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THE MACHINE TOOL INDUSTRY

by

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Introduction

We are all familiar with the higher wages, shorter hours and enrichment of every day human life that has resulted from the mechanization of industry. I venture to suggest that the replacement of obsolete machine tools can yield equally fundamental benefits to the armed forces of this country. Mechanical processes depend largely upon creative machines commonly called machine tools. The resume of the background of this industry which will follow is developed as a result of the outline furnished by Colonel Jordan, and touches on those high-lights which seem outstanding and important from your viewpoint.

Delineation of Industry

What is a machine tool? Many have attempted to answer this question and supply a definition, but when we in the industry speak of a machine tool we do not have in mind all metal working equipment but have adopted a definition as follows: "A power driven, complete metal working machine not portable by hand, having one or more tool and work holding devices used for progressively removing metal in the form of chips". That leaves out presses, brakes, metal shears, forging and stamping machines in general, but it does include grinding machines and honing and lapping machines, because they remove metal, although in the form of microscopic chips.

This may not be an exact way of defining a machine tool but it does definitely cover machines made by the members of the National Machine Tool Builders' Association, and eliminates certain types of tools used in metal working shops as a legitimate set-up in the line, as an element in the fabrication of the product manufactured. Obviously then, in our consideration of various characteristics of our industry, we will view it only from the angle of the Machine Tool Builders' Association, and without regard or consideration of those machines which might fall on the border line or debatable as to their classification.

Importance

Machine tools are the master tools of industry, because they are required for the manufacture of the equipment that is used in practically every branch of the American Industrial

structure. In order to make textiles, for instance, you must have textile machinery. This machinery in turn is made on machine tools. Even the processing and packing of foods is carried on by means of equipment manufactured by machine tools. That is why we call them "The Master Tools of Industry". Machine tools are capable not only of making all of the other machines and equipment required in industry, but of reproducing themselves.

Capital Investment

The importance of the industry is out of all proportion to the volume of its business or to its size or the number of men employed. In the long roster of American industries, the machine tool industry is one of the smaller ones. It is however the basic industry on which all the mechanical industries depend. There is invested in the industry about \$125,000,000. and while it is a little hard to speak of a normal output in an industry where demand is either on the way up or the way down most of the time, over very wide ranges there is, as you can see from the chart that accompanies this talk, a normal capacity of probably about \$100,000,000. per year. Our orders in 1936 amounted to \$140,000,000. The capacity of the industry is not a fixed and definite amount to be precisely stated, but is elastic, as under pressure we can work longer hours and are constantly engaged, when business conditions permit, in the training and development of additional mechanics. Roughly speaking, we may say that the cost of the machine tool is about one-third labor, one-third materials, and one-third for the other costs that enter into manufacture. The highest employment of which we have a record was about 53,000 men in 1919, but we are probably employing about 50,000 men today.

There are about 250 companies making machine tools, but the distinctively machine tool-building companies number about 150. The others are in the main companies which make tools as a side-line; engineering concerns, foundries and machine shops that may make a little vertical drill press of the bench type, or a small lathe, or other type of metal working machine that is sometimes purchased for home use. They are of course machine tool builders, but machine tool building is not their primary business. For all practical purposes you may consider that there are 150 to 160 machine tool plants primarily devoted to that work. The average company is relatively small, involving the investment of about \$800,000. Some of them of course are very large, employing as many as

5,000 men, and the investment amounts to eight or ten million, and some of them at the other extreme only employ eight or ten men. The typical machine tool company employs around 200 to 250 men. Most of them are owner-managed; that is, owned by one man or by a small group of men who have been brought up in the business. They have spent their lives in it, and any one of them is quite familiar with the varied problems of their business, whether it be purchasing, sales, design or management. We have a number of plants which are now being operated by the third and fourth generation of the founder's family.

The organization of a typical unit would resolve itself into four distinct branches: managerial or administrative, engineering and development, selling and distribution, manufacture or production. Whether the unit be large or small it is fairly safe to assume that these four functions would be a definite part of their set up, modified only as to the special division of the four principal functions, and varying only with respect to the elaborateness or simplicity with which it is carried on.

To illustrate: In selling certain types of firms might subdivide their selling into direct selling with sales offices and warehouses, and a corps of trained salesmen dealing directly between the consumer and the factory; sales engineering - to determine the application of the product to the customers' needs; sales research - to determine the possible markets; advertising - direct, indirect and national; statistical and routine, covering the clerical, order editing, follow up, etc.; or a more simple method of distribution might be employed wherein agents or dealers sell through their staff the machines manufactured by a group of non-competing concerns.

If I may add one more word as to the economic importance of the industry, it is more in relation to the length of time that machine tools are in effective use in the production and flow of goods than to the amount invested or the people employed. Economists generally state that the machine tool industry's relative importance is equivalent to about ten or fifteen times the normal size of its sales, because machine tools remain in effective use about that length of time.

