# THE AUTOMOTIVE INDUSTRY IN WARTIME

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1445

CONTENTS






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Mr. Thomas F. Morrow, General Manager of the Defense Operations Division, Chrysler Corporation, was born in New York City in 1912 and received his early education there. Later he studied civil engineering at the New York University and at Massachusetts Institute of Technology. Mr. Morrow joined Chrysler Corporation in 1936. He was assigned to the Highland Park Plant Cost Estimating Department and from 1937 until 1942 worked with the Export Division in sales and production work. In 1942 he was appointed to the General Manager's Staff at the Chrysler-Detroit Tank Arsenal, where he served as tool engineer, assistant planning superintendent and, later, on some important special assignments. Following the war, he worked in central cost estimating and in the Airtemp Division. In 1948 he became a member of the staff of the assistant to the vice president and general manager of the Corporation in charge of subsidiary activities. In 1952 he was made works manager of the Detroit Tank Plant and received his current assignment in July 1954. This is his first lecture at the Industrial College.

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GENERAL NIBLO: Admiral Watt, ladies, and gentlemen: You have heard previous speakers state, from this platform, that through the development of the techniques of modern mass production, our Nation now produces about one-half of the world's manufactured goods; and we do this with less than one-sixteenth of the world's population. Our guest speaker this morning is associated with one of the leading, if not the outstanding, industrial corporations of America, that is developing and employing the modern techniques of mass production. Mr. Morrow is General Manager of the Defense Operations Division, Chrysler Corporation. He will discuss for us this morning the plans of the automotive industry for economic mobilization.

Mr. Morrow, it is a pleasure to welcome you to the Industrial College and present you to this audience.

MR. MORROW: General Niblo, Admiral Watt, officers of the Industrial College, ladies, and gentlemen: "The Automotive Industry in Wartime" is the scope that has been given to me, and I feel that it is a singular privilege and an honor to be asked to be here today to speak to you about the automotive industry in wartime.

This industry in wartime, or peacetime, is basically a service industry. In wartime it serves to contribute its manpower and physical resources, its engineering, production, and management experience, to the needs of the country's military requirements. In peacetime the industry serves to meet the demands of its customers for transportation, and by so doing contributes to our national standard of living.

As an industry, automotive is dependent on other industries for its supplies. The discovery of the first oil in Pennsylvania, which lubricated the first automotive engines, and the development of the oil industry, are part of the story of progress. Similarly, iron and steel, glass, chemical, cloth--each contributed in great measure to the automotive industry and shared in its growth. All of these industries have progressed and have been dependent upon each other, with the result that they have financed a great deal of the engineering research and development contributing to their progress. And in this

progress, by the sale of products, the engineering laboratories have been financed so that engineers could develop better products, bringing about the lowering of costs, making many products available to more people, and contributing to raising the country's standard of living.

The interrelation of industries is cited merely to show the great dependency of one industry upon another, making up the complex pattern of this country's industrial resources which can be called upon in time of great need.

These are broad generalities underlying industry, but let's look at the automotive industry in World War II.

While war clouds hung over Europe in the late thirties, and reached the first of a series of climaxes at the declaration of war by England in September 1939, the military of this country had taken advantage of peace years between World War I and World War II to develop a strong nucleus of career men, who planned, as well as they could with the funds available, for the vital days of World War II. They kept alive with their meager allotments enough fundamental know-how and materiel to be able to tell the country what they needed in the frantic period between September 1939 and the fateful day of 7 December 1941.

These military planners had studied industry in general, and the automotive industry in particular, with the result that they turned to the automotive industry to produce a portion of the fighting tools so vitally needed.

It is true that many of these tools, conceived within the limitation of funds, were obsolete; but they represented a starting point and an opportunity for industry to become educated in the demands of military requirements.

