MACHINE TOOLS

Lecture by
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INTRODUCTION

For the purpose of this study a machine tool is defined as a power driven machine for cutting, stamping or shaping metal, except rolling mill equipment.

The machine tool problem is quite different from many of the other problems in which The Assistant Secretary of War's Office is concerned. In this discussion I will endeavor to point out our method of attacking the machine tool problem, some of the difficulties encountered; and our progress towards its solution.

The Assistant Secretary's Office in undertaking the machine tool problem started with a study of what was done in this connection during the World War. I will first briefly review the war experience of our Government in obtaining machine tools to carry out our munitions program.

Resume of the World War Machine Tool Problem.

When the United States entered the War we had little knowledge of what our requirements for machine tools would be and furthermore we were not familiar with the machine tool capacity of the country. It was evident that machine tools would be required in large quantities before quantity production of munitions could be attained. The

Machine Tool Section of The War Industries Board attacked the problem by obtaining a prohibition against the exportation of machine tools after July 1, 1917. Approximately 6,000 machine tools were located for Government use by obtaining from manufacturers and warehousing companies inventories of machine tools which were on hand and destined for export after that date. This step was followed by a capacity survey being made of the machine tool facilities of the country and concurrently information was obtained from manufacturers relative to the heavier types of machine tools which they had manufactured and sold during the past ten or fifteen years with the names of purchasers. A large number of heavy machine tools, of which there was a serious shortage, were thus obtained for Government work. In a few cases nonessential facilities were converted to manufacture heavy duty machine tools. Existing machine tool facilities were expanded but very few new facilities were built. Production was speeded up by getting manufacturers to cut down the number of lines of machine tools. Some difficulty was encountered in obtaining heavy duty machines on schedule due to the manufacturers of varied lines concentrating on small or medium sized machine tools in order to compete on deliveries with the companies which manufactured only the smaller or medium types, which resulted in delayed deliveries of the much needed heavy types of machines. This condition was much improved during the latter period of the War. The chief difficulty in producing machine tools was labor shortage. From sixty to seventy per cent of the machine tool facilities reported trouble from this source. To alle-

concerning prices were accumulated and published which had a tendency to control prices. Few prices of machine tools, at the time of the Armistice had advanced over the prices of 1917. The status of production and capacities of facilities including monthly reports concerning items affecting production, as, labor, power, raw materials, transportation, etc., were obtained from the Machine Tool Builders.

At the beginning of the World War there were approximately three hundred facilities engaged, either entirely, or partially in the manufacture of machine tools. During 1915 and 1916 the Allies orders absorbed nearly the entire capacity of this country for medium sized machine tools. During 1918 it is estimated that the total product was increased to three or four times normal. In round numbers 1,000,000 tons of machine tools, at an estimated value of $500,000,000 were produced during 1918. During 1918 our output of machine tools was distributed as follows:

	May 1918	October 1918
Government Contracts	66%	80%
For our Allies	21%	10%
For civilian use	13%	10%.

At the end of the war there were approximately 73,000 employees in the 420 machine tool shops of the United States.

The following estimates of requirements of fuel, power and raw materials for one year's production of machine tools were made just prior to the end of the World War. The estimates were based on the consumption during the year 1917 and six months of 1918:

Average demand of power from Central Stations	292,892 K.W.
Coal required for Heat and Power (Not including central stations)	802,629 Tons
Iron castings required (50 per cent scrap)	917,366 "
Pig iron	459,683 "
Foundry coke	351,650 "
Steel forgings	43,392 "
Screw stock	44,210 "
Black stock	91,567 "
Ground stock	5,778 "
Carbon tool steel	10,542 "
High speed tool steel	2,083 "
Steel castings	57,429 "
Bronze castings	10,720 "
Estimated production of machine tools per year	1,000,000 "

Planning for a Future Emergency.

I will now discuss the planning which has been done on this problem since the World War, including the methods and policies which have governed this work, the difficulties which have been encountered and the present status of the problem.

The ultimate object of war planning for industrial mobilization is to assure the delivery of the necessary munitions to the fighting forces at the times and places required. The logical procedure in attacking a problem of this kind is the determination of requirements, the determination of the production capacity of the industry, the

assignment of priorities, the application of conservation as applied to requirements and ~~hastly~~ the stimulation of production.

In this planning the General Staff furnishes the necessary information relative to the basic mobilization rates and rates of consumption of issue articles, while the computation of actual requirements and secondary products is a function of the Supply Branches. Information relative to Navy and civilian requirements is obtained by direct request on the Navy Department or through the Army and Navy Munitions Board for the Navy and through War Service Committees or trade associations for civilian needs.