Accordingly size alone is not a determining factor with respect to the economic importance of the industry, but

rather because it is viewed as a basic industry. Machine tools are creative machines. They are machines which produce machines, and without them we could hardly as a nation enjoy the luxuries or necessities of life. Man has taken advantage of the opportunity to convert energy through machinery into useful things for the comfort of mankind.

It is hardly necessary for me to point out to you the extreme importance of the machine tool industry in time of national emergency. As soon as we start to assemble an army we must clothe these men, and this throws an additional burden on textile mills and clothing factories. When they need additional equipment it must be manufactured on machine tools. Modern war depends more and more on the products of the machine, in equipment, munitions and transport, and more and more the tendency is to work to extremely close limits of accuracy which not only involves the use of machine tools but of modern machine tools. It would be extremely difficult, if not impossible, to secure the necessary accuracies in production quantities on machines that have been in use for ten or fifteen years. In the first place, they were not built to manufacture to modern standards, and there has been a tremendous improvement in that regard in the last few years; in the second place, while they may still be in operating condition, wear would naturally affect the accuracy of their output.

What is more important the development of the machine tool of modern design has eliminated in a large degree the manual effort required by the introduction of convenience in control and operation, and by lessening the skill required in operation, which insures a repetition in production of parts made to more accurate limits, and with greater ease than was possible ten or fifteen years ago. Under these circumstances machines produce larger quantities of more accurate work and it has become a real pleasure and convenience to operate them.

Distribution of Plants. Chart 1.

Practically all machine tool manufacture is confined within the northeast section of the country. The business started in New England something over a century ago and as the need for machine tools spread to the west the industry branched out. A group of manufacturers started in Cincinnati before the Civil War, and that is now one of the principal

centers. We consider, for our purpose in describing the location of machine tool builders, the New England territory as a whole. Plants are scattered throughout New England in Massachusetts, Rhode Island, Connecticut and Vermont. Then we come west to two great centers in Cincinnati and Cleveland, and ⁱⁿ the last half century a great number have come into existence around Rockford, Illinois. We consider Milwaukee and Chicago as a part of the Rockford District. There are one or two smaller manufacturers on the West Coast, but generally speaking the whole line of manufacture is in the great northeast industrial area.

.It is quite evident that machine tool plants have been located in their consuming market. They started in New England because at that time practically all metal working was carried on in New England, and the rest of the country was mainly agricultural. The industry has spread west as manufacture has spread. The plants are for the most part relatively near to their users from the standpoint of sales and service. While some of them are located in small cities, there is a tendency to concentrate in the larger cities, such as Cincinnati, Cleveland, Worcester, Hartford and Rockford, where a very substantial population of skilled mechanics has been built up over the years. There is no great difference in cost between the small communities and the large. The manufacturer in the small community is less likely to lose his men to other manufacturers in the same line, but has a corresponding handicap when it is necessary for him to increase his force, as he must bring trained men from other cities to develop them in his own shop. As it is extremely difficult to find, in any other type of metal working plant, men of the required degree of skill, it has become a tradition in the machine tool industry to develop our own men from apprentices, or from so-called learners. Learners do not go through an apprenticeship course and are usually older. They are given specialized training in operating a certain type of machine tool.

The development of specialists and skilled men for our industry is important in perpetuating the skill required to produce machines which in themselves must reproduce their own accuracy. Consequently it is desirable to emphasize the necessity for the development of our own men through apprenticeship training courses. These courses may take the form of the typical, old-fashioned procedure of apprenticing a young man to some line of trade, or expanded to an actual school of apprenticeship training, where the entire business of that

manufacturer is taught to a group of young men. It may take the form of the vestibule type of apprenticeship training or the specialist type, where the fundamentals of a specific operation or machine or job are taught, together with the related technical principles of the machine or job. There are probably 2000 or 2500 young men in training today in the shops of our members.

Tariff

The Tariff has been a factor in our growth, but not to a great extent. Formerly there was a thirty-five per cent tariff on imports of machine tools; this was dropped to twenty-five per cent for a few years and was then brought back to thirty per cent. The tariff has afforded some protection, but the growth of the American machine tool industry as compared to that of other countries is more largely due, I believe, to the greater expanse of country, the greater necessity for mechanization, and the wealth of our raw materials. The tendency toward the mass production of goods has been responsible for the development of the machine tool industry in the United States far ahead of foreign countries. The foreign countries are making an effort to cut down that differential now and they are making quite a job of it. In some cases they duplicate our equipment so successfully that if one should not happen to see the name-plate he might think it one of our own.

Still the same degree of accuracy, refinement and excellence of design are not yet carried out in machines of foreign manufacture, even though they be copies of our machines. Nevertheless it is only fair to say that the gap now existing is narrowing as time goes on, and foreign made machines are becoming better and better, and approach more nearly the quality and design of American made tools.

Relations with Federal, State and Municipal Governments

Excepting for their use in manual training schools, the machine tool industry does not come into contact with state and municipal governments excepting when, as corporations, we pay taxes to them. Our relations with the Federal Government largely hinge on the national defense.

