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POSTWAR DEVELOPMENT IN MANUFACTURING TECHNIQUES

17 March 1949

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GENERAL HOLMAN: Gentlemen, industry must always keep pace with scientific progress in improving its production processes. There is always a little better way to do the job out in the shop. The reward for improvement of production processes is a superior product at a lower cost and in less time.

Our speaker this morning, Mr. Joseph Geschelin, has devoted many years to design engineering and production in the automotive industry. He is the Detroit Editor of the Progressive and widely read publication "Automotive Industries." In this position he is in close contact daily with improvements of production processes in the automotive field.

It is a great pleasure to introduce to you Mr. Joseph Geschelin, who will discuss "Postwar Development in Manufacturing Techniques."

MR. GESCHELIN: Thank you, sir. General Vanaman, staff, gentlemen: It is a great pleasure to be here and I certainly appreciate the privilege of lecturing to the College once again. My talk this time is more in the nature of an outline of new developments because I have been asked to touch on as many new developments as possible. I doubt whether it will be possible for me to expand on many of these, except perhaps in the question period. So what I will give you is primarily an outline, with the possibility that parts of the outline might be followed later by studies of the developments that we discuss.

One thing that I would like to mention, because of its importance to the national picture itself, is the tendency in mass-production industry--I don't know to what extent in other industries, but at least in the automotive industry--the tendency toward the installation of the so-called transfer machinery. This machinery is completely automatic; it requires no operator attention; and it is a remarkable adjunct to the production process because of its greatly increased productivity. But the difficulty from your standpoint and from the standpoint of national security is the fact that such machinery absolutely freezes the facility to a particular design. That means that if we were faced with an emergency such as we had in World War II, there is absolutely no possibility of converting such facilities to the making of any other product. To make it more specific, Buick has transfer machinery for machining the cylinder block and cylinder head. None of that machinery, or even parts of it, could be salvaged for making anything except that cylinder block and cylinder head. The same thing goes for the machinery at Oldsmobile and in other plants. I think that is an important thing to remember because it emphasizes in my mind the need for having and storing somewhere a great deal of general purpose machinery that can be swung into action as we need it.

The second point of general interest is the necessity, in my opinion, of coordinating the advance in military designs with the knowledge in industry of manufacturing processes. I think that wherever possible there ought to be a cooperative effort between the engineering and design branches of the Military Establishment and the specialists in production industry, because we know in production industry that very frequently a design which is created purely from a functional standpoint is not always the best possible design from the standpoint of production economy. Since frequently just minor modifications in the design of a product will make its production possible by improved methods, I think it is very well worth studying.

I would like to high spot a few things in the field of metal cutting. One of the developments which is no longer new but still can stand considerably more expansion is the art of surface broaching. Surface broaching has been very widely applied. It is a process that primarily reduces milling operations. Generally speaking--of course it will vary with applications--surface broaching takes a seventh to a tenth of the milling time. It is an extremely fast operation.

One of the interesting things at Oldsmobile that could have other applications is a new machine made by Cincinnati Milling which is a combination of milling and surface broaching within one machine. That is used on the cylinder head. The reason they combine milling and surface broaching is because no matter how well controlled the castings are, you usually get hard spots. The surface broaching operation has been unable to cope with the hard spots, and they have had some difficulty in keeping tools going. Now, by putting in milling cutters just ahead of the surface broaching tools, the milling cutter removes the surface scale and the surface broaching tool does the rest.

Another very unusual machine which, of course, is adaptable only to mass production, is the Gisholt Turn Mill. It is an automatic machine for turning crankshafts. It does in one machine what you do today in a number of single operations. You will find an example of that machine at Continental Motors at Muskegon. It is an extremely flexible machine which handles a variety of crankshafts at the same time provided they are of lengths suitable for the centers of the machine Two of these machines are used by Cadillac on the new V-8 crankshaft.

Another development, primarily a postwar development, is the Micromatic honing machine. Honing is very widely used today for getting an extremely fine finish on the bore within very fine tolerances. Honing has never been associated with metal removal; it has been in the nature of a lapping operation where the amount of metal removed is hardly measurable. But these new machines are capable of taking off as much as 30 one-thousandths of an inch (0.030) of stock, yet give a perfection of bore--concentricity and freedom from bell mouth, or any other imperfections.

The important point about it is that you can now apply this method as a metal removal method. In certain cases you can apply it to do the complete job in one operation instead of starting with a rough forging and finishing, and you can complete the bore within fine tolerances without using intermediate semifinishing operations and without using grinding at the end.

