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SURVEY OF THE STOCK OF EQUIPMENT IN THE ISRAELI METALWORKING INDUSTRY AND ESTIMATED REPLACEMENT NEEDS [1]

by

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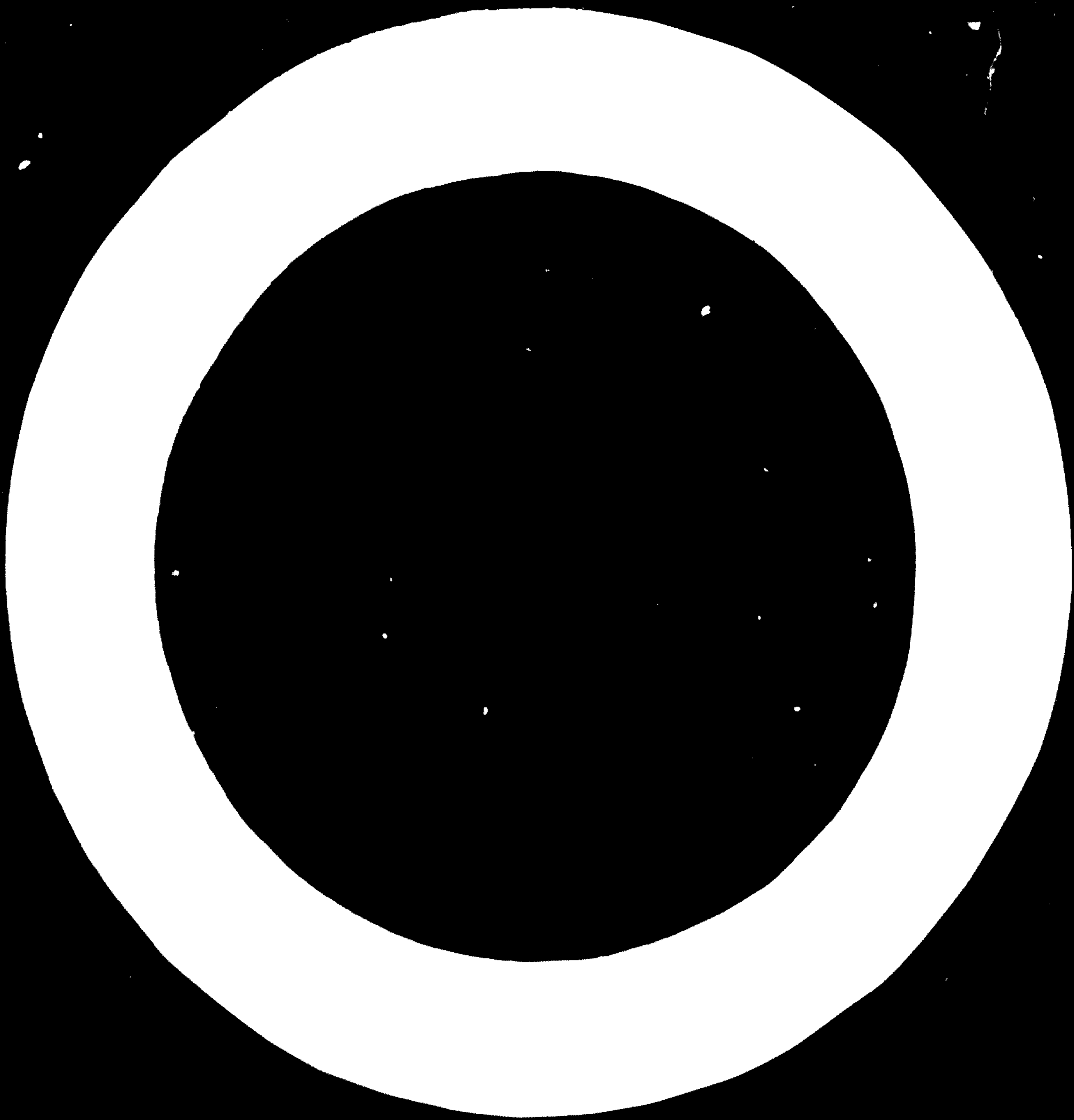

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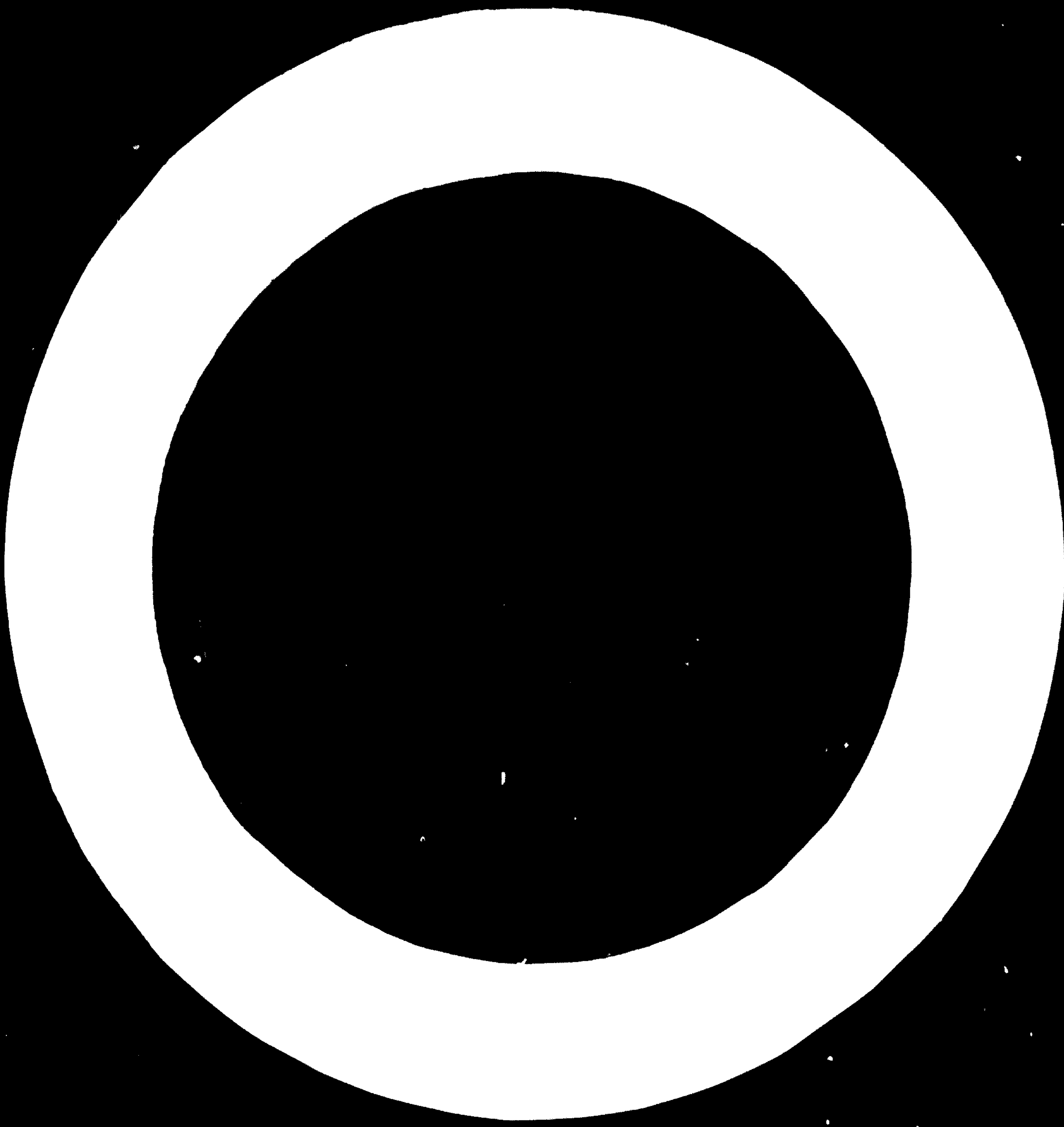
The survey was carried out by members of the staff of the Mechanical Engineering Faculty with the assistance of senior students.