Governmental bodies have not recognized the real value to the community, to the state and to the country, in development of branches of education and training which

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present to the boy and girl the opportunity to learn a trade, and thereby supply industry with the source from which it may obtain partly trained workers. As a result it has become necessary for the machine tool industry to provide this training. In the high schools manual training should be emphasized more than it has, and adequate facilities established in the way of equipment, so that those who elect may avail themselves of such training. Trade and continuation schools should be fostered, and funds maintained by the state or municipal government to carry on such work. The few trade schools that now exist in centers where our industry flourishes are inadequate from both the viewpoint of insuring facilities to those who wish to go to trade school, and also to supply industry with a sufficient number of those who graduate from the trade schools.

In times of a national emergency, a serious difficulty may result from under-manning our factories in order to ensure man power in our fighting forces. During the World War the draft compelled many young men qualified to work in our plants to take their places in the firing line.

For example: In the Fall of 1918 an Arsenal was unable to find a sufficient number of mechanically trained men to operate their gun manufacturing and other plants. It became necessary to select several hundred young men from army training camps and send them to the Arsenal. They actually worked there in their training camp uniforms.

Nature of Items Made

As you know, there are five arts of machining metal: milling, turning, boring or drilling, planing or shaping, and grinding. These rough classifications, however, do not tell the entire story, as there are many subdivisions of each classification. While they all come under some one of the general categories, the sub-classes extend down pretty far. We have gotten out a little book, giving the types of machines manufactured by all the people in our organization, and I have arranged to leave a copy for the record. More are available for those who can use them.

The next question has to do with bulk in our industry. As you know, we have machine tools that range all the way from the size that could be set up on this reading table to those requiring space as large as this room. There

is nothing perishable about a machine tool except that it grows obsolete and eventually wears out. "Wear out" is scarcely the proper term; it would be better to say that machine tools gradually lose their accuracy under hard usage. Still the greatest factor is obsolescence - a problem of particular importance to you. You are probably familiar with the study of obsolescence in the American metal working industry made by the "American Machinist" in 1935. This shows that 65 per cent of the machine tools in use in this country are more than ten years old.

A recent study made by our Association office indicates this percentage has not been appreciably reduced since 1935. The period of time that a certain design of machine tool remains as standard is approximately seven years. This varies a great deal, of course, but if a production machine has been in use for more than seven years it is a pretty safe guess that a better machine has been developed and introduced on the market to do that type of work. It is hardly necessary for me to point out that the average age of machine tools in use in Government arsenals, shops and yards, is a great deal longer than ten years, and that the percentage of obsolescence in the Government establishments is very much higher than 65 per cent. This, as I see it, is the extremely serious problem that rests in your hands and for which some solution must be found, unless we are deliberately to take serious risk by neglecting a link of critical importance in our national defense.

A great national emergency immediately throws a strain on the industrial system of the country. Increased production of food, of clothing, of equipment, of machinery and of munitions of war and methods of transportation; must be met and met quickly. When the World War began we were not engaged in it at first, and we were called upon to furnish the Allies in ever-increasing measure, so that our productive equipment was gradually expanded during those first years, and when this country entered the war we were at least partially prepared to equip and maintain our own forces. It is hardly necessary for me to point out that despite this period of preparation it took quite a long time for us to meet the requirements of the situation fully, and on many important items we had hardly gotten into production when the war ceased. It is by no means wise to assure that we will have this preliminary period of preparation if

another war should occur. The question of priority in the manufacture of machine tools is then immediately of extreme importance. Ours is not an industry, elastic though its capacity may be, which can double its output when the need arises, because we must have a certain type of skilled man, and we must have accurate machine tools upon which to do our work. In proportion to the number of men employed in our industry we buy more machine tools than any other industry in the United States. We do this not for sentimental reasons but because we appreciate the importance of modern, accurate tools in doing our work. It would be impossible, in case of national emergency, for the machine tool industry suddenly to replace the obsolete equipment in government establishments, and at the same time meet its own additional requirements of the many other industries whose output would have to be substantially increased without delay.

There is the further consideration that workmen in government establishments would have to go through a preliminary period of training before they learned how to handle these new machine tools to the best advantage; that is your problem and you are familiar with it. It does, however, aggravate a situation already sufficiently difficult. You will find the supply of trained mechanics extremely limited, and if you call upon us to furnish them we will merely be robbing Peter to pay Paul.

Patents and Brand Names

Trade names and patents are not so important in our industry. Firm names mean a great deal more to those of you who have ever had anything to do with things mechanical. There are a hundred or more firm names that are synonymous with and identify a brand name which represents a high standard of product. I know of no other line of business in which the manufacturer takes so much pride in his firm or is so anxious that every piece he sends out under his trade name be up to his standard. There are, of course, a number of manufacturers of each type of machine tool who do not intend or pretend to turn out the highest quality or the best, because there are places for many different grades and qualities, but for the industry as a whole every concern is most particular that its customers may be assured of getting the quality in each machine that their trade name represents.

