent that end item schedules were jeopardized. At the suggestion of one facility, an engineering deviation was secured, and it designed a satisfactory rolled armor, fabricated suspension arm and produced a sufficient quantity to meet schedules.

4. A large quantity of M36 Tank Destroyers were desperately needed by the Armed Forces by a given deadline date in December, 1944. This vehicle had been produced by Fisher and Massey-Harris. Fisher had manufactured all of the open turrets for both companies, but when its contract was completed, had started shipment of the tooling to Massey-Harris so that it could provide turrets for the balance of its contract requirement. In order to deliver according to demands, American Locomotive Company, Massey-Harris and Fisher committed themselves to supply these desperately needed Tank Destroyers and the 900 wanted were divided among the three companies. The manufacture of the complicated turret posed the most difficult problem principally because of insufficient castings for the counterweight and the shortage of boring mills with a 108 inch swing necessary to machine them. The only practicable solution was for some one manufacturer to be the "daddy" and assume responsibility for the turret for all three companies. Against its wishes, but because of the inability of any other company to guarantee delivery, Fisher agreed to undertake the task Delicate coordination of its subcontractors was required, but delivery of completed turrets to each of the contractors was made exactly to its scheduled requirements.

5. In the initial stages of the tank program, there did not exist an approved engine capable of being produced in quantities to satisfy demands. The Chrysler Corporation developed an installation whereby sufficient power would be delivered by tying together five of its Model No. A-57 Passenger Car Engines. The use of five engines to power one tank sounds fictitious, but here was an engine already developed, and one which was in quantity production. The Multi-Bank installation saved the tank program until such time as the Ford tank engine and the Continental radial engine could be developed and gotten into quantity production.

6. In the Spring of 1942, when preparations were being made for the African Campaign, Fisher Body's production of M4's was just getting under way on a volume basis. Interim production of M4 Tanks was being accomplished in the Fling Plant and preparations were being made to transfer assembly operations to the Grand Blanc Plant, which had been under construction since January and which was substantially completed by June 1st, a matter of less than five months. Materials, manpower, and facilities were critical, and Fisher had undertaken to manufacture planers and large boring mills to expedite the over-all tank program.

Coincident with this extensive program, Fisher had been carrying on the designing and engineering of the M10 Tank Destroyer and had completed the preparation of two pilot models. On April 23, a meeting took place in Washington, at which time Fisher was informed by Ordnance representatives of the Government's interest in continuing this engineering research and design activity in connection with the M10 Tank Destroyer.

Fisher's efforts were directed accordingly. In the latter part of May, 1942, Fisher was further informed that the military objectives of the United Nations required production of M10 Tank Destroyers without in any way decreasing the established production schedules of M4 Tanks. As a result, in addition to continuing the engineering and designing work, Fisher took immediate steps to acquire the requisite additional facilities, to procure or build the necessary tools, jigs, fixtures, and other manufacturing aids, to rearrange manufacturing areas, and to make commitments for materials and finished parts for the purpose of accomplishing this added production.

The M10 was a special adaptation of the M4 vehicle, designed for greater mobility and fire power. It carried a 3" cannon, with a firing range five miles in excess of the 75 mm. Gun carried by the M4, was approximately two tons lighter, and had a different type turret than the M4, which gave the advantage of a lower silhouette.

The M10 was an adaptation of the M4 vehicle, and many of the parts were interchangeable; nevertheless, there were many fundamental changes which caused substantial manufacturing problems under the difficult conditions obtaining at the time. The M10 Tank Destroyer required extensive engineering with respect to the turret and all its related parts. This

included an entirely new approach from a production viewpoint in the installation of the electrical system and of the elevating and traversing mechanisms required, and a change in the hull, all to accommodate the heavier gun. Proper balancing features had to be worked out, particularly with respect to the turret. The counterweight used in this instance served only as a temporary measure in view of the limited amount of time available. The temporary measures adopted, such as turret balance, counterweight, and other features, to produce functionally acceptable M10's on schedule were gradually engineered out of the job coincident with, and without interruption to production operations.

In order to meet these requirements of the African Campaign, Fisher was faced with the problem of furnishing these production vehicles in the short space of approximately three months, from June to September 1942, in addition to the continuing accelerated requirements of the M4. Fisher met the heavy Government schedules and in seven months, in the latter part of 1942 and the early part of 1943, a total of 2,113 M4 Tanks and a total of 1,556 M10's were shipped.