We will now return to our specific problem of planning for the procurement of machine tools. Our requirements are divided into two classes which are primary and secondary. Primary requirements are relatively easy to determine as they are the machine tools required for our maintenance shops in the field. Secondary requirements constitute our real machine tool problem and they represent the greater part of our requirements since they consist of the machine tools required to produce the vast quantity of munitions which make up our primary requirements. Before secondary requirements for machine tools can be determined the following steps in planning must be completed:

(a) A mobilization plan must be prepared which will prescribe the rates of mobilization of man power and the rates of their transfer into the Theater of Operations.

(b) Primary requirements for this mobilization must be computed.

(c) Supply Branches must complete procurement plans for requirements and place accepted schedules of production with manufacturers.

(d) Manufacturers must prepare factory plans for the production of required articles.

Of the foregoing all except the factory plans can be done by military personnel, but for the factory plan we must look to the manufacturer, and the manufacturer is reluctant to spend time and money to prepare these plans before an emergency exists. The branches are not, therefore, obtaining factory plans at the same rate that they are progressing with the other phases of their planning work. It is quite evident that secondary requirements for machine tools have not been determined to any great extent and probably will not be completely known for many years, if before an emergency exists. A means of obtaining factory plans at an earlier date would be through educational orders which have for some time been advocated but which have not been authorized.

This condition of not being able to determine secondary requirements for machine tools has led to a study of the second part of the problem, namely, the determination of the capacity of the machine tool industry for production. The Machine Tool Commodity Committee of The Assistant Secretary of War's Office has undertaken this part of the problem. The method of procedure as adopted was to divide the

machine tool facilities among the procurement branches for the purpose of conducting a capacity survey. Instructions governing this survey were issued to the branches in order to insure uniformity of the information obtained. In preparing these instructions the Commodity Committee and the Machine Tool Builders Association, prepared a classification schedule of machine tools consisting of ninety-seven different types of machines. This was necessary due to a complete lack in the machine tool industry of any accepted standards of nomenclature and size designation. It was not found possible to arrive at any standard of size designation so this phase of the work along with further study of classification standards has been referred to the American Standards Association where a subcommittee is working on this phase of the problem.

A large proportion of the machine tool facilities have been surveyed and the information consolidated in accordance with the adopted classification schedule. We hope to complete the survey during the present year.

The following instructions, applying to planning for the utilization of machine tool facilities in an emergency have been issued to the procurement branches by The Assistant Secretary of War.

(a) Definitions.

1. A <u>machine tool</u> is, for the purpose of these instructions, defined as a power driven machine for cutting, shaping, or stamping metal, except rolling mill equipment.

2. A <u>machine tool facility</u> is, for the purpose of these instructions, defined as a facility, or that department of a facility, whose normal product is machine tools as defined above.

3. The <u>tentative assignment</u> of a machine tool facility to a procurement branch is a designation of that branch as the sole agency through which a schedule of production for machine tools may be placed with that facility. The tentative assignment of a facility to a branch does not give the schedules of production of that branch any priority over schedules of production of any other branch desiring to utilize that facility.

4. The <u>allocation</u> of a machine tool facility to a procurement branch reserves the capacity of that facility for the use of that branch. Unless otherwise directed by this office that branch will determine the priority to be given orders which another procurement branch desires to place with that facility.

(b) The following machine tool facilities heretofore allocated to branches as indicated below will remain so allocated and are exempted from the provisions of these instructions.

(Note:-There are seven facilities in the list referred to above.)

(c) Allocation of all other machine tool facilities heretofore made are hereby cancelled.

(d) Machine tool facilities on the attached list are hereby tentatively assigned to the branch indicated.

(e) The branch to which a machine tool facility is tentatively assigned will be the sole agent authorized to place with that facility schedules of production for machine tools for all branches of the War Department, and priority in placing such schedules will be determined by the date of receipt of the sub procurement order therefor.

(f) When 75% of the normal capacity of a machine tool facility has been absorbed by schedules of production, the branch to which the facility has been tentatively assigned will submit a report to this office giving data upon which to determine priorities among schedules placed. Based on recommendation of the Machine Tool Commodity Committee, this office will allocate that facility, and, if necessary, determine the priority schedule therefor.

(g) Correspondence preliminary to requesting the placing of a schedule of production will be carried on directly between the agency desiring the machine tools and the machine tool facility.

(h) Hereafter no schedules of production for items other than

machine tools normally produced will be placed with a machine tool facility without prior approval of this office.