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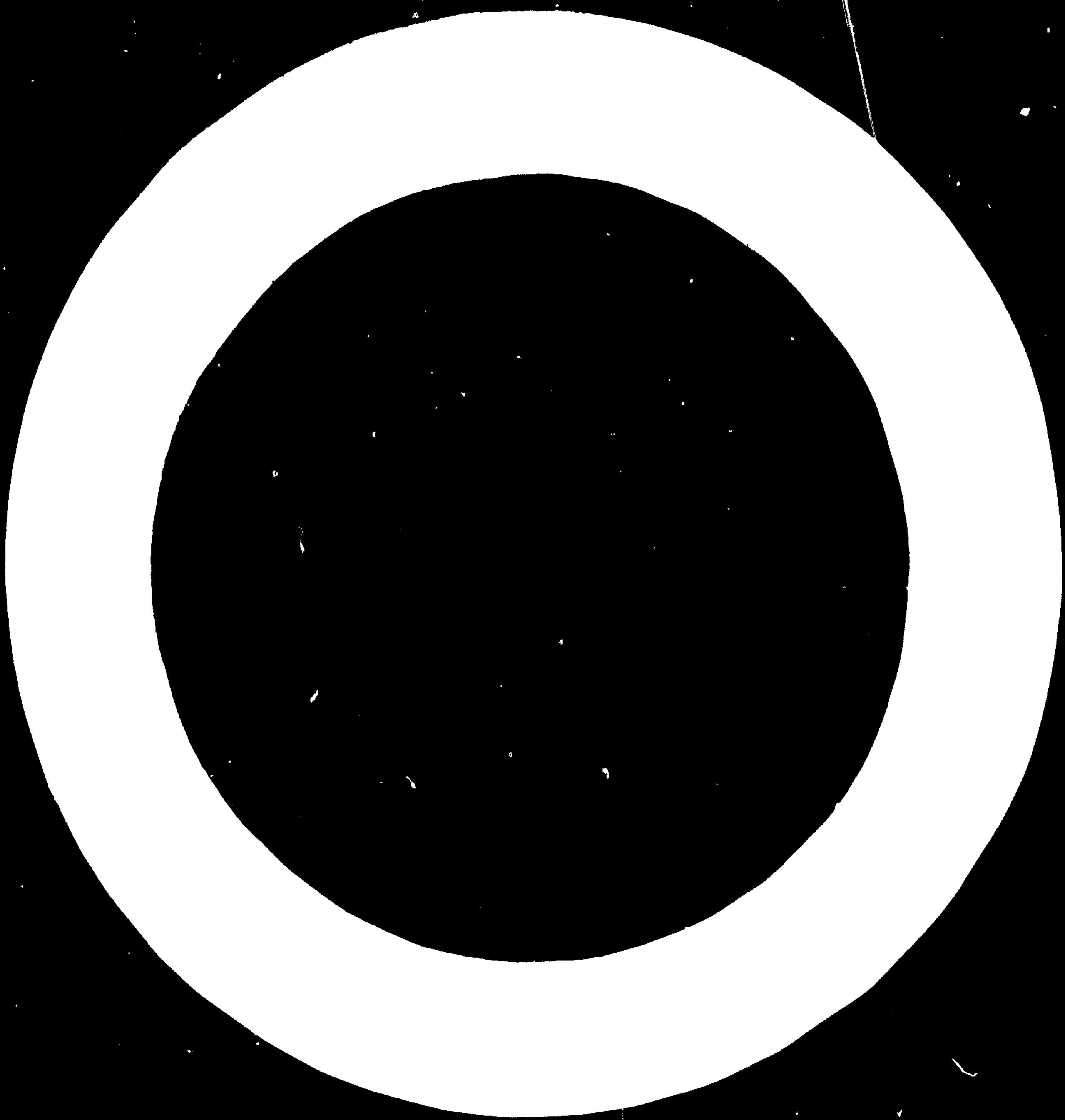

1. INTRODUCTION

The present increased national industrial export and production drive has made it necessary to examine Israel's potential by investigating a specific industrial sector. The metal industry was chosen for this purpose because of its key role in a modern economy. It comprises the production of a great variety of both consumption and investment goods so that it constitutes the basis for many additional industries. The crucial importance of this sector for technical progress is well known.

The first push towards the development of this industry in Israel was made during the Second World War, when the Middle East was cut off from the supply of consumption goods from Europe and America, at a time of considerable military requirements on the part of the Allied Forces stationed in the area. Since the Jewish population was able to supply the necessary manpower major orders were placed with local manufacturers which helped them to expand their workshops into small plants and thus created the basis for future developments. With the establishment of the State of Israel a considerable amount of war surplus equipment was bought up mainly from the United States and Great Britain. This enabled Israel's young industry to meet the domestic demand which was growing constantly as a result of mass immigration. In spite of its considerable relative growth, the local market nevertheless remained very small by comparison with the markets of more developed industrial countries. This, in fact, is now holding up the further development of this industry, which therefore must turn to exports and base its production on the foreign rather than on the domestic market. The required reorientation involves far-reaching changes in the structure and technology of the industry, and requires quantitatively heavy and qualitatively different investments and, of course, also appropriate industrial planning. In order to be able to make provisions for necessary expansion and conversion into an export industry, the need for a number of basic studies became apparent.

The purpose of the present study is twofold: The first is to estimate the present potential of the industry, and the second, to examine the changes required in equipment and technology so as to enable the engineering industry to expand and produce to a much bigger extent for the foreign market.

In the present study, which deals primarily with the first stage of these investigations, the main stress is placed on the stock of equipment, its maintenance and performance, and on the technological processes commonly employed. The potential and limitations of the industry are evaluated in terms of its ability to produce for the foreign market. Secondly, the equipment needs of the industry are estimated in the light of its existing potential and the orders already placed for new equipment. This estimate is based on the current trends and past experience of developed metal work industries. On the basis of this estimate of the additional equipment or replacements required an attempt was made to ascertain whether the local production of equipment for this industry is justified.

A survey of this kind, assessing the available equipment and future equipment needs of Israel's metal working industry, was suggested in two preliminary methodological studies [1], [2] which recommended the following procedure:

1. Selection of a representative sample of the metal industry.
2. Survey of the plants sampled and collection of data on:
   a. Means of production and technological processes.
   b. Systems and instruments for inspection and control.
   c. Manpower.
   d. Product mix and marketing methods.
3. Analysis of results.
4. Recommendations.

To carry out these recommendations in full an enormous amount of information would have been required, mainly general information on the enterprise investigated, its production methods and means of production with particular reference to the age of the equipment and the levels of precision. Since this, however, is the first survey of its kind and no former experience was available it should be regarded merely as a preliminary study which cannot provide a full answer to all the questions posed. On the other hand it provides satisfactory information on the distribution of the data so that it may form the basis for a more extensive study conducted in the future. Its results also serve as a good indication of the answers to be expected, and give an outline of the major characteristics of Israel's metal industry.

The sample on which this study is based was not selected by purely statistical methods, and in view of its necessarily small size, the selection was guided by known technological considerations. While not strictly representative in the statistical sense the sample nevertheless reflects the present state of technology (see Sampling). On the basis of the processed data material, an attempt was made to estimate the replacement needs of the plants included in the sample. The main criteria used for this purpose were the age of the present equipment and the tolerances attainable with it.

In this industry the precision of performance of the equipment directly affects the export potential, and cases are known in which orders were returned because they did not attain the required standard. The information collected in this respect was not sufficiently reliable to draw conclusions regarding the standards of precision of the machinery. This could be done only from the data obtained on the control and measurement procedures of the plants investigated. Although of a more general nature, this information nevertheless gave a clearer picture of the standard of precision.