The monthly schedule was as follows:

Month	Quantity	
	M4	M10
September, 1942	190	105
October	192	179
November	324	128
December	448	180
January, 1943	325	294
February	344	340
March	290	330
TOTAL	2113	1556

The now famous North African Campaign began in November, 1942, and both the M4 and M10 Tanks were available to meet the planned military actions, in which they served with a high degree of success.

And now let me point out a few examples of measures taken by Ordnance to assure maximum acceptances. I refer you to "Historical Project Supporting Paper" on Industry Integrating Committees, from which the following examples have been extracted:

1. PROBLEM: New Process Gear Company could not furnish Modified Gear Boxes in time for Pressed Steel Car Company to meet its schedule for overseas shipment because of the shortage of two items of castings and one item of pinion gear shaft.

ACTION TAKEN: The Integrating Committee Office received permission from Chrysler to use its patterns and its source for the two castings. A source for machining the castings was located through the efforts of Office, Chief of Ordnance-Detroit. Deviation permitting the use of steel of a different specification was also obtained.

2. PROBLEM: Changes in specifications for armor castings reduced the available quantity of transmission housings.

ACTION TAKEN: The Integrating Committee Office located 168 at Continental Roll and Steel, which were part of the Ford cancellation. An additional 278 were found at Ford's, in Detroit. These were sufficient to tide Buick and Chrysler over until Scullin Steel could increase its production.

3. PROBLEM: Westinghouse was unable to obtain materials in order to deliver stabilizer units for the 76 mm. Gun, so that delivery of urgently needed tanks was jeopardized. The principal item of shortage was a condenser. A revision had made obsolete a large quantity of condensers at Pacific Car and Foundry, at Lima Locomotive Works, and at Ford's.

ACTION TAKEN: It was learned that the latest revision had a 3½" wire lead, whereas formerly there was a 2" lead. A method of lengthening the lead was developed, and approval for use of the older type of condenser was secured. Westinghouse purchased all of the above obsolete stocks, cancelled its purchase order for new condensers without cancellation charges, and made delivery of stabilizers on time.

4. PROBLEM: A sufficient supply of bearings did not exist to supply all transmission manufacturers.

ACTION TAKEN: It was learned that Mack Manufacturing Company was going out of the production of transmissions, yet was scheduled to receive 2500 pairs of these bearings per month. Investigation as to why Mack needed these bearings when it was scheduled to go out of production on the item disclosed that it was filling a spare parts order for the New York Ordnance District. Through the efforts of Office, Chief of Ordnance-Detroit, the spare parts requirements were reduced and Iowa Transmission was able to secure a sufficient quantity for its needs.

5. PROBLEM: Pullman Standard needed two sets of spare parts for Eclipse Generators.

ACTION TAKEN: Investigation disclosed that American Locomotive had over-shipped two sets of these spares to Rock Island. A trade was negotiated and all parties were satisfied.

The recital of these selected problems and actions taken has been condensed so as to make the answers seem obvious and simple. Such was not the case, for complications were many and varied. Many different individuals and organizations had to be coordinated before the problem was cleared

Some of the most difficult and aggravating problems were encountered with remanufacturing programs. Obviously, to insert an important remanufacturing program into a plant already producing to capactiy a variety of models of new vehicles would seriously reduce the quantity of new vehicles. Remanufacturing requires a tear-down line, extra inspection, ordering of parts determined faulty, and reassembly. Because of this fact the ratio of remanufactured vehicles to new vehicles which can reasonably be expected from a facility is about one to two.

Several remanufacturing projects were handled in the following manner

1. The Chrysler Corporation cleared its plant at Evansville, Indiana, which had completed its small arms ammunition contract. It rearranged facilities to permit the tear-down and reassembly operations in bays on a job shop operation rather than on an assembly line. The results were remarkable.

2. In 1943, Pressed Steel Car Company was called upon to remanufacture a quantity of M4 Tanks and convert them into M7 Gun Motor Carriages. This job was carried on in conjunction with the manufacture of new vehciles. Salvage and disposition of removed materials had not been worked out, consequently, when old tanks began to roll in and were stripped removed materials presented complications. Due to expense and difficulty of cutting to proper size, junk dealers evidenced little interest in handling the turrets. Many of these turrets remained undisposed of two years later. Adequate disposition was finally developed, but the sidewalls were really bulging before smooth operation was again established.