Another development of perhaps minor interest is something that was done by Buick research workers very recently in their welding laboratory. They are experimenting with the use of the submerged arc welding technique which was originated by Lincoln. Up to now submerged welding has been used to make long welds such as on an automobile frame or any other mechanism, but there are times when it is desirable to have interrupted welding. That is, you weld a certain length and then skip and weld again, and no one has accomplished that up to now.

Buick production specialists found it necessary because on the Dynaflow transmission they have to weld the ring gear to a disc. They found if they made a complete seam weld around the circle, it would distort both the disc and gear. They found it necessary to weld at only three or four points at the most. So they developed an electronic control, which automatically times the welding cycle so as to start the arc and break it within a fraction of a second. There may be other applications of this technique.

Most of you are familiar with powder metallurgy. The only thing new about it that I know of is the fact that the people who are making powdered parts can now make them out of almost any useful metal. You will remember before the war it was more or less restricted to bronze alloys and iron. Today they can use zinc, aluminum, or almost any useful metal they want; I think that is the main contribution to the art at the moment.

There has been a tremendous advance in heat-treating techniques, particularly induction heating. Originally, this high-frequency machine was designed for hardening parts. During the war it was found very useful for heating forging blanks which had previously been heated in a furnace. The most extensive application of induction heating and induction hardening equipment that exist in the country will be found at the Louisville plant of International Harvester. I don't know how many million dollars worth of equipment they have there, but certainly it is by far the biggest plant in the country, I would say.

Today induction hardening is used for heat-treatments and, particularly, for selective heat-treatments; that is, where a fairly complicated part requires hardening only at certain portions. Induction hardening will do that without any masking such as you would have to do in an ordinary furnace. I think the biggest value of induction equipment today is in the heating of forging blanks. The time cycle is a great deal faster than in a conventional furnace and control is much more positive, control being very essential in forging operations.

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One of the new things in this field is the Cincinnati flame hardening machine. Now there is nothing new about flame hardening, but the new thing that Cincinnati has added to the flame hardening machine is electronic control of the surface temperatures. You will find most flame hardening machines have no control whatever of metal temperature. The Cincinnati machine has a control that starts right with the temperature at the surface of the material, shutting off the arc as soon as the proper temperature is reached.

An interesting trick in heat-treatment is the use of a carbon-nitrogen atmosphere which has been developed at Buick. Buick factories, incidentally, have been responsible for many developments in the heat-treating art. This process is similar to the nitrogen hardening process except they use normal materials and introduce nitrogen in the form of ammonia gas into a standard furnace. The usefulness of this method lies in the fact that Buick has replaced cyanide hardening for a great many miscellaneous pressed steel parts. This process is much quicker and gives better quality control.

I don't know how familiar you are with the electrostatic painting but that is an important postwar development. You may have seen an application of the process during the war in the technique that was called "detearing," used in the painting of ordnance parts, such as the shell for land mines, and also some of the shell casings where it was desirable to eliminate varnish drip. That type of technique has been applied to spraying paint, and the biggest advantage of the process, apart from the fact that it is completely automatic so that you reduce the number of people required, is that it can save about 50 percent of the paint normally consumed. So from the standpoint of conservation that is a very important process to consider.

There are several things happening in the heat-treating field, but unfortunately I can't give the complete story because these things are so new they haven't yet been completed. I simply want to give you the information on them in advance. I refer to the adoption of the mar-tempering process. The unique feature of the present development is the possibility of completely mechanizing the entire heat treating cycle, and greatly reducing the time involved. They save a lot of machining operations, and so on. I will read just a paragraph of something that was mentioned about two weeks ago by one of the metallurgists on mar-tempering.

"Of the recent developments this is one the most outstanding. High hardness, comparable to water or oil quenching, is available with a remarkable control of distortion. In many cases the savings made possible by this distortion control will more than cover the entire heat-treating costs. Mar-tempering is often combined with carburizing, and the entire treatment is accomplished with one heating. The following represent some applications: Crankshafts, transmission gears, automatic transmission parts, bearing races, cylinder sleeves, etc.

"Induction heating has also been used in conjunction with austempering and mar-tempering on an experimental basis. Gears which have been mar-tempered from the inductor block show very little distortion and highly favorable residual stress patterns. Induction heating and a subsequent mar-tempering operation lends itself to hardening numerous small parts where distortion and residual stresses present a contending problem."