I am reminded of that period in 1940 when Chrysler was approached by Mr. Knudsen on 15 June in a Sunday morning telephone call which he made to our Mr. K. T. Keller, to ask the simple question, "Are you interested in building tanks?"

This started the evolution of tank production in this country. We found ourselves in July 1940 visiting Rock Island Arsenal, looking at the M-2 model tank, and returning with 169 pounds of blueprints. A letter of intent was given to Chrysler; and on 15 August 1940, the

contract was signed to produce 1,000 tanks. In this very short period of time, from the time of the telephone call up to the time of the signing of the contract, the M-2 model changed to an M-3, which mounted, as you know, a 37-mm. gun in a turret and a 75-mm. gun above the sponson.

In September 1940 ground was broken for the first tank-production plant in the United States, after the necessary farmland had been purchased a few miles from Detroit. From the farm's cornfields came a plant which was capable of producing five tanks per day. As the steel columns were erected, roofing was fabricated, machine tools were ordered, arrived, and were emplaced to start cutting chips.

In April 1941 less than ten months after the telephone call, two pilot vehicles were delivered in a ceremony which should go down in history as a great monument to the military-industry teamwork which made this performance possible.

In July 1941 this tank plant was producing at five per day, and plans were already under way to produce a better vehicle, the M-4, which became the wheel horse of World War II. I believe that the only time we produced 5 a day was that period of time when we went from 4 per day on up to 15 per day to meet the accelerated demands of the impending conflict. The first 1,000 tanks of this accelerated schedule were produced long before the originally required schedule date.

Models were changed, growing from M-3 to the M-4, without the loss of a day in production, coordinating the expansion of both the plant and its tooling, so that the rest of the corporation's and our suppliers' facilities could phase into the great effort that this country embarked upon on 7 December 1941.

Much could be said, and a book has been written, on the subject of tank production. But, to summarize this quickly, this tank-production plant produced approximately 25,000 medium tanks, including experimental quantities of certain gun carriers to meet the requirements of the Air Forces. This was one company's effort on one item, but it represents what a segment of an industry can do when the military-industry team sets out to do a job.

In quickly reviewing this one plant's tank history, it perhaps minimizes conditions surrounding the year 1940, the lead time, and the individual efforts for this accomplishment.

For planning purposes, it is suggested and recommended that major complex items be scheduled on the basis of reaching production 18 months after date of contract. This 18-month period can be shortened only by the amount and scope of mobilization planning that is invested. And serious consideration should be given to not only obtaining industry acceptance of an item for mobilization, but to the production-engineering of the item, and eventually pilot or educational quantity production before M-day.

There is no substitute for the actual experience of producing, which gets the bugs out of not only tooling but the item itself. The benefits to be realized in cost and time savings in time of war will offset any current investment.

But I want to cover this subject later. Let's get back to the history of the automotive industry in World War II.

In dollars of accomplishment, the automotive industry turned out 29 billion dollars of materiel. You might be interested in the breakdown of this huge sum of money.

Aircraft, aircraft subassemblies, and parts, 11.2 billion dollars; military vehicles and parts, 8.6 billion dollars; tanks and parts, 3.8 billion dollars; marine equipment, 1.9 billion; guns, artillery, and parts, 1.6 billion; ammunition and components, .9 billion; all other war products, .9 billion. That sums up to approximately 29 billion dollars.

If any of you are interested in the reference material, these figures were taken from a book called "Freedom's Arsenal," the story of the Automotive Council for War Production, which originated with the Automobile Manufacturers Association. I understand from the AMA that a limited number of copies of this book may be obtained from the Automobile Manufacturers Association.

The following production numbers involved in this World War II dollar figure will serve to measure the industry's capabilities for your possible future reference:

4,131,000 engines for aircraft, marine, tank, and military trucks.

2,812,000 tanks and trucks, of which light, medium, and heavy tank production amounted to 49,058; the balance being made up by

production of military trucks, gun carriages, armored car and tank types, and amphibious tanks.