3. American Locomotive and its affiliate, Montreal Locomotive, were engaged in a project of remanufacturing M10 and M10A1 Gun Motor Carriages and converting them into M36, 90 mm. Tank Destroyers. Among other things, the reworking of Diesel engines was a critical item. Detroit Diesel Division of General Motors Corporation was contacted to undertake the rebuilding of these engines. Its capacity was taxed to the limit, and this additional work could not be undertaken. The engine, being a proprietary item, it was insisted that Detroit Diesel accept the contract, assume responsibility, and develop a subcontractor. The firm of C. Jim Stewart & Stevenson, of Houston, Texas, which had previously done some rebuilding of Diesel engines, accepted the subcontract. American Locomotive Company removed the engines from incoming vehicles and shipped them to Texas befor

Stewart & Stevenson had been able to provide any storage capacity. New construction was necessary, but to await necessary approval would have prevented engines being returned to American Locomotive in time to meet its schedules. Stewart & Stevenson contracted with a third party to construct a building and continued to accept delivery of engines to be rebuilt. Necessary parts were not available from Detroit Diesel. A quantity of parts was located in Field Service stocks at Rock Island Arsenal and a loan of several carloads of parts was arranged. Stewart & Stevenson applied such energy to this work that rebuilt engines were returned to American Locomotive Company at a far greater rate than they could possibly use them, and Stewart & Stevenson actually had to slow up its rate of shipment.

With all of these superlative accomplishments, there had to be, of necessity, another side. I would like to point out that everyone who had a procurement or production responsibility was convinced in his own mind that far too many engineering changes were issued. It is admitted that the production people were not in a position to determine the necessity for all engineering changes. Seemingly, too many of these changes were issued without sufficient though being given to the delay in production and the increase in costs, particularly where the benefits to be gained were of a doubtful nature.

Quantity changes in an end item such as a tank, where there is a complicated network of subcontractors, consisting of many tiers, just cannot be made by turning the pipe line valve off and on overnight. Many months are required before results of schedule changes show up at the end of the assembly line. Schedule cutbacks made today cannot be reinstated two weeks hence, as was attempted at times. Too often this fact seemed to be overlooked. In modern warfare, it is naturally impossible to determine the exact quantities of any given vehicle which will be required eight to twelve months in the future. Because of this fact, unless the most serious needs dictate, quantity changes should not be made. By the time the change becomes effective, the tactical requirements will have changed many times.

Another fact related to the above which was seemingly overlooked is that when you are producing two or more models of vehicles, you cannot reduce one model by a given quantity and increase another by a like number and expect to drive away at the end of the month the same total number of units as originally scheduled.

In closing, I wish to emphasize that a whale of a job was done, a job far in excess of anything originally considered within the realm of possibility. The factors contributing to this success were:

The ingenuity and resourcefulness of American Industry.

The all-out effort of labor.

The unprecedented contribution of women in men's jobs.

The close harmony and cooperation of Ordnance and Industry.

The willingness of manufacturers to help one another.

Finally, no attempt on the part of Ordnance to try to tell Industry how to do its job.

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440

SCHEDULING INTEGRATED WITHIN INDUSTRIES

9 December 1946

SPEAKER — Lieut. Colonel G. C. Wilhide, Chief, Detroit Ordnance District

SUPPLEMENT TO ABOVE LECTURE CARRYING DISCUSSION

FOLLOWING MAIN TALK

THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washingtion, D. C.

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9 December 1946

COL. MCCARTHY:

What in general was the aim of those integrating committees?

COL. WILHIDE:

The integrating committees had a chairman, who was an Army officer, who supervised the Army operation; and a vice-chairman, who was a member of the industry producing the particular item. The committee was composed of four men, and generally one member was from each of the manufacturers of that particular item. For instance, on the Tank Integrating Committee there was a member each from Fisher Body, Chrysler, Pressed Steel, and of many of the major subcommittees, such as transmissions, engines, and various things like that.

The integrating committee would very closely follow the production of every one of these plants. They would follow the schedules of the end items of the producers and follow their shipments, so that whenever a shortage developed which indicated an end item might be deficient at the end of the month, the integrating committee got to work. Their lines went out in all directions. They had information before them from all the series of subcontractors.