The age of the machine, which undoubtedly affects the precision of performance, also affects the standard of efficiency since the technology of old machines is likely to be obsolete. Even when a given machine is physically still in good shape becaus it is well maintained or has been overhauled, it may be technologically obsolete and the plant using it may thus be unable to compete with other plants using a modern technology. Accordingly the tendency of Israeli plants to prefer overhauls over machine replacements must be regarded as a very short-sighted policy. In the long run it holds up the introduction of new techniques and reduces the plant's competitive capacity.

To assess the industry's development and expansion trends the firms interviewed were asked about the orders for new machinery that had been placed but not yet delivered, as well as about their expansion plans for the future, and above all about the equipment they intend to order. Exact particulars were obtained on the orders placed, including the type, model and size of the machine, the country of origin, the estimated delivery time and the price. Regarding long-term development plans it was found that most of the plants interviewed had no well-defined projects and most of them were still engaged in drawing up their plans so that they were reluctant to provide information on the matter, and even when requested to give merely a rough estimate indicating the orders of magnitude contemplated no replies were obtained. It seems that the lack of response to questions relating to development plans was due less to a desire for secrecy than to the non-existence of such plans, indicating the complete dependence of the local plants on the fluctuations in the domestic market.

Finally the problem of equipment replacements was investigated. As stated, an estimate was made of the current replacement needs of the existing equipment. Since in most instances no information could be obtained from the plants interviewed on the price of the alternative machinery, prices of conventional machinery were obtained from the local agents. From this required investment for equipment replacements was computed, assuming that the existing machinery were to be replaced by new machinery of the same type and size. Though this kind of replacement would constitute a step foreward with respect to the level of technology, it cannot reduce the gap between Israel's industry and the industries of more developed countries. In informal talks with the plant managers and in view of recent development trends of the metal work industry in the USA as outlined in the following chapter, it appears that if the local producers want to compete on the world market the old equipment will have to be replaced with equipment using a more advanced technology. This applies particularly to the replacement of old machine tools, by numerical control machines. These new machines, especially machining centers,* have a far greater precision, efficiency and versatility but are much more expensive than the conventional machines. This introduces additional factors into the calculation which therefore becomes extremely complex.

* A machining center is a complex multi-purpose machine fulfilling the functions of two to three ordinary machines and operated entirely by numerical control. Sometimes it consists of a combination of a lathe, milling machine and boring machine, or any other combination made to order

2. DEVELOPMENT TRENDS IN THE METAL-WORKING INDUSTRY

a. Introduction

Starting from the premiss that Israel's metal-working industry must reorganize for export production and be able to compete on the world market it is useful to examine the expected world trends in this industry which Israel's industry must relate to, and take part in. This applies particularly to that part of the industry which is engaged in production and is intending to export. In order to be able to compete with other modern industries it must follow the trends in the rest of the world. This does not always mean that it must imitate the existing trends but it can also use its knowledge to predict which new markets may be open to it and which of the old markets may become accessible.

The following survey deals with development trends in the two main technological categories – chip removing processes and other metal forming methods. The material relates mainly to the American industry and some of the European industry, and was taken from last year's publications. Special weight was given to the views of manufacturers and managers of leading Western firms, as expressed in the open discussion of the matter in the professional press during June 1968.

Owing to the important position which machining occupies among metal processing techniques we shall discuss it separately from other metal-forming processes, such as casting, forging, and the like. As will be seen in what follows, similar considerations affect all the different chip-removal processes and they can therefore be discussed together. We shall dwell only on those aspects which in the light of our findings have a bearing on the local industry.

b. Machining

Machines tools are the backbone of the metal working industry. There is practically no metal product in present consumption some of whose surfaces have not been processed by machine tools. The prominence of this processing technique may also be seen from the distribution of the machinery in the present survey sample where it was found that 66.2 per cent were of this type compared with 20 per cent non-machining equipment, while another 13.8 per cent consisted of various auxiliary special purpose machinery. A similar distribution is also found in the industries of developed countries. Machining has therefore become the main focus of research that has led to a new generation of numerical control machine tools, which cover a price range from $ 30,000 – 40,000 for the more simple models up to $ 450,000 for the highly complex machine center types. Their impact has been such as to bring about what is generally called a second industrial revolution.

It seems that the main preoccupation of the metal industry the world over is the introduction of numerical control machinery. It should be noted that this machinery was slow in entering the market owing to its high price and the fact that some of its advantages, despite their importances, cannot be directly translated into financial terms. This is illustrated by the history of these machines. Their adaptation for industrial use first came about at the instigation of the US Air Force, when aircraft and rocket parts became so sophisticated and required such complex and precise machining that the industry was unable to keep to the required time schedule. The delays became particularly disturbing when modifications had to be introduced in the course of planning which is obviously unavoidable in projects of this type. The problem was solved by the numerical control milling machines developed in 1953. In 1955 numerical control machine tools made their appearance on the commercial market and since then much experience has been accumulated which by now makes it possible in many cases to assess their profitability in advance by appropriate cost accounting. It is evident that with the growing number of machines of this kind already used in industry their introduction becomes essential even where a study of machine time per part does not clearly indicate their superiority, because of other advantages not directly measurable in machine time but affecting such aspects as the delivery time, the rate of rejects and the ability to cope with alterations of the original design. Thus, although the numerical control machines at first encountered great difficulties in being accepted on the market, their number showed an exponential growth once they had been introduced. At present machine tool manufacturers estimate that about 75 per cent of the general purpose machinery in 1970 will be of this type.

The material published on this subject shows that in spite of the importance of all the ancillary aspects unit cost considerations still predominate in the introduction of numerical control machines. Though the cost calculation varies for each plant and product it may be assumed that machine time will always be decisive in determining the level of costs. An average computed on the basis of the experience gained so far shows that a numerical control machine spends about 20 per cent of its time in chip-removal, compared with 5 per cent for an ordinary machine tool. Another point on which there is general agreement is the size of the minimum series required to reach the break even point, which is smaller for numerical control than for conventional machine tools. Obviously these are only average estimates based on instances produced by the machine manufacturers and cannot be taken as a general rule. Nevertheless they indicate the enormous potential of these machines.

Undoubtedly the investment in numerical control machines is much higher than in conventional machines but in view of the technological requirements that Israel's industry will have to meet during the seventies — and partly has to meet already today — a realignment seems indicated. The necessary conversion to numerical control machines should be made gradually and begin with machines of the simplest and cheapest type.

A description of several machines of this type and their price range are given below

1. N.C., two axes, point to point machines without tool magazine, capacity about 5 HP —
   Manufacturers: Giddings & Lewis
   Pratt & Whitney
   Cincinnati Milling Machine Co.
   Price range — $30,000—40,000
2. N.C., three axes, point to point machines without tool magazine, 4 - 7 HP
   Manufacturer: Cincinnati, Cimex
   Up to $60,000
3. N.C., three axes, point to point vertical machines with tool magazine maximum drill 3/4"
   Manufacturers: Brown & Sharp $85,000
   Giddings & Lewis, VNC-10
   40 tools in magazine $125,000
   Giddings & Lewis, VNC-15
   40 tools in magazine $160,000
4. Continuous pass machining center, three axes, HP 4 - 7
   Manufacturers: Cincinnati $100,000 — 150,000
   10-15 HP
   Manufacturers: Giddings & Lewis, Cincinnati $380,000
   Kiern & Tracker $450,000

(All these machines are highly universal and with a large number of axes.)

c. Other Metal-forming Techniques

Most of the accepted metal-forming processes require a considerably bigger series to reach the break-even point but with large series unit costs are much lower than those obtainable with machining processes. The general tendency therefore is as far as possible to substitute forming for chip removal in the production of very big series. In practice this means that forming techniques are being constantly developed with a view to the ultimate elimination of all machining and finishing operations. At present the development is proceeding in four main directions:

1. cold forming
2. powder metallurgy
3. pressure fusion
4. plastic materials.