27,000 complete aircraft.

This summation names only a few of the major categories of equipment in World War II. There were millions of items produced, from small arms ammunition to shells, torpedoes, bombs, field ranges, radar, and so on.

To further define the capabilities of industry, it might be well to look at the automotive industry's percentage of total war output. The 27,000 complete aircraft represented 10 percent of the output; tanks, 57 percent of the output; armored cars, 100 percent; aircraft bombs, 87 percent; and machine guns, 47 percent. And so it goes through the rest of the items, giving you some indication of the industry's capacities.

You are interested, I know from the scope that has been given to me, in how some of these production accomplishments came from an industry which produces thousands upon thousands of pieces of transportation in its peacetime pursuits.

The first item in the scope includes fundamentals of production, such as engineering, planning, and control; tooling; quality control and inspection; and scheduling, which, of course, includes lead time.

Each company must do a very thorough job of forward planning in order to make possible the accomplishment of model changes from year to year to maintain its competitive position. At the time of the introduction of the 1955 models, for example, long-lead-time items of the 1956 model were being released from engineering to manufacturing, so that the necessary tools and processes might be planned and accomplished. The day that you look at the gleaming chrome along the hood, or the new lowered profile of the roof on a new car, the engineering department is releasing the 1956 roof panel, because it takes a long time to cut die blocks for that roof panel.

While this 1956 model is started in the releasing stages, the 1957 model is on the drawing boards, and dimensions are being taken from the clay models, so that each item can be released in an orderly fashion. In all probability, the 1958 model is being composed in the clay room for top management to review, for guidance, for judging; so that it, too, may follow the process of evolution and become a reality.

It is fundamental in this industry that the forward planning of a company can be the "make or break" in its economic history. This has been brought about by competition, by the demands of the consumer, and by the desire for progress.

In the early days of World War II the automotive industry had little or no knowledge of military requirements, except for the knowledge of some of the automotive industry's leaders who took part in World War I. The common expression in industry at that time was, "Tell us what and how many you want and we'll make it for you." But as a new generation of doers entered World War II production, guided by the military career men and led by the experienced top management of World War I, the industry as a whole turned its talents to the engineering phase of military requirements to supplement the efforts of the military engineers. This resulted in complete engineering staffs going to work on tanks, guns, and all the other articles of war, so that these items could be quickly produced in the automotive shops with the least possible expenditure of time and money.

It is a matter of record in the book I have already mentioned--"Freedom's Arsenal"--that cost reductions of five major categories of automotive-produced combat equipment amounted to an average of 32.5 percent during the 32-month period between January 1942 and August 1944.

You might be interested in the individual percentages on some of these items on which cost reductions were accomplished.

| | |
|---|---|
| Guns | 55.8 percent |
| Aircraft and components | 36.5 percent |
| Ammunition | 31.0 percent |
| Marine | 31.0 percent |
| Tank and combat vehicles | 3.5 percent |

That figure of 3.5 doesn't do justice to the tank business. It was pretty competitive, too.

The term "engineering" in the automotive industry implies and embraces all engineering phases, from basic research through production engineering, from the time that an idea is conceived and tested in the laboratories, and approved, to the time when it is blueprinted and released for production.

You might be interested in knowing that we worked on the fluid drive for seven years in our laboratories before it reached the first car on the production line.

At the present time in Chrysler Corporation, 25 percent of its engineering talent is devoted to military engineering.

As an item is released by engineering, it goes into a product-planning stage. Individual parts are released through a central routing section, which acts as a connecting link between engineering and production.

Top management and plant management confer and establish the parts they will make or buy; that is, the parts that will be made by the company's own plants, and the parts which it will purchase from suppliers.

The planning department sets up records accordingly and issues requisitions to the procuring purchasing departments for both raw materials and finished components.

The purchasing department brings in both known suppliers of the past, as well as new suppliers, for competitive bidding.