Now there is a lot more going on in the heat-treatment field. For example, Ford factories are operating an independent forge plant in Canton, and most of the Ford forgings are made there. Incidental to the operation of this plant, they have installed what is called cycle annealing. Cycle annealing is an isothermal salt-bath treatment. Now the beauty of this process is the fact that the salt-bath furnace can be placed adjacent to an individual forging press to accomplish two things simultaneously. Not only does it anneal, but it also removes all of the scale. Whatever scale you get in the forging process is knocked off in the salt bath. It is done without any handling because the operator takes the forging out of the press and simply drops it into a chute leading into the salt bath. They are making tremendous savings there. The important thing about the process, though, apart from the fact that you do both processes simultaneously, is that the annealing time now ranges from one to two hours. The comparable rate of the conventional method runs from 6 to 24 hours. That will give you some idea of what can be accomplished.

While we are talking about forgings, it might interest you to know that one of the latest developments in the forging field is the use of press forging. That again is not new. I think most of you have heard about it. But the art of press forging is being expanded and is replacing hammer forging in many cases. I might mention that the Ford plant has placed in production the extrusion forging process. I believe that plant is the only one doing it in large-volume production.

Ford is making steering knuckles, for example, by extrusion. A discussion of just that one thing alone, to give you an example of what I am up against, would take a complete lecture. Not the least advantage of this technique is that they save not less than one pound of weight per billet. If you multiply the number of knuckles the Ford plant needs by one pound and convert that to tons, you get some idea of the saving, coupled with the fact that you don't have to transport excess material. In addition, the extrusion forging process--for reasons that are beyond me--gives much better control of the dimensions than the normal forging process does, with the result that very little excess metal is left for finishing. That is a virtue in reducing the machining time.

I was asked to comment on the special techniques in the field of materials that were in the news about a year ago. The use of oxygen in steel making was specifically mentioned. When this process was first

promoted, our understanding was that it was designed to greatly speed up open-hearth and electric furnace melting procedures. I checked some months ago and found that the metallurgists ran into a snag, that the oxygen not only speeded up the process, but it speeded up the burning of the roofs of the furnaces very materially. This caused them to wonder just where the economy lay. While the steel-making process could be speeded up the furnaces went down and had to be rebuilt. I asked one of our metallurgists to check up for me just last week and he reported that in the opinion of steel makers the process has been overrated, that it is being used only to a slight degree, and only in portions of the cycle. So I would say it apparently is not so important as it was made out to be

As to materials, there is not much I can tell you because often new materials are obtained, and you are familiar with the current developments. The only new thing I have seen is an announcement made by International Nickel Co., just within the week, announcing the development of ductile cast iron which I think is quite unique. The iron combines the properties of gray iron with the properties of cast steel. This company knows how to make ductile cast iron. It is done with controlled introduction of magnesium. I have here a paper that I can leave with you. (Retained by Production Branch.) The International Nickel Co. is apparently in a position to impart this technique to any foundry that wants to use it. It is really a marvelous thing because with cast-iron practices you now get the physical properties of steel, and you get a great deal more ductility than you can ordinarily get with iron.

Another interesting thing is a line of liquid resin for making foundry match plates and pattern fixtures. I don't know anything about it beyond the literature the company sent to me. It is making a type of liquid resin that lends itself to the making of foundry match plates and pattern fixtures and even dies for light press work. The company claims that this material has very low shrinkage so it can be cast into molds and come out just about the size you want. This material has great accuracy of detail, comparable almost with die sinking, and is easily machinable so you can machine it into any shape desired. I was told by one of the representatives of the International Nickel Co. that quite a number of manufacturers around Detroit are actually using this material.

The only other thing I can add here is the fact that I visited the Rochester Products Division of General Motors in Rochester a few weeks ago. I was quite surprised to find its people had converted entirely from what they did during the war. During the war they made a lot of ordnance parts and electrical equipment. All that is out. Their main business now is as the Fuel Division of General Motors. I think from that standpoint it will be interesting to you. General Motors has become the biggest producers of tubing for automobile people, making low-pressure and high-pressure tubing, the latter for hydraulic brake li linings, while low-pressure tubing is for vacuum lines, oil lines, gas lines, and so on. Tubing is made by the hundreds of miles.

General Motors has one process that is rather unique. In fact, it is just getting into operation right now, that is, the continuous copper plating of steel tubing. This company has a series of immersion tanks lined up with blocks in between to continue the electrical contact in the baths, and the interesting thing about it is the possibility of running tubing through at 80 feet per minute, producing a coating of about four ten-thousandths of an inch continuously. It is really remarkable. It may have some usefulness.

Gentlemen, that sums up the high spotting and, at your pleasure, if I can expand on any of it, I will be glad to do it. Thank you.