Research, Development and Improvement

This process is going on in every machine tool plant all of the time, but it is usually retarded when we are extremely busy. The same engineers who design our machines are busy at that time in the development of the special attachments and tools required for application to their standard machines for special lines of work. New ideas are suggested and new requirements present themselves but are put aside until business falls off. In times of depression then, the industry devotes itself to a redesign of machines and to improvement in manufacturing equipment. Due to the extreme fluctuation in the load thrown on our industry, and because of the constant development of new machines, this is a point of importance which I should like to stress. If the machine tool builder is to survive the depression at all, he must have cash reserves, and these must be accumulated during periods of good business. The margin of profit in our industry over a period of years is extremely limited.

Examination into the history of our industry will reveal the fact that we travel pretty much in ten year cycles, and these cycles are divided into four periods. The first period of three years is the rise from depression to what you might call good business. Then there will be a period of about three years of good business, and a decline from this for three more years to the depression area, with one year of practically no business. So that our industry in three years of good business should protect itself against the other seven years of indifferent and poor business. A better term might be three years of profit-making business and seven years of non-profitable business.

Not only must we hold together a nucleus of the trained men who have been developed, we must also in times of depression expend substantial funds in the development and design of new machines and experimentation and research in the manufacture of patterns, jigs and fixtures so that as business starts to come back we will offer better tools, in order to stimulate the recovery and to maintain our place in industry. The new tax on undistributed surplus therefore represents an extremely serious handicap to the machine tool industry. Large companies, with already accumulated substantial cash reserves, and especially those engaged in manufacturing consumer goods, who do not have this violent fluctuation, may face the requirements of this tax with less concern. But to many a machine tool builder of relatively small size, it is a serious handicap which may lead to disaster when the next depression comes.

Style Influence

Practically speaking, style in machine tools does not play as important a part as it does in many other lines. For example: automobiles, boats, radios and so on. Recently there has been a trend in the direction of what one might call style-consciousness, and some firms have even stream-lined their machines, developed modernistic exterior construction and so on. Of course firms have leaned a bit on the side of simplification of lines, smoothing up flat and unbroken surfaces, making nice round corners and introducing an attempt at gracefulness of line. This is of a practical nature rather than with any idea of developing a pleasing appearance. Since smoothed lines provide ease in keeping the machine clean, rounded corners prevent accidents, and it also facilitates and simplifies foundry practice. You will also find machines tending to the use of chrome plating on handles, handwheels, etc. but here again this is for a practical purpose rather than any style tendency, inasmuch as it provides against rust in those elements of the machine which are handled.

In the matter of painting much time has been given to the selection of a color that will not show oil in the factory, the material from which it is made would not be affected by the cutting compounds used, and which would be pleasing in appearance. As a result we have standardized upon "machine tool gray" which is used by all members of our Association. Occasionally we find a customer who insists upon some special color to fit in with the paint scheme that has been adopted in his factory, but these cases are infrequent.

Standardization and Simplification

There has been a constant tendency toward the standardization of tools and attachments, spindle noses, chucks, etc. and this process is still going on; it makes for economy for our customers who do not have to carry so varied a line of tooling and attachments in stock. It greatly simplifies the problem of the purchasing agent. The machines themselves, of course, can hardly be standardized, lest we discourage development. Simplification has been an outstanding trend in our industry during the last few years, but by that I mean a trend to simplify the operation of the machine, to make it easier and more

convenient for the operator, and to make it possible for the employer to use less skilled men in the operation of machine tools, while securing greater production and a higher degree of accuracy. This means, of course, that we must build more skill into our machines, and to that extent the machines themselves have become more complex and more expensive to build.

This trend in development is really what has been responsible for the introduction of hydraulically operated machinery. I think it can be safely stated that there is no real advantage in hydraulically operated machines as compared with mechanical or electrically operated machines. Sometimes you hear hydraulically operated machines referred to as a fad. This is a misnomer. Hydraulics have entered into our design because of the demand of users who require us to furnish machines that will function in certain definite ways, and machines that have built into them the skill formerly exerted by the operator himself. In order to accomplish this result, which means interlocking of various mechanisms, and timing of certain sequences in the control of the machine, it was found necessary to provide some form of power which could be conveniently transferred from place to place without the complication of levers, shafts, gears and so on.

Raw and Contributory Materials Required

All of these are available in this country, and I may say in passing that one of our advantages over foreign competition is both in the quality of the raw materials and the high degree of uniformity of products that have been developed by American industry. Interference with the supply of tungsten from China, however, would seriously handicap us. This element is used as an alloy in steels employed in cutting tools. It tends, as you know, to increase the hardness of the steel at high temperatures. In regard to cutting tools, I would like to point out that although many American plants have spent a great deal of time and money in experimentation, our industries are not using cemented tungsten carbide cutting tools to anything like the extent they are being used in European shops. The price of these tools is very high. They are covered by patents, which makes their manufacture a monopoly.