This will interest you, I know: To supply Chrysler Corporation's yearly production, we utilize over 10,000 supplying vendors--some large, but mostly small businesses.

In the instances where new suppliers are involved, their capabilities are investigated before decisions are made. When the decisions are made, the purchasing department gives the supplying vendor an order. This information is transmitted back to the planning department.

Scheduled releases are then set up, so that the vendor in turn can plan for tooling and production. This exercises the necessary control of scheduling material in such a manner as to meet final production schedules, to avoid handling problems of space and time.

Time and space are so important that our Plymouth plant, which produces 3,000 passenger cars per day, stocks only four hours of production requirements for tires. That assembly line is entirely dependent upon the flow of railroad cars from the supplying vendor to our plant in order to keep the production line going at its scheduled economical rate. One miss on an engine switch and that plant is out of production.

There are many other items that are handled in the same manner because the requirements of warehousing and handling would otherwise be too costly.

You might be interested in the fact that forward schedules are established on the basis of the sales department's estimates of the market. This is reduced to a smaller increment, referred to as a 90-day material authorization. This 90-day period is broken into 30-day periods, called firm, in process, and raw; and releases are written to schedule the incoming shipments daily. In the instance of tires, this is actually broken down into hours.

When the sales orders are received, they are compared with the sales department's estimates and the planning department's authorized material schedule; and, when compatible, scheduled so that each order becomes a custom-built unit to satisfy the customer's individual demands.

This complex but fundamental planning system allows the high-speed production line to produce four-doors, two-doors, convertibles, and so on, intermingling and in a variety of colors, trim, engine, and transmission combinations, which are staggering.

Some, more mathematically inclined, indicate that this series of combinations amounts to hundreds of thousands. One west coast assembly plant, which produces all four models, has a variety of 57 paint combinations and 103 trim combinations. But this planning is a fundamental of the business, which was applied to the production of military requirements in World War II.

I want to go into this a little bit, because it has a counterpart.

As each item is released and the make-or-buy decision is made, the part funnels into the master mechanic's section, wherein it is studied against the available machine tools or the necessity to

procure new tools for what is now fancifully called "automation." This subject of automation, of course, is as old as the invention of the first wheel. We have been automating our plants to minimize human effort, control quality of production, cut costs, and increase production, ever since the first vehicle was produced.

The tool engineers in the master mechanic's department perform the job of providing the necessary holding fixtures, cutting tools, and inspection gages, so that the parts will go together easily at the final inspection point.

Herein also was introduced one of the other important facets of cost control, which calls for redesign of some items so that the individual parts can be produced more inexpensively.

Tools are ordered from Corporation tool rooms, and in many, many instances from the innumerable small tool shops, so as to meet new model introduction dates and subsequent production schedules.

When new machine tools and individual fixtures arrive, the master mechanic and his staff, supplemented by toolmakers, diemakers, and setup men, try out new tooling, so that production can be furnished with functional tools to meet production schedules. That is one of the toughest parts bringing in a new model--making everything fit together.

The master mechanic, in providing the necessary tooling, provides the necessary gages, based upon past experience and in coordination with the inspection departments.

Inspection is broken down into receiving inspection, in-process inspection, and final inspection. Receiving inspection, of course, checks out castings, forgings, sheet metal, and finished parts for agreement with engineering specifications, utilizing all of the necessary and latest tools of that function, and referring to engineering sufficient samples for laboratory analysis, including fatigue testing, metallurgy sampling, and so forth.

So, we find that engineering comes back into the picture to supplement the efforts of the other members of the production team. This engineering testing goes on throughout the model year in search of not only better quality control, but better ways of making parts for current models and engineering components for future models.

I have referred to scheduling and lead time in building up the foregoing, and mentioned a long lead time of a roof panel die, amounting to one model year, This is only one item. It applies equally well to engines, as well as frames, power steering controls, fabrics, tires, and all the other components, in greater or lesser degree, depending upon the lead time required to meet production.