While all four techniques are already in use they are still undergoing further research and development. The most important of the four is cold forming. When applied to the manufacture of certain parts it not only brings about considerable savings in time and money but above all eliminates the need for further finishing operations. Losses of material are cut to a minimum, sometimes to zero. Nevertheless, although this technique has been in use for many years, it has so far not been developed and is expected to be much more widely used in the future.

Powder metallurgy is a fairly new field of production which is developing rapidly and has considerable achievements to its credit in saving machining and other complex operations. It provides almost complete control over the composition of materials and makes it possible to obtain materials unobtainable by any other method. Constant development and research are under way and many innovations are expected.

For light metals, pressure fusion provides an efficient means of cutting down machining operations or eliminating them altogether.

Plastic materials have moreover recently replaced metals for the production of many parts. This obviously can only be done when no rise in temperature is to be expected. The substitution is useful because of the low price of plastic materials, the shorter production time and the practically complete elimination of machining processes, and is therefore taking place at an increasing pace. Recently entire systems have been constructed operating under fully automatic control. The system comprises automatic feeding and conveying devices from one moulding station to another.

Apart from these major lines of development which are likely to have a direct impact on Israel's metal industry there also are other technologies which are being gradually introduced in the more highly developed industries and require constant alertness on our part, above all electro-discharge machining (EDM) and electro-chemical machining (ECM) processes. At present these machines pay off only in fairly specific fields and are relevant chiefly for diemakers. They are already extensively used in Italy, Switzerland, Germany, France, England and the USA and this will probably have a bearing on the competitiveness of our die-making industry.

d. Measurement and Inspection

For several years there has been a growing tendency to introduce in-process control. Inst of measuring and checking the product only after it has been finished it is thus intended to reveal errors at an early processing stage. The present trend is to disclose dimensional errors as soon as they occur so that the automatic machine can immediately make the necessary adjustments and the part can be corrected in the course of the process or at most only one part need be discarded. This can of course be done only by means of sensors of a new type placed at a certain distance from the workpiece, which react to the slightest deviation, and cause the machine to correct and adjust itself accordingly. Such devices have already been installed in several processes and received a considerable impetus with the introduction of numerical control machines which because of their high cost per hour require automatic in-process controls. The process inspection now in use consists of optical, electrical and pneumatic instruments. Increasing use is also being made of lasers, especially for the accurate measurement of dimensions and widely spaced distances, such as axes, spindles or the motion of the carriage or the machining table of machine tools.

Measuring and control technology is thus developing hand in hand with the processing technology. Measurement and control, in general, and in-process inspection in particular, form an integral part of present processing developments and any disparity between the two is bound seriously to affect the efficiency of the new technologies.

8. SELECTION OF THE SAMPLE

The sample was selected from a list of enterprises supplied by the Ministry of Commerce and Industry which also served for a study on the occupational structure of the labour force. This list provided the following information

Classification of metal-working enterprises by number of employees into 4 size groups

Group 1 – 10-29 employees
2 – 30-49
3 – 50-98
4 – 99 and above

The plants in each group were further classified by 18 sub-branches, as follows

a.	Basic iron and steel industry,	Code No. 320
b.	Iron and metal casting	321
c.	Non-ferrous metals	322
d.	Pipes	323
e.	Fittings	330
f.	Sheet and pressed metals	331
g.	Netting and metal wires	332
h.	Heating and cooking appliances	333
i.	Cutlery and work tools	334
j.	Metal constructions	335
k.	Cooking utensils	336
l.	Metal coating and painting	337
m.	Screws and other metal products	339
n.	Industrial and building machinery	340
o.	Agricultural machinery	341
p.	Machinery for services, commerce and household use	342
q.	Pumps, compressors and pumping equipment	343
r.	Mechanical metal work	344

This information was summed up in the following table with the undertakings classified by size groups (columns) and sub-branch (lines).

TABLE 1.

Sub-branch (Code No.)	Size Group				Total
	1	2	3	4	
320	12	2	3	2	19
321	7	2	2	2	13
322	10	2	1	3	16
323	3	2	0	3	8
330	15	3	7	1	26
331	25	4	5	3	37
332	13	8	3	2	26
333	14	4	0	1	19
334	16	4	7	2	29
335	100	25	15	6	146
336	9	0	1	0	10
337	7	2	3	1	13
339	18	3	3	2	26
340	32	10	8	6	56
341	32	7	4	1	44
342	33	7	6	5	51
343	13	10	1	1	25
344	42	2	0	0	44
Total	401	97	69	41	608

Since the present survey is concerned solely with the equipment of the plants, they had to be classified by the technological processes used rather than by their product mix in order to be able to assess the function and real value of the equipment in the production process. This is particularly necessary in order to decide whether a given machine is still adequate or must be immediately replaced. Thus, for instance, it no longer pays to keep a 20-year-old milling machine in a plant producing long runs of parts by machining methods, because of its old-fashioned structure, lack of attachments and low number of revolutions which make it impossible to use modern cutting tools. The same machine in another technological group, such as a light metal foundry using pressure casting, may well be used for another 5-10 years if used for maintenance and repairs.

For budgetary reasons the present survey had to limited to about 60 plants. We therefore had to confine ourselves to only 6 technological groups in order to obtain significant results. In determining these technological groups we tried as far as possible to base ourselves on the sub-branch classification of the original lists, although the match between technological groups and sub-branches is far from perfect. The following technological groups were defined as follows:

Group 1 – Continuous-run machining in small and large series. This group is engaged in continuous-run production requiring machining and are equipped with machine tools.

Group 2 – Sheet metal work and stamping. The equipment of the plants in this group consists mainly of presses, bending machines and guillotines of various types. They comprise small workshops for the repair and treatment of dies. Several plants also manufacture assemblies which require some machining and therefore also dispose of different machine tools.

Group 3 – Structural metal-work including machining and sheet metal work.
This is a general group since the plants comprised in it carry out a wide range of jobs, generally to order or in small series. The equipment is mixed and varied with a high proportion of welding and bending machines, saws and drills. According to their requirements they also dispose of guillotines and machine tools, such as milling machines and lathes.

Group 4 – Casting or forging, with or without machining. The main equipment consists of furnaces and in forging plants also of presses and pneumatic hammers. The bigger plants tend to manufacture finished products so that they are likely to comprise a machining department for finishing work.

Group 5 – Special in-line products.
These plants produce one or several products with special machinery designed specifically for that purpose. The machines are arranged in line with inter-connecting feeding devices. A line for the production of metal tins, for instance, consists of 40-50 machines each of which carries out a single bending or cutting operation. The partly processed product from one machine is more or less continuously fed into the next. The rate of output of such a line is high and it is able to produce thousands of tins per hour. The same is true in the production of nails, etc. Within the same line or as a preparatory stage one may find ordinary auxiliary machines such as presses. The plants have a maintenance department with machining equipment for tools and dies, but as distinct from the plants in group 2 the machining equipment must be of a high standard of performance and accuracy.

Group 6 – Services and general metal work.
This group carries out repairs and single orders, and comprises a large number of small workshops and service shops. The chief equipment consists of a welding machine, lathe, saws, a small melting furnace or forge and sometimes also a small press.

The distribution of the 18 sub-branches of the survey frame by technological groups is shown in the following table.

The classification can only be approximative since the sub-branches do not always correspond to a given technological process and one sub-branch may be sub-divided among several technological groups. Moreover, the sub-branch classification had to be adjusted also where the technological process fully coincides with the sub-branch since an erroneous classification may easily falsify the picture.