We are variously informed that the quality of such tools available in this country is not as good as in those made abroad, but this has been denied by those who should know. It is stated that since manufacture abroad is in smaller quantities and on simple, single purpose machines, they do not object to replacing a tool there after an hour's run, where we subject it to harder usage and expect it to run through an eight hour shift without attention. Whatever the facts may be, may I suggest that it would be a valuable field for Governmental investigation. If materially greater production is being secured abroad by the use of these cutting metals, it is a matter of the utmost importance to you.

Seasonal Factors

In general this presents no unusual problem except indirectly as related to the problems of serving different sections of our great country over a span of 3000 miles long and 1500 miles wide. Geographic centers where large mills and completely equipped plants now exist, together with the trained and skilled mechanics to operate them, must be interconnected and served with ample transportation means. Movement to ultimate location is an element of cost, and facilities for handling our products must be made available. Railroads have recognized this to some extent by the introduction of sectional rates. In a national emergency railroad facilities must be ample to provide and maintain the necessary rolling stock. This appears to me to be a major problem.

I would like to recommend that in your studies and plans in connection with the manufacture of materials needed in a national emergency, consideration be given to the transportation facilities for getting raw materials to the plants, and the completed products to their ultimate destination. I may add that our merchant marine is in even worse condition, and you are undoubtedly familiar with that problem and of the steps that are being taken to cope with it.

Price Stability

Prices of machine tools do not change frequently or over a very wide range. The greatest single influence on our prices is the cost of labor and, of course, when that goes up the price of the finished machine must go up as well. It has long been a tradition in the machine tool industry that we should keep our prices as low as we possibly can in order to widen our markets and thereby manufacture in larger quantities.

Our industry has always stood for a one-price policy, that is to say, one-price without quantity discount and without change in price for any reason whatsoever. The necessity for keeping the price at the lowest possible level has emphasized the necessity for such a policy. Consequently our industry enjoys the distinction of furnishing the means by which marvelous mechanical devices are created for our comfort and for our needs, and at an average profit on the invested capital scarcely equal to bank interest.

Monopoly Control

With the exception of a few types of machine tools which are patented, there is no monopoly in the machine tool industry. There is a trend in our industry for each company to develop one type of machine tool or a limited number of types to an extremely high degree of perfection, but not to attempt to supply all kinds of machine tools. Fifty or sixty years ago, every machine tool builder built any type of machine tool that you wanted to buy, but a company who tried to do that today would find in every division of the field a group of specialized competitors, and could not hope to compete successfully in the face of constant changes and improvements. The trend is toward specialization, but not towards monopoly.

The industry has trained a tremendous number of men for other industries. If you were to go through the great automobile plants and refrigerator plants, and all the newly developed mechanized plants you would find a surprising number of executives, engineers and mechanics who got their start in the machine tool business. The industry requires a bent for development and pioneering that appeals to certain types of engineers, and usually such men are not particularly interested in building great monopolies.

Competitive Assets

Competition in the machine tool industry is very keen. Purchasing is usually based on convenience of operation of the machine tool, the accuracy to be secured, and the increase in production that the machine tool will give. Price is secondary in most transactions; it should be in Government buying.

Production Processes

Larger castings come from the foundry in relatively small lots. Only in manufacture of small elements do we get anything like quantity production - on gears, pins, cap

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screws, etc. To as great an extent as possible, elements of the machine are made interchangeable over an entire line. Thus, one head-stock will serve for lathes of various lengths, may even be employed on two sizes (of swing). A hydraulic feed system might be employed on each of several sizes as well as several types of grinders, etc. Wherever possible, small parts are first made for stock in quantity, drawn out for assembly into sub-assemblies, and these again are drawn out for main assembly as fast as the base or bed of the machine comes to the assembly floor. Extensive use of gages, jigs and fixtures affords interchangeability of parts. Every operation is inspected in order to catch error at its source and to avoid further work on spoiled parts.

Although machine tools are usually bought singly, our customers get the advantage of quantity production and continuous manufacture insofar as we can give it to them. But in the last analysis our business might be called a tailor-made or custom-made business. Many manufacturers have gone as far as is possible in building up the various types of machines demanded by our customers in the unit type of construction. Mass production, therefore, is not known in the machine tool industry. Because of the many ramifications of types and sizes, service and demonstrations have always played an important part in our sales programs.

Special machines, departures from normal commercial standards, and unusual specifications seriously interfere with normal manufacturing processes and mean confusion in the engineering department. The manufacture of single pieces, or even small lots, complicates production control and makes it more difficult for our men to earn a wage incentive because the job is unusual and slows up production. It is imperative that government plans be based on using our commercial standards. There will be no time to produce special machine tools in an emergency.

Predominating Machine Types

As the major castings come through the shop we see planers, planer type milling machines, horizontal boring, drilling and milling machines, radial drills, boring mills and large grinders. The smaller parts require just about every type of machine tool made. It is interesting to note that machine tools are required to reproduce themselves - machine tools are made with machine tools.