Now, this is the pattern of the automobile industry in normal commercial pursuit, but these fundamental operating principles apply equally well in wartime, as demonstrated during World War II.

Mobilization planning of materiel can be substituted for the forward planning of 1956, 1957, and 1958 model cars and trucks mentioned earlier. As a matter of fact, this is being done for many items--such as tanks, aircraft, guided missiles, et cetera. The model years are not as clearly defined, but the research and development work is being done within the limits of the defense budget.

The engineering has been contracted to industry, so that its engineering staffs may keep abreast with the technological developments in military goods and requirements. This served two purposes--namely, it conserves engineering manpower between the services and industry; and it gives industry an opportunity to serve and work more closely with the military in accomplishing the military's assigned missions.

With your indulgence, I would like to tell you what we in Chrysler are setting up to do, and thus by example, instead of in the abstract, draw the necessary parallel between the automotive industry in peacetime and wartime.

We in Chrysler, being ever mindful of the lessons of the past, and recognizing the limitations of the present, studied our World War II assignments and the more recent assignments of the Korean period, so that we might develop and foreshorten the time required to get into production of military items in the event of another war.

This study has resulted in the formation of a Defense Operations Division, whose responsibility it is to keep abreast of current military requirements, produce current requirements in five defense plants where current requirements exist, administer contracts under the Government's rules and regulations, and provide mobilization planning for all of the Corporation's plants. This was done with the thought in

mind that, come another war and the bell rings, we will not have the time which was available to us prior to our entering World War II.

We currently seek out those items which fit into our defense plant facilities and capabilities, and those same or similar items which may be required under wartime mobilization in greater quantities. We found in World War II that, due to lack of mobilization planning, some of our facilities were completely torn apart to make way for the production of war materiel, with resulting serious impacts on reconversion and peacetime employment.

Currently, in Chrysler Corporation, we are studying the allocation of our facilities to as many items as the military departments indicate they need. I think the lesson of World War II should be referred to as it relates to current production and mobilization requirements.

It is our desire and intention to operate defense plants, which might well be called reserve plants, to produce goods currently; and thereby be able to expand rapidly our production from the 5 plants to 50, if required.

The defense plant, devoted solely to defense goods, which can currently produce pilot quantities or educational orders, will be able to provide the necessary experience of handling military requirements, setting up planning records, operation sheets, time study, and keeping a nucleus of its manpower abreast of both requirements and technological advances. We propose that this be done so that our plants engaged in commercial pursuits can be converted quickly to wartime production. These defense, or reserve, plants, in the event of expansion of requirements under mobilization, thereby become major assembly plants, being fed by other plants, so that production requirements can be met.

So much for the Chrysler parallel.

The work being done today on legislation to provide the necessary priorities and allocations of materials in line with the so-called 1,000 items, or 970 items, I understand right now, to be more exact, of preferential nature, is sound. But it should be kept current to meet changing conditions and requirements. This work should also accomplish the minimum of lost time in converting to war production.

I would like to express one thought, which probably oversimplifies an economic cycle of competitive business; but I know you realize its importance for the strength of the military-industry team. When the chips are down, industry must be strong, so as to be able to contribute to the demands of the military services for production. When the economy of industry is restricted, its strength is restricted and the strength of the team is restricted.

To be a good team member of the industry-military team, industry must remain strong. Industry must contribute to the overall economy of this country. It can do so if its own economy is strong. To make its economy strong, it must operate at a profit, so as to pay the wages of the men who work in industry--so that it can pay the wages and costs for research and development in engineering--so that it can pay for machine tools--so that it can pay for plants so necessary to keep industry in a strong position--and so that it can pay taxes out of profits--to finance newer weapons of the defense program.

There, I think, is a little bit of a definition of a national life insurance policy; and I like to think that it applies to defense production as such.