A STUDENT:

We have been hearing quite a bit about the very remarkable record of the machine tool industry for not holding up production of tools for producing especially heavy ordnance equipment. I believe that Fisher Body had to make those. You spoke of another company that had to make some, some company in Illinois, which caused a two years delay. I wonder why you couldn't get those from the machine tool industry, which had such a marvelous record for not holding up production.

COL. WILHIDE:

Because of the great backlog of orders. They just couldn't produce them. They didn't have the capacity to do that job.

A STUDENT:

Colonel, would you tell us what part was played by the small war plants in the picture of automotive production, especially tanks, other than as subcontractors?

COL. WILHIDE:

That is a question to which I don't think I can give you the answer that it is entitled to. The smaller war plant was considered to be of tremendous value to the Ordnance Department. In each of the ordnance districts there was set up a representative of Smaller War Plants. Whenever production order came through small enough to be considered that a smaller war plant could handle it, this was first turned over to the representative of Smaller War Plants. He in turn, with his record of subcontractors and other facilities and manpower and capacities, would designate on the order that he wanted this particular order to be placed with a small war plant. That was the direct approach to Ordnance.

Then the end item manufacturer himself, having had a very fine purchasing department and a very fine knowledge of resources and all the various manufacturing elements within a particular area, derived a tremendous amount of good from these small war plants. For instance, we were up on the shelf for certain items. The representative would work very closely with these smaller war plants.

Also there was a lot of headache with the smaller war plants, because a lot of those fellows grew up as backyard shops, alley shop operators. They were not always too stable, not always too reliable. Their workmanship in a lot of cases had to be very closely supervised and inspected. They were not always up on technology. In the over-all picture I think they were very worth while.

A STUDENT:

Suppose you had a problem with the War Production Board. Did that go through Washington or was there a local WPB representative to talk to about it?

COL. WILHIDE:

It was first taken up with the local WPB. If they couldn't decide it, it was carried up to higher authority.

A STUDENT:

What relation did the inspectors have with the industry integrating committees?

COL. WILHIDE:

As I understand that, each industry integrating committee had an inspector. Each ordnance district, of course, had their inspectors in all these plants. The various component manufacturers were inspected at the source. The industry integrating committee inspector more or less coordinated the particular inspection which would be accomplished by all of these various end item inspectors throughout the tank program, so that one inspector in one district would not be accepting one particular item which another inspector in another district was rejecting.

A STUDENT:

In the original design of the M-3 and the M-4 there was enormous difficulty because of engineering changes. There were as many as five hundred changes that came through a month. Can you tell us where most of the trouble was?

COL. WILHIDE:

Most of the trouble was due to engineering changes. We received in the Tank Branch in the neighborhood of two hundred engineering changes a week. Some of those didn't mean anything. Some were just a change in a pin--little things that didn't mean anything. Many of them were very complicated and would change the tank or change various components and would affect two or three tiers of subcontractors. That presented tremendous complications with respect to settlements of claims as a result of these engineering changes. Sometimes materials could be used on another contract, and various things like that.

But the production slow-up was due primarily to the engineering changes that would come in, shifts from one job to another, from one type of body suspension to another right in the middle of the production, before you could run out what had already been committed.

A STUDENT:

I am wondering whether the larger percentage of disturbances and hold-ups in your production of tanks were caused by engineering changes. Were not the major part of those run through according to the specifications and then changes made in your tracks and your suspensions of bodies? Weren't they made at the modification centers or tank centers?

COL. WILHIDE:

To a certain extent. Some engineering change would come through and would be put into effect on tank No. 1978 in one plant and on tank No. 1342 in another plant.

A lot of times a study would be made as to when this plant could best and most efficiently put this engineering change into effect on that particular tank. If the change resulted in a product which was wanted immediately, then a kit would be made in the modification center and those kits would be shipped into the field installation points, so that they could be applied to the tanks then in service.

We had a great deal of trouble with one tank which was quite vulnerable. A lot of you people probably experienced it. There were three weak spots. The Germans were able to pick out those spots. They knew just where the ammunition was located, and they would fire at those points, the shell would go right through, and set the tank on fire. So they developed a means of welding a couple of armor plates together, one on one side and one on the other. Then everything was all right. Those kits were not put in the tanks as they came off the production line, but waited until such a time when they got them over there that they could correct them.

CAPTAIN BENSON:

I think we have heckled Colonel Wilhide long enough. I want to thank you very much on behalf of General McKinley and the faculty and student body for your time in coming down here this morning.