TABLE 2

Technological group	Sub-branch
1	344, 339 and others
2	333, 336 and others
3	Part of 335, 340, 341, 342, [illegible]
4	321, 322, 330
5	Part of 331, 323 and 338
6	320, 337

Serious difficulties arose from the fact that the technological groups do not correspond uniquely to the sub-branches and that original classification of enterprises to a given branch was not always correct. In some major instances it was altogether impossible to rely on the sub branch classification which proved meaningless with regard to the technological process. Sub-branch 334 for instance, includes the "Reded" and the "Metal Buttons Company", which use a press technique, as well as "Hanita" and "Iskar", which produce cutting tools. These are major enterprises which employ entirely different processes so that their equipment is also totally different. For several technological groups the sub-branch classification could not be used to construct a representative sample of the equipment, and therefore had to be disregarded and the enterprises had to be selected from the crude list showing the plants in running sequence. This was done on the basis of our personal knowledge of the local industry and the advice of experts who are familiar with its structure.

A further difficulty in selecting the sample arose from the fact that the list had been prepared for a survey on the occupational structure in industry. For an equipment survey the size distribution of plants by number of persons employed is not sufficient because this alone does not indicate the equipment available. Here, too, it was therefore necessary to make use of our prior knowledge of the local industry and of the processes used so as to avoid any bias due to the differential ratio between manpower and equipment in the different technological groups.

Accordingly the sample was clearly not selected on a purely statistical basis, but according to personal and expert knowledge and information it may be regarded as a representative sample of the equipment population in the metal working industry. The sample selected according to these criteria is shown in the following table.

The size group ranking of the plants was brought up to date to the actual per period of the survey so that occasionally it may not exactly correspond with the ranking shown in the original lists.

TABLE 3

Technological group	No. of plants (by size group)				Total
	1	2	3	4	
1	8	5	4	1	18
2	[illegible]	[illegible]	[illegible]	[illegible]	10
3	[illegible]	[illegible]	[illegible]	[illegible]	20
4	2	–	1	1	4
5	–	[illegible]	[illegible]	–	[illegible]
6	3	–	–	–	3
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

It was intended to select a sample that represents about 10 per cent of the population. In the size distribution greater weight was given to the bigger plants, so as to give a better picture of plants that are already exporting or will be able to export after they have been expanded or developed. Some of the considerations that guided us in our selection are discussed below.

Group 1 – Continuous-run machining in small and large series.
The two principal sub-branches which make up this technological group, 339 and 344 (see Table 2) contributed 7 plants to the sample group. However, plants from most other branches also belong to this group. Since the sub-branch classification often cuts across the process classification, a total of 18 plants were thus selected from the lists to represent this category.

Group 2 – Sheet metal work and stamping.
Here again the sub-branch classification does not coincide with the technological classification and the group was represented by 10 plants, many more than were found in sub-branches 333 and 336 alone.

Group 3 – Constructions, including machining and sheet metal-work.
This group covers 5 sub-branches including 332 plants of which 201 belong to the smallest size group. Since plants were selected from several of these sub-branches to represent groups 1 and 2, a corresponding adjustment was made and the representation of this group was set at 20 plants, 12 of them in the lower size groups.

Group 4 – Casting or forging with or without machining.
Here 4 plants were selected out of a total population of 55 plants. In this group the correspondence between the technological process and the sub-branch was satisfactory. The representation was somewhat decreased because two plants originally included dropped out of the sample, one being temporarily closed down and the other refusing to participate.

Group 5 – Special line products.

This group includes some of the plants of sub-branches 323, 331 and 332. As most of them are medium sized it is represented by only 3 plants.

Group 6 – Services and metal workshops.

Many of the "enterprises" in this technological group turned out to be hardware and building material stores as well as metal-bending workshops for the building industry which had no mechanical equipment at all. All these were eliminated and 3 workshops representing the metal service industry were selected.

The list of plants included in the sample is given in Appendix No. 1. Plants Nos. 57 and 58 did not originally appear in the appropriate categories and were added later on.

4. DESCRIPTION OF THE FIELD WORK

a. Preliminary Survey (pretest)

Questionnaires on the equipment and its operation were constructed, including general questions on the plant, the handling of raw material and other particulars (see Appendixes 2 and 8). The survey was divided into two stages. During the preliminary stage a small number of plants (8) was investigated and the results were analysed in order to test — 1) the questionnaire 2) the data collection method 3) the efficiency of the survey staff.

On the basis of the conclusions drawn from this analysis the field workers were given further instructions and their attention was drawn to points of special interest on which they should try to obtain the most accurate information possible. The questionnaires were revised and several questions were added relating to development, equipment orders placed but not yet delivered and additional orders contemplated, while other questions were eliminated and replaced. Four teams of investigators were set up to collect the necessary information and fill in the questionnaires.

b. The questionnaires may be divided into two categories:

1) General questionnaire (see Appendix No. 1). Here stress was laid on general information such as the size of the plant, the number of persons employed, production control and inspection procedures, the product mix, the type and source of raw materials. This questionnaire also contained several questions relating to the development plans or future intentions of the management, and the order of priorities of equipment to be purchased during the coming 1-3 years.

2) Production equipment questionnaires

a. Machine tools. Owing to the diversity of these machines it is difficult to draw a dividing line between machines of different sizes and in order to classify this machinery data were collected on performance, dimensions and capacity, and the tolerances at which the machine is able to produce. All these data were required because precision of performance is a major criterion in evaluating the machine's export production capacity and indicates the level of technology and maintenance and the degree to which the equipment is adequately utilised. The information collected was computer processed and made it possible to classify the machines by size and performance according to various criteria. Stress was also laid on the condition of the machine, its age and its maintenance, which affect its performance, and the date of its last overhaul, if any, was noted (see appendixes 3-7).

b. Standard equipment – saws, welding machines etc. Here the classification was made only according to the operational conditions of the machine and the operating method used. Age is of very little significance as far as these machines are concerned (see Appendix 8).

c. Specialized machines – The specific machinery for the production of metal tins, gear cutting etc. is too varied to be fully recorded but an attempt was nevertheless made to record in detail several such machines for sub-classification by output, capacity o performance. Where no sub-division was possible the descriptive particulars, age and condition of the equipment were noted.

A standard "machine operation" questionnaire was attached to each machine questionnaire (see appendixes 3-8), containing particulars of the operator, his experience and training. The form also included additional data on the rate of utilisation, and efficiency of application of the machine, the measuring instruments employed and the operator's actual tolerances.

c. Implementation

Most of the plants selected proved cooperative and helpful but some unfortunately refused to participate in the survey. Others had closed down and ceased to exist, specially among the smaller plants, while still others were closed for annual holidays. Several plants no longer belonged to the same size group into which they had been originally classified. Thanks to the fact that a reserve had been provided for from the start substitute plants could be investigated instead of those eliminated for the above reasons, so the distortion of sample as a result of the causes listed could be kept to the minimum.

d. Collection and Classification of the Data

The entire information contained in the questionnaires was classified so that there should be no more than 11 sub-categories for each answer. For instance, there were lathes with a maximum r. p. m. of 400, 600, 800, 1000 etc. up to 5,000 r. p. m. These figures were reduced into 11 groups in such a way that they still represented the technological structure of the machine, and the same was done for capacity, rates of feed, etc. In this form the entire information could thus be fed into the computer.

The equipment was classified into 19 sub-groups, as follows:

1. milling machines
2. drilling machines

3. shapers
4. presses
5. guillotines and bending machines
6. saws
7. welding machines
8. furnaces
9. pressure casting machines
10. centre and turret lathes
11. vertical lathes
12. specialized machinery
13. automats
14. grinders
15. gear-cutting machines
16. jig borers
17. broaching machines
18. other automatic machines
19. equipment ordered but not yet delivered.

A further sub-group contained the information included in the forms filled in by the plant managers and engineers.