I hope that this covers the subject; but, as we both recognize, in the course of the studies in which you have been engaged, much can be said and much could be written about all of the various facets which enter into this complex picture. Speaking for Chrysler Corporation, we want to be on your team and do the job so necessary for not only growth, but the existence of the country.

COLONEL BENEDICT: Gentlemen, Mr. Morrow is ready for your questions.

QUESTION: Mr. Morrow, we are all agreed that time is going to be a pretty important factor if we have another war, probably the most important. If my notes are correct, you said you got the first contract for 1,000 tanks on 15 August 1940, and you referred to the first production of 5 per day in July 1941.

MR. MORROW: Right.

QUESTION: You further said that mobilization schedules should be planned on the basis of an 18-month lead time.

MR. MORROW: Right.

QUESTION: Can it be expected, if the highest priorities on materials are guaranteed to Chrysler, that it will do as well as they did in that tank production, if we had another war?

MR. MORROW: I hope we will do better. But I recommend to you and I suggested that you consider 18 months, because no one can define all of the conditions that will exist at the time, of critical need of any one item.

Today, I don't think any one of us can say what kind of priority system is going to exist 6, 12, or 18 months from now. I think we have to take each item up as we come to it. That is why I emphasized that you should come back to this 18-month basis for planning. I tried to draw the parallel between that and our planning for the 1955, 1956, 1957, and 1958 models. In other words mobilization involves forward planning methods.

While we had no forward planning in 1940 as such, remember, Rock Island Arsenal did a lot of work. It did that basic work which allowed us to get 169 pounds of blueprints and get started.

Also, in 1940 we did not have the scarcity of machine tools that we would have today. While the machine-tool business is down today, it takes a long while to get a big jig built in wartime. It takes a long time to get a 20-foot vertical boring mill built. It takes a year to get a spar mill and some of the other large pieces of equipment that are required today.

All I am trying to say, sir, is that the more mobilization planning we have the better equipped industry is to do a job. I don't know whether we could better that figure, or whether we could cut that figure if prescribed under today's conditions. I merely gave it to you as an example.

Does that answer your question? I have tried to give you the impression that you just can't measure everything by examples. We have to start from a benchmark--"it is a mile from here to there." How far you go in mobilization planning to accomplish that mile will lessen the amount of time it takes you to get to the goal somewhere down the line.

QUESTION: I believe you mentioned three types of inspection--incoming materials, in process, and final. Can we cut the time in between the pilot line and the final inspection? Do you actually permit the production of a car before it has left the pilot line?

MR. MORROW: Several things take place in the production cycle of cars. When you go from the clay to your plans to release, the engineers have built pilot models as such, and they have run the devil out of those pilot models. They will put 10,000 miles on them in a very short period. They will tear them down, revise the blueprints if necessary, revise the dimensions, revise the tolerances, et cetera.

Now, when that job hits the line as a production item, immediately engineering starts siphoning off a few models from the line. It will test those just as though they were the same pilot models. They give them production tests, merely to see if production can work with the blueprints. There is that kind of sampling. There is quality control sampling, inspection sampling, and other types of sampling. In other words everything that we make right saves money. It is much easier to make it right than wrong. You have a lot of work to do if you make it wrong and have to correct it.

QUESTION: Sir, do you think the automotive industry as a whole will have enough engineers to absorb an emergency mobilization in its stride? Or is it likely that the demands for engineers may be a temporary bottleneck?

MR. MORROW: In 1931, 1932, 1933, getting enough engineers was no problem. As you probably well know, none of us feel that we have enough engineers today. I understand from a report recently published that we have been turning out 20,000 a year. Our potential enemy is turning out 50,000. They do things different than we do. There is no freedom of choice. If you are above a certain level, you are in, you are an engineer, whether you like it or not.

Engineers could very well be a bottleneck. You read the newspapers today and there is ad after ad after ad for engineers. I would like to have some of those, too. I think the more engineers we have now, the easier we make the job later on.