Adaptability to Change

The machine tool industry can do practically any job in iron, steel or other metal for which their varied equipment is usable. This applies particularly and especially to those operations which require a high degree of accuracy. For instance: a machine tool plant may be producing lathes, but it could build hydraulic presses if it were necessary to do so. Still the most effective use of any given machine tool concern is in the manufacture of its own type of machines. This is due primarily to the skill acquired by the organization through years of actual experience. It applies equally to management, engineering, selling and manufacturing. This peculiar training cannot be expected to produce equally good results in some other line of endeavor.

Power Requirements

These are not particularly large. There seems to be ample capacity in all of our industrial centers to meet the requirements of the machine tool plants.

Patent and License Control

Since machine tool builders buy machine tools and are therefore each others customers, the atmosphere in the industry is very friendly and cooperative, and this is true even among competitors. Consequently, so far as the Army and Navy is concerned, there would not be the slightest difficulty in working out any conflict that might arise. Machine tool builders are not given to litigation or bickering. Their relations are such that the N.M.T.B.A. is looked upon as one of the finest trade associations in the U.S.

Seasonal and Cyclical Characteristics

In 1933 the Army and Navy helped our industry by placing orders for about five and one-half million dollars worth of machinery - a big help to the manufacturers, coming as it did in a period when there was so little other business available. It would be planning of a very enlightened kind if Government were to engage in an extensive program of replacing obsolete machine tools during a business depression. The funds expended would keep intact the highly trained personnel in the machine tool plants, and the money paid would be spent for consumers goods by these workers. There would

be ample time to give proper attention to each project in our engineering departments. It would also be very helpful for us to know how much money the Government is spending for machine tools year by year. The only figures we have are issued by the Department of Labor and embrace those contracts which amount to \$10,000. or over. These figures are, of course, not complete.

Labor

It is estimated that about two-thirds of the men in a machine tool plant must be skilled men, with one-fourth of these skilled men highly skilled. That is due to the fact that the operation of a machine tool requires training and skill; the tooling up of a machine and such operations as the manufacture of tools, gages and fixtures, also the inspection of parts, testing and demonstrating, are even more exacting operations. During the depression our industry simply could not afford to keep all the good men they would like to have in their organization. A machinist or a high-grade mechanic is not the type of man to dawdle; when his class of employment is closed to him he seeks other fields.

When business improved we made a study in which we asked two typical plants in different sections of the country to analyze their 1929 payroll and ascertain what each man was doing. They discovered that during four years between thirty and thirty-five men out of a hundred had been lost to the industry, most of them permanently. Some of these mechanics had opened garages of their own and were doing well. Others had gone into businesses, widely different from the machine tool industry and were making good. We found them on milk wagons making more money than our people could afford to pay them. They said they did not have the responsibility - deliver a bottle of milk and the job is all done, but make a mistake in machining a part and the responsibility has just started. Some were induced to return to their jobs, so that at the beginning of 1935 the industry had lost about twenty-five per cent of the men employed in 1929. As you can well understand, there were few apprentices trained during the depression.

Difficulties were encountered when we started on the upgrade again in 1933. Men who in 1930 were proficient and capable came back to work after two or more years elsewhere,

almost afraid of the machines they were operating. They were nervous; their eyes had changed; they had lost their touch and skill which must again be developed and reacquired.

Some of our wiser manufacturers recognized that and set up separate departments for the rehabilitation of those men who had been out, putting in charge a patient foreman who got them back on their feet again.

All of our people who had conducted apprentice schools have now reopened them. A good many college and high school men who came out during the years of '29 to '33 and been unable to get satisfactory work, liked the idea of taking up apprentice work, and those young men seem to be going through with more speed. The boy who has taken his father's automobile apart and put it together again has some mechanical ideas, and many of our people report those particular young men are becoming proficient much more rapidly than in the past.

Some of our people have splendid apprentice courses. One of our manufacturers mentioned the other day the whereabouts of some of his former apprentices. I am sorry I do not have the figures, but there were represented some presidents of companies, more vice-presidents, and a number of chief engineers and general superintendents.

Wages - Regional Differentials

Practically speaking, the entire industry is in one industrial region. In general wage rates are lower in the smaller cities where living costs are lower, but the variation is not great and tends to grow less and less as time goes on.

Rates of Turnover

Relatively these rates are very low. You see in plants averaging 200 to 250 men, the management and men become very closely associated on account of the nature of their work. A survey of members in the older and more important plants would indicate that 25% of the men had been with the company 5 years or more, 10% 10 years or more, and so on, up to firms who have men employed 25 years or more in large numbers. It is necessary for management to keep track of the work and see what goes through. It is not an unusual case at all to see the president of one of our companies beside a mechanic examining some part or listening to suggestions. There is

that close relationship that is good in any business and serves to help keep down turnover.