5. FINDINGS

a. Obsolescence of Equipment

In evaluating the obsolescence of equipment it is necessary to take into account other factors affecting the performance and capability of the machine to fulfil its tasks in addition to its age. The principal factors to be taken into consideration are:

1. The physical age (year of manufacture).
2. The level of maintenance which determines the possibility of uninterrupted and faultless operation.
3. The ability to perform at the accepted tolerances for the type of equipment in question, which is of special importance for machine tools.
4. The overhauls carried out during the lifetime of the machine and the number of elements replaced such as ballbearings, keyways, etc.
5. The cost of operation of an old versus a new machine having the same function.

When it is a question of going over to export production and competing with foreign manufacturers on the world market the last factor, that is the technological age of the machine, is of special importance. In that part of the industry which is engaged in servicing and repairs obsolescence is far less important. Below we shall accordingly refer mainly to that part of the industry which is engaged in production proper. Here it seems that most of the problems are connected with chip-removing machines. During the last 20 years numerous improvements have been introduced in these machines, above all in machine tools. The current trends are described in Chapter 2. As a result of these developments a machine that has passed this age limit of 20 years, regardless of its condition, is no longer profitable. As far as the machinery surveyed is concerned, the main problem is the number of revolutions and the capacity. Machine tools of the forties, working with high-speed steel tools, had an average capacity of 2.5-4 HP and a maximum of 800-1,000 r.p.m., with centres generally up to 200 mm. high. When the height of the centres exceeded 200 mm the capacity of the machines was somewhat higher – 3-5 HP – but the number of revolutions was still within the range of 500-700 rpm. In recent years most of the machining operations are carried out with carbide tools where the speed required is 3-5 times as high as for high speed steel and the capacity required is 2-4 times as high as that of the older machines. For this reason carbide tools cannot be used by the older machines which therefore cannot compete with the new ones in operating costs.

This is true even when the old machines have been overhauled and functionally are still able to perform. Without going into the economic aspect of differences in wages, which in Israel are still lower than in the USA or in Europe, it is inevitable that the use of old machinery must lead to a situation where the output of the local worker is lower than that of the American or European worker, a disparity which is bound to be still further increased by the introduction of numerical control machines. This will over time tend to erode any wage advantages now still existing.
We shall now discuss some of our findings relating solely to the age of the equipment, confining ourselves to a small number of machine tools. The figures relate only to the sample surveyed, and were not blown up.

1. Milling Machines

Of the 148 milling machines of different types, 47 per cent were over 18 years old and only 53 per cent were of a more recent vintage (see Table No. 4), with only 21 per cent being less than 6 years old. The industry is aware of the outdatedness of its equipment and 28 new machines have been put into operation while 15 have been ordered and should soon be delivered, so that the proportion of new machines should go up to 26 per cent within a year. The situation was found to be substantially the same for all other basic machine tools as well. The milling machine is a basic piece of equipment and is extremely important for the manufacture of complex items and therefore manufacturers naturally paid special attention to its development. The first numerical control machines were in fact based on its performance, and very far-reaching developments of this type of machinery have taken place (see Chapter 2).

2. Drilling Machines

Although some improvements have taken place in recent years the tools have remained substantially the same, and the number of revolutions has also remained fairly constant since the materials used for these tools have improved only slightly. The main line of development has been the manufacture of combined electronically controlled milling and drilling machines but the need for conventional drill presses has not been eliminated. These machines have a fairly long lifetime especially for auxiliary or marginal production tasks, so that an 18 year old machine can still be usefully employed (see Table No. 5). It should be noted that a drill press costs much less than any other machine tool so that this type of equipment is replaced more frequently. During the past 6 years 65 new drilling machines were put into operation - slightly over 19 per cent of all the drilling machines found in the plants surveyed. This is reflected in the small number of new orders placed: Only 3 new machines were on order together with the machines introduced during the last 3 years constituting slightly over 10 per cent of the total (36 out of 342 machines at the beginning of 1969).

TABLE 4. Age distribution – July 1968 Milling machine

Age (Years) / Type of machine	0-1	2-3	4-6	7-9	10-13	14-17	18-23	24-33	34-43	Over 43	Old – age unspecified	Total	Up to 10	Over 10	On order
Spindle	3	3	2	14	4	1	9	7	1	4	9	57			
Head	1	–	2	3	–	–	2	–	–	1	3	12			
Spindle and Head (Universal)	4	6	–	7	[illegible]	1	–	2	–	2	[illegible]	30			
Separate Spindle and Head	–	1	1	–	–	–	–	–	1	–	–	3			
Two or more heads	–	1	–	–	–	2	1	3	–	–	1	8			
Special milling machines	–	1	–	2	–	–	–	2	–	–	2	7			
Miscellaneous	2	2	2	4	2	–	2	2	–	2	5	20			
Total	10	14	7	30	14	4	14	16	3	9	30	148	70	60	35

TABLE 5. Age distribution – July 19[illegible] Drilling machines

Age (Years) / Type of machine	0–1	2–3	4–6	7–9	10–13	14–17	18–23	24–29	30–40	Over 40	Old – age unspecified	Total	Up to 10	Over 10	On order
Bench	6	5	11	19	41	4	7	4	1	3	32	120			
Vertical	4	14	10	28	33	10	11	7	3	5	24	161			
Radial	–	2	4	4	–	4	2	2	1	1	6	28			
Special	–	–	–	–	–	2	–	–	–	–	–	2			
Miscellaneous	–	–	1	1	–	–	–	1	–	1	4	8			
Total	10	21	26	52	74	20	20	14	5	10	60	307	211	100	5

3. Lathes

The lathe is the most basic machine tool for the manufacture of circular-section bodies which form part of most items used by modern society since there is hardly any moving body without a considerable number of such parts. During the last 10 years the structure of these machines has undergone tremendous developments, because the introduction of new tool materials – carbides, ceramics, diamond tools – required machines with a higher speed of revolution and capacity. This gave rise to special structural problems and above all called for greater rigidity. The new machines are more strongly built and have a different profile. New materials meeting the structural requirements of the machines were introduced so that the machines should not be too heavy, and this has raised their cost. At the same time new accessories and devices were developed to increase the work rate and expand the performance range of the machines by reducing the down time.

From this it appears that the main point as far as lathes are concerned is their general economic efficiency of which age is one of the chief criteria. There were 238 lathes of different types in the sample including turret lathes over half of which were found to be obsolete in all respects, with 50 per cent over 18 years old and somewhat over 41 per cent 24 years old or more (see Table 6). As happened previously in Europe* however, there is a tendency to replace the old lathes and since about 1960 over 31 per cent have been renewed. This means that 1960 was the turning point when the old equipment began to be replaced. Taking into account the orders placed and the machines purchased during the past three years it appears that by 1969 slightly over 11 per cent will be totally new machines less than 4 years old. In modern industry there is a tendency to replace some of the lathes with screw-cutting machines or cylinder grinders which perform some of the ordinary operations better and more accurately than conventional lathes. To some extent this tendency may also be noted in Israel, especially as regards the introduction of automats.

4. Grinders

The use of grinders, traditionally regarded as finishing machines only, has been recently expanded with the development of special abrasive wheels for cutting. Grinding is also being increasingly used to remove big quantities of material (especially for cylinder processing) at a higher speed and with greater precision than with a lathe.

* The high number of old lathes is due to the fact that during the first years after the establishment of the State of Israel many machines were bought from American and British war surplus stores which had been originally designed for military production. The European industry also bought these machines at the time but by now they have almost completely disappeared since they have in the meantime been replaced by modern machinery of local or foreign manufacture.