I think we have to get stability of design. I see that coming in many items. I see model years coming up on many things. Defense production may not allow the production of the 195-X model, but at least it is

in the system. It may not be completely blueprinted, but there has been some work going on. I think that is going to help emergency mobilization.

QUESTION: To what degree is the Chrysler Corporation aware of what it would be required to produce in the way of war materiel if there should be a war? And how does that filter down in the organization so your plants are aware of the situation?

MR. MORROW: We have about 43 million square feet under the Chrysler banner at present. We have 13 million feet committed. We have another 18 million feet being studied at this moment. We are constantly making every effort to have 100 percent mobilization plans, even though we know that this 100 percent today will change tomorrow because some items will be dropped off.

On some items it has filtered down to the point where our World War II experience, plus the studies that are going on at the present time, will permit us to jump in pretty fast. On other items there is no funding available for what I call our detailed mobilization studies.

QUESTION: On this filtering-down proposition, do you feel that, to sustain that west coast assembly plant, it is required that its representatives be brought into the picture at this time and be told what they might be required to do, what readjustments they may have to make or retooling or changing their assembly lines? Has it filtered down that low or is it merely staying in Detroit?

MR. MORROW: Fortunately, the plant that you picked out--the west coast plant--is involved in production at the present time, making some 40 sets of missile parts. So it in effect can expand that what we call pilot production into the whole plant if necessary.

There is no substitute for educational orders in training your people to get thinking along military lines. So, again I repeat, give us those educational orders. Educational orders are the difference between sitting around and theorizing and actually getting to feel the physical piece and knowing that you have done something. This is why we make such a strong point of pilot production lines.

I cited the example of the Detroit Tank Plant producing 5 a day only because it represented a pilot production line. It wouldn't have been possible to do the job that was done in expanding production from 5 to 50 a day if we hadn't had that 5 a day. Maybe it doesn't have to be 5 a day. Maybe only 1 tank a day is enough.

I will tell you this: Once you have your ground rules set up, your pilot line production can be a lot less expensive than it is at the present time. If you set up as a ground rule that this is to be done with the least amount of cost, you set up a challenge to industry. You save a lot of money that industry will otherwise have to expend in time, overtime, expediting, and so forth.

QUESTION: In my fifth month of lecture-listening, I feel compelled to congratuate you on your clarity and your brevity. You mentioned that you have had experience with automation for many years. Would you please tell us about your experience with automation in labor and the guaranteed annual wage?

MR. MORROW: I will try to be brief. As I previously stated, automation has been going on for a long while. With the invention of the wheel, transportation became automated. Instead of pulling against the friction of the ground, you only had to pull against one line of friction within the axle; and you could move a load with a lot less effort.

I am glad you brought up automation. There is one point I want to raise.

In World War II a lot of our equipment was converted to military production. But with the very great degree of competition that there is in our business today, we have had to gear our plants in order to remove some of the costs; and that has brought about very involved machine and product designs. The fenders are no longer straight. This has taken additional operations, additional tooling. If we were making that same car 15 years ago, it would require four times as much labor. We have done that even though there was a scarcity of labor in this country in 1946, 1947, and 1948.

But with automation today a lot of the machine tools used in the industry aren't going to be available come world war X, because an automated cylinder block line is such that it takes cylinder blocks only. You can't change it very much. As a matter of fact, that is one of the problems with automation. So we will not have the same degree of convertibility of our essentially automatic machine tools, in my opinion, as we had in World War II. And that points up the need, the great need, for the standard-purpose reserve tool program which is presently being done.

You had a second point. What was it, sir?

QUESTION: The annual wage to labor obligation we have read about.

MR. MORROW: That will be negotiated over the bargaining table at some future date. If I knew the answer, I probably could not tell you. It is a tough one. It has to be done over the bargaining table.