QUESTION: Your new broaching machine, sir, sounds very intriguing. I wonder if you would go a little deeper into the discussion of it. Will it take large castings, is there much tooling involved, and can holes be broached?

MR. GESCHELIN: The broaching machine I speak of is not intended for castings. The thing I am talking about is called surface broaching, and what you do there is to generate any kind of external contour that you want as long as it is external. For example, it is being used in blading for gas turbines. It is also being used at Allison for broaching the wheel into which the buckets or blades are set. The cavity is done by surface broaching by a series of operations.

One example of how broaching is used most effectively in the automotive industry is the modern way of making a connecting rod. The connecting rod is forged in one piece, that is, the rod and cap are forged together. You can pass that through the broaching machine, which will in one operation finish the length of the bosses for the bolt holes, the sides, and then in that same machine or another machine you use a broaching tool which is very thin. It is in effect a saw, which cuts the two apart. Then, after they are sawed apart, you put them back into the broaching machine and with a circular shaped tool you can finish the half-round role. Now to contrast that with conventional operation: It eliminates milling; it eliminates grinding; it eliminates many other operations.

QUESTION: Will you expand your remarks on electrostatic painting?

MR. GESCHELIN: Well, I think the best way--without trying to go into the design of the thing--is to describe one typical application. One of the earliest applications is at Gabriel. Gabriel makes shock absorbers at Cleveland. For this discussion the shock absorber is primarily a cylinder. The problem ordinarily is that if you have a cylinder, it is usually necessary to use conveyors with spinning fixtures on them. You must spin the work around while the piece is passing by the spray gun. In the new process they energize the path through which the conveyor passes.

This electrostatic field is so arranged that it tends to force the particles of paint completely around the work, and the paint covers the whole piece completely. Because it does that, you can adjust the spray nozzle so as to eliminate all over-spray. That is one reason why you can get a reduction in paint volume of sometimes 50 percent and more.

More recently they have gone even into spraying irregular shaped pieces. For example, take the automobile hood or fender, and, depending on their size, you can put on three or four on a fixture to give approximately cylindrical form, or cone, which can be painted by electrostatic spray. Apparently there is no limit on its applications since factories are attempting to spray a complete automobile. There are no operators. The guns are completely automatic. The main thing that does the trick is this electrostatic field. You can see it at Gabriel; Houde at Buffalo has the same setup on shock absorbers.

QUESTION: What products are they making in powdered metals? What metals are used in the automotive industry?

MR. GESCHELIN: Well, it is a little hard for me to visualize all the products they do make. One of the commonest is the oil pump gear. That is where you use a spur gear oil pump. That has been made for a great many years. Both gears are made with powder iron, just pure Fe. They are made right to dimension and require no finishing to dimensions.

Mechanical clutch facings are made by powder metallurgy. Examples are the bronze clutch facings made by S. K. Wellman and Raybestos-Manhattan, the people who made them during the war for military vehicles-for clutches and brakes.

Generally speaking, powder metallurgy is very useful wherever you have an extremely intricate part that does a functional job, and where you don't require very high physical properties. Obviously, physical properties can't be high with this method because it is primarily a nonferrous process, except for the irons. But you can make parts of great intricacy--cams, cam profiles, fingers of all kinds--in copper, bronze, iron, aluminum, or zinc. The main thing about it is that you have to select the parts that are required in great quantity so you can justify making the dies. Apart from that, if you do have adequate volume, you can probably beat any other process. You can beat any process that requires machining because these pieces come out to form without any machining whatever.

QUESTION: Could you give us any more information on extrusion forging?

MR. GESCHELIN: General Vanaman brought up that point during the recess, and I have left a copy of an SAE paper that describes the Ford process very completely. I think you would get the answer more satisfactorily there. What I can tell you, though, is that Ford has done

considerable work with steering knuckles made by the conventional hammer process and by extrusion forging. Ford finds it gets much better flow lines and much better control of these lines. Physical properties are improved somewhat. In fact, I think there are some tabular data in this paper. I think the improvement is very marked in physical properties.

Incidentally, in this extrusion process, I think you can liken it to any phenomena of plastic flow in that they start with just a slug, just a small cylinder that is squeezed into a die. The greatest virtue this extrusion process has, as I visualize it, is in making parts where there is a big difference in sections. The steering knuckle is an excellent example because you have a big rectangular flange with a long stub end. The axle shaft is another example of a piece that might be out of the range of extrusion forging, but nevertheless an example of what can be done, because there you have a flange of relatively large diameter and a long shaft of small diameter.