The foregoing governing policy may be considered as a tentative solution of the problem. If it becomes necessary in shifting from a peace to a war basis, The Assistant Secretary of War can call for reports of the status of production schedules in all plants and take over the clearing of additional orders and the determination of priorities among orders already placed.

The following data shows where our machine tool facilities are located, the number of persons engaged in the industry and the value of products.

(See next page for table.)

MACHINE TOOL PRODUCTION FOR 1927.

State	Number of Establishments	Persons Engaged in the Industry	Value of Products
United States	355	42,642	$ 159,513,125
California	5	25	107,115
Connecticut	33	6,050	19,053,134
Illinois	37	2,960	13,895,799
Indiana	12	1,141	3,901,785
Massachusetts	30	2,676	10,829,724
Michigan	32	2,814	12,426,002
Missouri	6	168	527,373
New Hampshire	4	96	405,856
New Jersey	12	833	2,756,638
New York	25	2,486	8,743,619
Ohio	89	11,117	42,561,488
Pennsylvania	28	3,075	13,410,696
Vermont	5	1,710	7,239,627
Wisconsin	19	2,106	7,450,790
Other States	18	5,385	16,203,479

MACHINE TOOL PRODUCTION - UNITED STATES

Year	No. of Establishments	Wage Earners Engaged In the Industry	Value of Product
1914	310	29,814	$ 50,000,000(Estimated) (1/3 exported)
1918	420	73,000	500,000,000(Estimated)
1919	403	53,111	212,400,158
1927	355	35,269	159,513,125

NOTE:-Production of sheet-metal-working machines, welding machines and wiredrawing machines is not included in the above data for 1919 and 1927.

DIVISION OF MACHINE TOOL PRODUCTION FOR 1927.

	Percent.
Parts and attachments	22.3
Other products	14.3
Lathes	11.2
Portable tools	8.7
Grinding machines	8.3
Milling machines	6.
Drilling machines	5.2
Presses and punches	5.
Screw Machines	3.3
Boring machines	2.
Forging machines & hammers	1.9
Gear cutting machines	1.8
Planers	1.2
Shapers	1.
Threading machines	1.
Pipe cutting and threading machines	.8
Shears	.8
All others	5.2

During the last six months of 1929 more metal working machinery was placed on the American market than during any similar previous period. Roughly there was an increase of twenty (20) per cent.

EXPORTS OF METAL WORKING MACHINERY

1913	16,000,000
1923	13,105,000
1924	14,590,000
1925	22,037,000
1926	18,868,000
1927	25,379,000
1928	34,125,000

However, for the month of January, 1930, new orders had fallen off 37.7 per cent; shipments 28.2 per cent and unfilled orders 16.4 per cent as compared with January, 1929.

The foregoing data gives us an idea of the trend in the production of machine tools while the following information on the present trend in machine tool design is of interest in that it will eventually materially affect our machine tool requirements. The tungsten carbide cutting tools now in use have been largely responsible for many of the changes in design. The use of tungsten carbide is rapidly growing especially for use on cast iron and non-ferrous materials. It appears to best advantage when light cuts are taken at extremely high speeds. In order to permit the use of higher speeds, machine tool builders are using ball and roller bearings in tool spindles, gear boxes and in some cases they are being used for live tail stock centers. Increased speeds have made a demand for automatic lubrication of all gears, bearings and tools. Hardened gears are also being used more extensively. Accuracy, tool life, and speed require rigidity of frame and other parts. Many new types of machine tools have been designed with this in mind. Hydraulic feeds, clamping and indexing are now being used to some extent. They provide great flexibility in control of feeds, longer life of these mechanisms and smooth continuous feed of tool, leading to greater tool life.

The job shop has been sacrificed for the automobile industry, the principal effort has been to produce special tools for the latter.

This industry has now learned that even it cannot afford to scrap millions of dollars worth of special tools when the model of an automobile changes. It is understood that overhead runs as high as 400 per cent in automobile manufacture, a large part of which has probably been caused by changes in machine tools. The trend now is to demand "standard tools" which can be made over by changing parts or attachments so that they may be used as special purpose tools. This, I believe, will result in an inferior "standard" tool for the job or small shop.

In conclusion I wish to repeat that this problem during The World War was more one of planning and control than of increasing manufacturing facilities to meet requirements and I believe that this condition will prevail in any future emergency. Consideration should be given to the problem of providing sufficient skilled labor. Government requirements will, to a large extent, replace civilian requirements. The United States leads all other nations in the production of machine tools which places us in a very superior position insofar as this very essential product is concerned.

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