TABLE 6 Age distribution – July 1968 Turret Lathe

Age (Years) / Type of machine	0-1	2-3	4-6	7-9	10-13	14-17	18-23	24-33	34-43	Over 43	Old – age unspecified	Total	Up to 18	Over 18	On order
Ordinary	6	8	21	28	18	9	18	13	–	–	63	184			
Turret	3	3	2	4	3	2	2	4	1	1	11	36			
Lathe and Turret	–	–	1	2	–	–	1	–	–	–	5	9			
Multi-spindle	–	–	–	6	1	1	–	–	–	–	–	8			
Special	–	–	–	–	–	–	–	–	–	–	–	1			
Total	9	11	24	40	22	12	21	17	1	1	80	238	118	120	7

TABLE 7. Age distribution – July 1968 Grinders

Age (Years) / Type	0-1	2-3	4-6	7-9	10-13	14-17	18-23	24-33	34-43	Over 43	Old – age unspecified	Total	Up to 18	Over 18	On order
Universal	8	1	4	2	15	4	3	1	–	–	13	52			
Surface	9	1	4	10	11	3	5	3	1	1	11	59			
Tool and cutter	–	1	3	1	1	1	1	1	–	–	–	9			
Thread	–	–	–	1	3	1	2	1	–	–	–	8			
Gear	–	1	–	–	1	–	1	1	–	–	–	4			
Carousel	1	2	–	–	2	–	2	–	–	–	–	7			
Special	7	6	2	2	3	4	3	1	1	–	7	35			
Total	25	12	13	16	36	13	17	8	2	1	31	174	115	59	14

The sample included 174 grinders of different types, mainly cylinder and surface grinders and their use seems to be expanding with the higher precision standards required. Accordingly the number of old grinders was small. Only 34 per cent was over 18 years and 29 per cent less than 6 years old. Including the 14 machines ordered and the 25 machines installed during the past 3 years the proportion of grinders that are less than 4 years old should be 26 per cent by 1969 (see Table 7). Considering that these figures relate to the end of 1968 it may be assumed that additional orders will be placed by the end of the year, since manufacturers who stated that they did not yet know exactly when they would place their orders said that a decision to that effect would be taken in the near future.

5. Shaping machines

These machines for the production of plane surfaces are not accurate and exact tolerances cannot be obtained. The shaper scrapes the surface and is therefore hardly used in production lines where milling machines are used instead, except when large surfaces are required. Milling machines can carry out 95 per cent of the jobs performed by shaping machines. For maintenance work, repairs and overhauls, on the other hand, this machine is extensively used. It is relatively cheap and has a long lifetime, because its simplicity makes it easy to overhaul. The age distribution is therefore hardly significant. Out of the 49 machines only two were less than 3 years old, 5 were up to 6 years old while 16 were less than 18 years old – altogether 31 per cent. The remaining 67 per cent were over 18 years old. With any other machine tool this would be serious but considering the type of the machine and the functions it fulfils the situation is not bad at all, as may also be seen from the fact that only 1 new machine has been ordered.

6. Presses

Here the international tendency is to go over to high speed presses with automatic feed. In fact it was found that 5 such presses have been ordered, for two of which no price was given (the order is part of this year's plan). The other three cost a total of IL 150,000, (one of them having specific operating characteristics for different speeds and costing IL 80,000. The lifetime of a press is generally long and the existing machines, including the older ones, can still be used for many years to come. Of the 214 presses in the sample 50 per cent or 105 were less than 18 years old and the rest were older. Taking the 10 that are less than 3 years old and the new orders placed there should be slightly over 7 per cent new presses by 1969 which is fairly reasonable, although some 30-40 modern machines are required to take out of action the obsolete presses used in current production. Machines that are over 25 years old – 87 in number – constitute slightly over 40 per cent so that partial replacements are definitely justified. Though the quality of the presses manufactured locally is satisfactory, the models are obsolete.

7. Saws

These are very cheap machines and most plants were unable to indicate when they were purchased since the smaller and medium sized plants regard them as non-durable equipment. When the saw breaks down which with the simpler models is a rare occurrence it is easily and fairly rapidly repaired but if the cost of the repair is too high it is promptly replaced. The machine serves the stores and supplies production material. In production plants a machine of this type is placed at the beginning of the line as the first machine that supplies the material of the required dimensions to the remaining machines. There is a tendency to go over to horizontal band machines which are able to cut metal rods at a very high speed.

For these reasons the age of 70 out of the 86 machines in the sample was not known and at least half this number was presumably bought up to 10 years ago. The percentages were not processed because of the missing data. It should be noted that reciprocating saws of a fairly high quality are manufactured locally and only fast bandsaws must be imported. Only two such machines have been ordered.

8. Guillotine Shears and Bending Machines

Simpler models which have a very long lifetime are found mostly in small workshops. Somewhat more complex adjustable machines with a higher degree of precision - which are therefore also slightly more expensive - are found in the big producer plants. The sample covered 78 machines of which 46 were over 18 years old, 38 - over 25 years and only 32 - or slightly over 41 per cent, less than 18 years old, with 16 or 20 bought up to 5 years ago. Only 3 machines are on order. Simple bending machines and guillotines for sheet metal of small or medium width - up to about 2 m - are manufactured locally in small machine construction plants. The blade is usually imported. The machines are built to order and not produced for the general market.

Although this machinery can be quickly overhauled and the precision required is not high, the state of the equipment is not satisfactory and needs improving.

9. Vertical Lathes

This is a fairly specific machine of which only 7 were found in the sample. Two of them are very old and no information as to their age was obtainable. Another 3 are up to 25 years old while the remaining 2 were in the 4-6 year age group. Vertical lathes are used only when ordinary machines are unable to do the job so that their rate of utilisation is low and their numbers few. They are dealt with separately not only because of their specific function but because their structure is completely different from that of ordinary lathes and the findings are not applicable to lathes generally.

10. Gear-cutting Machines

These, too, are specific machines and the sample findings are not applicable to the general population because: a) 22 out of the 23 machines in the sample were found in one single plant*, and b) to the best of my knowledge only 3 other machines exist in the rest of the population. The machines surveyed were made by 2-3 major US firms and one Swiss firm and the models are suited for several types of work:

- a. Straight ordinary quality type gear wheels
- b. Straight high quality and hardened gear wheels
- c. Special gear wheels for motorized vehicles, including crowns and pinions.

Some of the gear-cutting machines were bought second-hand but thoroughly overhauled about 7 years ago and again about two years ago. They are all fit for operation but not all are fully employed, with only a minor portion of the 22 machines concentrated in one plant being utilized at the time of the survey. The plant was, however, taken over by a new management several months ago and is now being reorganized.

Since the machine were bought second-hand the age of some of them could not be ascertained but they seem to be over 18 years old. The age distribution arrived at [illegible] cordingly as follows:

1	machine	34 43 years
2	machines	25 – 33 "
4	"	18 – 24
1	"	10 13 "
2	"	7 – 9 "
13	machines, unknown, estimated at 18 – 25	

11. Automats

These machines were first introduced in major quantities during the sixties, but some two years ago purchases came to a halt as improvements were expected and various problems had to be overcome. Most of the problems have in the meantime been solved and in the next few years the number of machines of this type may therefore be expected to grow. A serious rival are copying and multi-spindle lathes whose use is constantly expanding. Several manufacturers desist from buying additional machinery of this type for the present in the light of modern developments in automation. The age distribution of the 25 machines in the sample was found to be as follows:

1	machine	unknown (bought second hand)
1	machine	18 – 23 years
1	"	14 – 17
12	"	7 – 9 (in different plants)
5	"	4 – 6
3	"	2 – 3
2	"	0 – 1

* In each type of machine the dispersion among enterprises was checked before drawing conclusions; a similar atypical concentration was found under the headings "special automats" and "special machines".

Other plants in **Israel also have** machines of this **type** so that **the sample seems fairly representative.** For the **reasons** mentioned no **orders for new machines** had been placed.

These machines generally work in one and a half to two and a half **shifts. Some** plants use them in three shifts. The machines are relatively **cheap and are** used continuously until their performance flags, when they are **not** overhauled but replaced. In spite of their simple structure fairly **close** tolerances are obtained. There are several small plants **employing 5 - 7** men which have two automatic machines of this type and work as **sub-contractors** at a highly satisfactory quality and output.