In most machine tool plants members of the sales and engineering departments have either developed from the shop or had extensive training courses in the shop, and this brings a mutual understanding and respect throughout the entire personnel.

Working and Living Conditions

The typical machine tool plant is clean and neat, perhaps because the kind of men who do accurate work are by nature orderly in their habits. It is well lighted; it has to be, to work to extreme limits of accuracy. Because of the type of workmen employed, working conditions are as good as you will find in any industry in this country.

The machine tool mechanic is not of a roving disposition. Many plants have fostered housing plans and practically all the good workmen own their own homes and live in communities together where they take pride in good citizenship. They are a high calibre, high type of individual who enjoy the better things of life and indulge in good, wholesome recreation. Most companies foster club life among the workmen, athletic sports, outings and things of this nature.

Markets and Marketing

It is fitting to begin our discussion of markets with a look at the chart of orders. The shaded area represents domestic sales; the light section, foreign sales. Over the years about twenty to twenty-five per cent of the total sales are for foreign destinations.

The customers of the industry are all the metal working shops, including a miscellaneous category of industries, as you well know. Our marketing is carried on in two principal ways. There are what we call "dealer sellers" and "direct sellers". In many cases the same manufacturer will sell direct in one district and sell through dealers in other districts. Originally the selling was largely dealer selling. That was when the machine tools were simpler, and customers' requirements were less complex. Now that the machines have been more highly developed, more engineering selling has been called for, and there is a greater amount of direct selling, although there is still a very substantial amount of business done by dealers.

Both the salesmen employed by the manufacturer and those employed by the dealer quite generally are themselves trained mechanics who started their careers in the shop, went through an apprenticeship system, became demonstrators and subsequently became salesmen. They are therefore unusually well informed as salesmen go.

There is not much demand for installment selling. Our customers do not like long time accounts. It is not unusual for a purchaser of machine tools to get two or three months' credit either from the dealer or the manufacturer, but there has been relatively little of what we know as "time sales" - sales with monthly payments over two, three, four or five years.

Price Policies - Effect on Demand

Most machine tools are purchased on an investment basis. When the customer has work to do and finds that he can secure a very high return on investment in new machine tools, he comes into the market. Most of them expect new machine tools to pay for themselves in from one to four years, and many machine tools pay for themselves in less time in the savings they make possible. It is theoretically possible for a machine tool builder so to increase his price as to make it impossible for the customer to show a profit, thereby retarding the sale of machine tools, but the policy of the industry has always been conservative, and there has been no experimenting in that direction. On the other hand, a drop in price does not stimulate sales. When business is not good, no matter how cheap the machine tool is the customer will not buy it. The machine tool is a capital investment, and when business goes down people do not invest their money in capital investments; they keep their dollars in the bank.

Financial Structure

What has occurred to the financial structure of the industry during the depression is well illustrated by a study of 16 companies, representing a fair cross section of the industry. From 1929 to 1935 there was a shrinkage of 44 per cent of the capital surplus of these companies. That is what the depression did to this particular industry. I have already touched upon the effect of the tax on undistributed surplus. We have no figures as of today but it can be safely

said, without fear of contradiction, that it has been an extremely difficult matter to replace these depreciated assets, and very little progress in that direction has been made by most of our companies.

Some time ago the Roberts Morris Association studied the profits and losses of the industry based on net worth, and they found that for the 14 years from 1919 to 1932 inclusive the average earnings were 5.8 per cent. As a matter of fact, if our companies paid the dividends the investments should earn, they could not lay aside the funds necessary for the development and research required to keep abreast of the market. The small average earnings show that the men in our industry are interested in high achievement rather than in high earnings.

Railroad Repair Shops

I want to make one point I think tremendously important before I close, and that has to do with the railroad repair shops. The "American Machinist" study shows that railroad repair shops have the highest percentage of obsolete equipment. In an emergency the railroads would be called upon to take up the load almost immediately in the transportation of men and materials. As they are equipped today they could not begin to cope with the transportation problems that would develop. The railroad shops may be looked upon as the bottleneck in an emergency. I do not think we can afford to overlook their condition, because if locomotives and cars are not available in sufficient quantity and in good repair to furnish transportation, whatever the industrial plants can turn out will not mean a great deal.

Our industry made a survey of the requirements of the typical repair shop about three years ago, and that study was the subject of the last report made by Coordinator Eastman before he closed his office.

In summary, may I comment directly on four points which Col. Jordan has drawn to our attention:

- (1) The advisability of procuring simple single purpose machines rather than general purpose machines. In all probability you will have definite ideas of the quantity required of each item to be made on machine tools. The next

step is to lay out the machines required to supply these items at the required rate. One complete unit at least should then be installed and operated in some government establishment to check on this part of your plan. The question as to whether you buy a single purpose or general purpose machine will almost be answered automatically - your primary problem is maximum production with minimum direct labor; and do not forget that skilled men are scarce in war time. Operations must be simplified so semi-skilled men or machine operators can do the work. But let me say again: avoid unnecessary departures from commercial standards.