QUESTION: What is the reaction of the workers to these new production machines?

MR. GESCHELIN: Well, I don't believe that their reaction could hold back the introduction of machines. What has happened is this: Every once in a while when a machine is introduced--you may have seen this in the papers; I am not saying anything that is confidential--there have been disputes. Obviously from an engineering standpoint when you buy a new type machine, you buy it only because of economic considerations. You buy it because you can get higher productivity out of it. The amount of effort on the part of the operator usually is less and less with the introduction of these specialized machines, and yet the operator insists and the union insists upon the rates that have been established on that particular operation, regardless of the machine. So if you had a standard, say, of 200 pieces an hour on an older machine, and then you took the old machine out and put in a new one, and the new one is capable of turning out 1,000 pieces an hour, despite the fact that the operator does not contribute any more, the union will still try to hold the output of that machine down to 200 pieces. That has been tried.

On the other hand, new machines are being introduced all the time and I think these things are being ironed out. I believe that one of the reasons it is possible to iron it out today is because the automobile industry has had a constantly increasing curve of production, with the result that the introduction of new equipment has never produced layoffs of working men. I don't know of an instance where introducing new machinery in an automobile plant has made it necessary to lay off people. What has happened is this: They may reduce the number of people in one department, but those people are then shifted over somewhere else, because there has been a tremendous expansion of activity. Of course, if we run into depression conditions at some time, that is another matter. You couldn't help yourself there no matter what kind of equipment you had.

QUESTION: In welding automotive parts, for instance, on your gear rack and your drum in the Dynaflow, will you please tell us what methods you use to check for defects in the weld, such as cracks?

MR. GESCHELIN: They don't. It is purely visual. That is not so important naturally as a pressure vessel, for example. The only function of that weld is to hold the starting ring to the flywheel. The starting ring is used only occasionally when you start the engine. The load is not great. The amount of weld they have in there--probably six to eight inches of weld--has enough shear capacity so that even if it has defective spots, it still wouldn't matter.

QUESTION: What about other welds throughout the body, machine parts and things like that?

MR. GESCHELIN: There is very little welding done except on the body. Of course, on the body you have a tremendous number of welds. I don't believe automobile parts, from the standpoint of economy, can stand very much inspection of the type that you would have in pressure vessels. On naval parts, for example, that type of inspection has been found necessary. What they try to do is control quality, primarily by controlling the work--that is cleanness of the work. Everything is cleaned thoroughly, chemically cleaned--and then by control of the machine itself For example, in this so-called skip welding process there is electronic control of the cycle and the timing of that is very precise. That is about as far as it goes. Then the weld is inspected visually.

QUESTION: On this automatic transfer machine which freezes design, how many operations are those machines good for normally, 100,000, a million, five million, or what? What is the life of the machine?

MR. GESCHELIN: I would say the life of a machine is indefinite. Of course, we have had no experience with one, but you know as well as I do that there are lathes and presses and forging machines being used in industry today that were used before I ever knew anything about automotive plants. There are plenty of machines 20 and 30 years old that are still working. All they need is maintenance. The thing you have to remember is in mass production the controlling element is obsolescence. I don't care how much money Buick or Oldsmobile or Cadillac invest in transfer machines, if a year from now or five years from now they are still in business and they still have demand for their products, and some manufacturer comes along with a better transfer machine, they will throw out what they have and put the other in, provided they can prove it economically sound. That process goes on. A lot of machinery is scrapped, not because it has become ineffective, but simply because of obsolescence. That is the only reason the cost of things has been held the way they have until the present postwar period.

QUESTION: Can you tell us more about this liquid resin they are using in cast molding? Is that from coal, petroleum, cellulose, or some new material?

MR. GESCHELIN: It is not a new material. I have a bulletin here that will give you the picture. That will be a lot simpler. I haven't attempted to go into that.

COMMANDER FAIRCHILD: Would you discuss the Rabinow clutch we read about approximately a year ago, where they use steel filings with a magnetic arrangement. The clutch was developed by the Bureau of Standards.

MR. GESCHELIN: Rabinow, as a matter of fact, is presenting a paper on that right now in Cleveland. It is an SAE transportation meeting and he was called on to present the paper. I should hesitate to venture any opinion for publication. I think it has been given a lot of publicity and all I can say is that it is not a device that has had the benefit of any commercial development whatever. It simply has had a lot of public attention. I don't think I would want to go beyond saying that.

COMMANDER FAIRCHILD: On behalf of the College, I wish to thank you for a very excellent lecture and especially for the question period.

(22 April 1949--750)S.