REAR ADMIRAL M. WATT, JR., USN, Chairman, Naval Industrial Plant Review Board: You said you have something like 43 million square feet, with 165,000 people. Your last reply raises a question in my mind as to what percent of the machine tools in those 43 million square feet could be used for war production and what percent would require retooling, because, if it is going to take very much of it, that is something that has to be done during this defense period, isn't it?

MR. MORROW: Yes, sir. I don't have the answer to that in percentages. It will have to be studied in mobilization planning.

We have a big job and a great deal is going to depend upon what kind of equipment is needed for that job. If it is a sheet metal part, we have plenty of equipment. Dies will be required and we can plan on simple dies in three weeks and six weeks for a more complex die; and for the automotive type it will probably require six months, more or less. As to percentages of equipment, I will have to reply to you on that question from the results obtained from the mobilization study for the item you have in mind.

QUESTION: My question has to do with dispersal. You have shown that a pretty big slug of military items comes from the automotive industry. Does the industry feel it is adequately dispersed against possible atomic attack? If not, what is being done about it?

MR. MORROW: I will merely comment that the radius of the A or H circle is increasing all the time, as the technology of nuclear fission advances. We used to talk about a 10-mile radius. We are now talking about 16,000 people in an area. Today we are beginning to talk about something a little greater.

I don't know how far we could disperse the industry in order to meet the problem of "the bomb." In industry in general, and in the

automotive industry in particular, it would be very difficult, for example, to put up a million square feet of floor space without giving due recognition to the pressures of competition. And when you do that--taking, as an example, the erection of a body plant--you wouldn't put a body plant 100 miles from the assembly plant. Not if you could help it. If someone is buying, he will not buy that body just because it is coming 100 miles away from the assembly plant. He will not be interested in that at all.

So you have these competitive pressures in this country--which I believe have actually contributed to the progress of the country--versus dispersal. I think we yet have some real problems to solve in that area.

I think one of the solutions is the reserve plant. I think the reserve plant can overcome a great deal of the effect of bomb damage, because your reserve plant, you see, is an integrated plant. It is capable of making five a day all by itself, for all practical purposes. It is capable of having everything to disperse when it becomes a large assembly plant. I think the reserve plant may be one of the answers. I think we have some real problems. Look at Pittsburgh and Gary and some of the other great centers of industrial production.

ADMIRAL WATT: You spoke about reserve plants. You also stressed the importance of time in war production. Would you give a little outline of your thinking as to the difference in timing as between getting a completely cold reserve plant into production and getting it up to full production and getting a plant that has been running at, say, 20 percent capacity with one hot line, into full production? What would that mean in months?

MR. MORROW: Anything I say in that respect has to be examined on the basis that I will answer you today and conditions may change tomorrow or a month from now.

I am drawing upon experience for this example. We had the same kind of problem in the tank line, producing 30 to 35 tons of material in each item. We were able to go from production of 5 a day to the line running 15 tanks a day in a period dating from July 1941 to December 1941. Then we were able to go to 50 a day in approximately nine months because we had a production line running. We changed models during this period without the loss of production, so I would say, sir, that on that basis there is no substitute for a going reserve plant if we can

afford it. I think we can save possibly 9 to 10 months, possibly more. It all depends upon the item and the degree to which it is tooled up, and the concept under which it is tooled up--the degree of engineering changes, and so on.

Stability of design is a very important thing. For stability of design there is no substitute. To revert to 1955 car production, we actually stabilized our design in the last six months. Our basic production design is completely frozen. The only changes allowed to come in after that freeze date were absolute functional changes that must be made to make the car or truck a good, sound piece of merchandise. You have to get away from the whims of people in this commercial field, because all of us good engineers will engineer ourselves forever if we are allowed to.

COLONEL BENEDICT: Mr. Morrow, on behalf of the Commandant of the Industrial College, I thank you for a most informative and interesting lecture and discussion period.

(4 Apr 1955--750)S/mmg