(2) Due to the accuracy required it is difficult, if not almost impossible, to adapt facilities to the manufacture of machine tools not ordinarily used for that purpose. It is my opinion that an emergency will overload all our facilities for metal-working in every field. Some machine tool builders had subassemblies and parts manufactured in outside plants during the war and experienced considerable grief in getting satisfactory results. This does not seem a practical procedure.

(3) Drastic restriction of procurement of any machine tools other than standard machines without gadgets. Gentlemen, there is such a wide variety of machines available today that with tooling and attachments properly designed we can meet most of your needs without designing any special machines. Frankly, we find your engineers trying to redesign our machines when you buy them, specifying how large shafts must be, of what material, and what kind of bearings to use. I do not infer for a moment that your ideas are unsound, but you simply will not have time to buy this way in case of war, and we will not have time to read these specifications, to say nothing of trying to meet them. Tell us what you want to do and let us tell you what we know you should use to get results. Hold us responsible for the consequences. That is what American industry does when it buys machine tools. It seems to work.

(4) Lack of skilled machinists for the manufacture of machine tools and lack of skilled operators to operate those tools. Performance counts. Our school system is still turning out thousands of boys and men every year with a type of educational training for which there is no market. They must be re-educated before industry can absorb them. Hardly did industry start upwards out of the depression before there was a shortage of skilled men. We have that shortage now in almost

every field of industry - right alongside of unemployment, probably affecting millions of people. The far-sighted training and use of man power is the greatest problem before the nation today.

Association Activity

Our Association is an active, fact-finding organization. We promote a machine tool show where our members display their new machines at intervals of from four to six years. We have a fine statistical and forecasting division where sales research, publicity and promotional work is carried on for the machine tool industry. At Cleveland, Ohio we have comfortable, adequate quarters, and a capable and well-manned organization of experts in Association work. We have innumerable records as well as a history of the industry. During the N.R.A. regime our Association office carried on this work smoothly and effectively.

The membership record of the National Machine Tool Builders' Association for the past ten years gives striking evidence of the stability and activity of the machine tool industry in the United States.

90 firms who represent the backbone of the industry were members in 1927 and are members in 1937.

31 members of 1927 have dropped out. Most of these were not rightfully classified as machine tool builders, being manufacturers of floor stands, tool post grinders and similar products, and no effort has been made to have them retain their membership. In the same 10 years, 47 new members have been added.

This number includes firms who have been machine tool builders for many years, and also many who have been engaged in the making of machine tools within 10 years.

We have regular meetings with committees on legislation, relations with dealers, cost elements, cooperation with government departments, fostering of apprenticeship work, publicity, sales work and standardization work. These are our active working committees. The officers and Board of Directors meet regularly. We have two conventions per year, six months apart, which are always well attended by practically a full membership.

RECOMMENDATIONS

I would like to make some constructive suggestions for your consideration.

1. In a national emergency transportation will be a very important part of our national defense. Railroads should be encouraged to recognize the importance of the movement of machine tools to points of designation, and facilities provided to equalize the delivery costs. They should be encouraged to modernize equipment in railroad shops which today is inadequate and antiquated.

2. In the selection of machine equipment for use in arsenal field base or factory, skilled engineers selected from the machine tool industry should form a Planning Board, under Government supervision of course, to aid in the selection of the proper equipment for the job.

3. All articles to be manufactured should be planned with the same degree of attention as a factory which must show a profit; each operation laid out, with the very best tools, jigs, fixtures and machines provided for that operation which, of course, is dependent upon quantities to be produced and accuracy desired.

4. Specifications covering the purchase of equipment should be so simplified as to allow for the selection of the best machine for the job. (My own personal experience with government specifications is that they are much too complicated and in too much detail.) It matters little whether a particular shaft in a machine is $1\frac{3}{4}$ " diameter or $1\frac{7}{10}$ " diameter. Again, it matters little whether some unimportant part is made of 30 point carbon steel or 40 point carbon steel. Just because some specification sheet, written by some advertising manager, happened to dwell on that feature of design, doesn't necessarily make it an engineering requirement. Too often we find specifications written around some machine manufactured by one particular concern, with no particular reason for it. As pointed out in my previous remarks, each firm takes a pride in maintaining its own principles of design, its own ideas, and relies on this to meet competition. Differences in detail will exist in comparable but competitive machines made by different manufacturers. Restricted specifications on bids requested may prohibit all but one manufacturer from

even entering a bid.

5. Skilled man power in factories is just as vital in a national emergency as trained and skilled soldiers in the battlefields. Attention should be given to the fostering of those facilities which will develop such skilled labor as will provide an adequate supply when the time comes to meet this emergency. By this is meant more emphasis on manual training in our high schools, more, larger and better trade schools located geographically where the demand for skilled mechanics exist, and funds with which to carry them on.

6. Use the facilities of the National Machine Tool Builders' Association in whatever manner such facilities can be of benefit to you.