12. Jig Boring Machine

There are only few machines of this type in Israel, as is **evidenced by the** fact that only 4 machines distributed over 4 plants were **found in the sample.** No new orders were found to have been placed and **few are likely** to be placed in the near future. On the average the **industry buys one** such machine per year. The age distribution of the **4 machines in the sample** was as follows:

1 machine 34 years
2 machines 7 9 years
1 machine 4 6 years

This is a high precision machine which must be **operated** in **an isolated** room, if possible with controlled temperature or **at least** with **ventilation** and a maximum humidity of 50 per cent.

13. Broaching Machine

This is a specific single purpose machine of a very simple **construction.** It is used to cut grooves in rods or borings by cutting with **small teeth** ranged consecutively at small differences in height. The sample was found to contain 5 machines of this type, 2 were new, up to 1 year old, and 3 were of ancient, unknown vintage. Most of the jobs **performed** by this machine can be carried out by milling machines and there are **milling** machines equipped with special accessories for this purpose. This is why the number of broaching machines is so small. They are **used** only by major production plants as for small plants there is little sense in keeping this specific machinery.

14. Miscellaneous: Furnaces, **Pressure Casting Machines, Special** Automats and Specific Machinery

Here the lifetime of the equipment is difficult to define. A furnace, **for instance,** can work 50 - 60 years if it is dismantled and reassembled **once a year.** Pressure casting machines also have an extremely long **lifetime.** They have come into increasing use during the past few years. **They** consist of a small furnace and a device which exerts pressure on the mould which is exchanged after a given number of castings. The moulds are mostly made of metal. Special automats and specific machines generally form part of the production line with the various units being replaced or overhauled in accordance with the general maintenance policy for the production line as a whole.

From the age distribution of the different types of equipment included under this heading it appears that the number of machine tools bought during 1948 - 50 is much higher than in previous or subsequent years. This was due to the purchase of surplus war production equipment available in Europe and America during the post war period. Another peak is noted during 1955 - 61, due to equipment purchases out of German reparations funds. Examination of the particulars of the equipment confirms this conclusion, with the bulk of the machinery purchased in 1948 - 50 being of US manufacture and the rest British-made, while most of the equipment bought in 1955 - 61 is of German origin.

b. Distribution of Equipment

The distribution of the machinery among the various technological groups is shown in Table 8. All types of machines appear in group 1, but machine tools are preponderant. The group distribution generally reflects the plant distribution, with the following more or less constant ratios:

5 milling machines
6 lathes
7 grinders
7 drilling machines
1 shaper
2 presses
1 saw
1 furnace

To this must be added the standard auxiliary equipment required by every plant, such as a welding machine and the like. These proportions need not apply to every plant in this group. Slight variations in the composition of the equipment may be caused by the different requirements of the products manufactured. In the four last mentioned types of machinery these variations may be considerable. On the average the distribution conforms to the accepted values [2] and the 6.5 ratio between lathes and milling machines seems highly reasonable under present Israeli conditions where numerical control machines have not yet been introduced. The 6.7 ratio between lathes and grinders seems rather high (see the discussion of grinders) and a ratio of 6.8 or 6.9 would have been preferable. In view of its flexibility and versatility and its constant machinery ratio this technological group is the best candidate for the introduction of numerical control machines.

In technological group 2, too, (sheet metal and stamping) the machine ratio found in Table 8 largely reflects the ratio found in the individual

TABLE 6: Distribution of Machines by Technological Group

Technological group \ Machine	Milling machine	Drilling machine	Shaper	Press	Guillotine and Bending	Saws	Welding machines	Furnace	Pressure casting	Lathe	Vertical Lathe	Special machines	Automatic	Grinders	Gear-cutting machines	Jig-borer	Broaching machines	Other Automatic
1	105	146	25	43	2	18	30	27	5	130	6	2	25	133	22	3	5	10
2	8	48	9	97	63	17	61	2	-	22	-	4	-	13	-	-	-	-
3	12	65	12	28	18	59	66	4	-	58	1	-	-	2	-	-	-	-
4	21	69	-	18	1	1	4	4	-	22	-	-	-	24	1	1	-	-
5	2	6	2	28	-	1	-			19	-	15	-	2	-	-	-	-
6	-	2	1	-	6	8	-	4	-	3	-	-	-	-	-	-	-	-

plants, although the scatter is wider than in group No. 1. A typical basic production unit has the following equipment ratios:

presses	25
bending machines and guillotines	12
welding machines	15
furnaces	0 – 1
drilling machines	12
saws	4

Bigger plants may also have a basic auxiliary servicing workshop with the following basic equipment

1 grinder
1 – 2 milling machines
2 lathes
1 shaper

The fact that the composition of the machinery in the different plants is fairly constant indicates the versatility and flexibility of this technological group which indicates the possibility of mergers of several plants for the formation of bigger production units.

Group 3 (constructions with machining and sheet metal work) constitutes a collection of widely divergent plants varying according to their different functions. They are able to undertake a wide range of non-routine orders, and in order to do so must dispose of a multitude of equipment and services. Nevertheless, with a view to a more streamlined use of equipment and in order to attain a higher utilization rate some plants specialise in a given product or group of products such as mobile cranes, construction equipment, etc. Here the compositon of equipment is obviously greatly affected by the type of product manufactured. In the more versatile and flexible plants the basic unit is as follows:

welding machines	8
presses	2
bending machines and shears	2
saws	3
drilling machines	5
lathes	4 – 5
shapers	1
milling machines	1 – 2

As stated, the rate of utilization of equipment of a unit of this kind is generally low.

In group 4 (casting or forging with or without machining) the composition of the equipment is not greatly affected by the product so that a typical ratio may be expected, but since the sample representing this group was very small no representative basic unit could be constructed. On the other hand a comparison of the different casting and forging plants shows that the distribution of the equipment is similar even when machining processes are included. This, of course, does not apply to either presses or furnaces. Forging furnaces are built quite differently from casting furnaces. While the forging furnace heats the material but does not melt it, the casting furnace is designed to liquefy the material. This makes for the existence of combined forging, casting and machining plants which are very common in the USA and in Europe. In Israel there are only few such plants at present and further developments may be expected.

In Group 4 (special in-line products) the plants specialise in specific items so that the machinery is specific and cannot be converted to other uses. Such plants are justified by the domestic consumption or the export prospects of a given item. The investment is high so that the erection of a plant of this type depends on the marketing potential of a specific product as distinct from other plants which with relatively slight modifications in equipment and machine lay-out are able to shift from one product to another.

Group 6 consists mainly of servicing plants or big metal workshops and here the basic equipment unit cannot be defined.

c. Equipment Orders

The equipment orders by type of machine and by technological group are shown in Table 9. Since no price estimate is so far available for some of these orders it was difficult to arrive at the total cost.

Most of the orders were placed by technological groups 1 and 2. This is understandable if we bear in mind that many big plants are found in these groups. In fact the orders were placed exclusively by plants belonging to size group 4, with over 99 men each. Only few orders were placed by the remaining technological groups and none at all by group 6. Summing up the orders for which price estimates are available, the following picture is obtained.

Technological group 1	52 machines	IL 3,833,600
2	9	137,000
3	1	2,400
4	5	290,000
	Total	IL 4,263,000

Additional machines were ordered or about to be ordered, but the price was not yet clear. These are shown in Table 9. It is estimated that their total value does not exceed 15 per cent of the orders whose price is known and that they amount altogether to about IL 640,000.

TABLE 9. Equipment in Order (in S. million)

Technological group \ Machine	Milling machines	Drilling machines	Shapers	Lathes	Grinders	Presses	Shears and bending	Saws	Welding machines	Furnaces	Gear-cutting machines	Pressure-casting machines	Miscellaneous automats (including N.C.)	Vertical Lathes
1	481,600.– 11 mach.	558,000.– 4 mach.	—	420,000.– 4 mach. + 2 at no charge	536,000.– 13 mach.	30,000.– 1 mach.	20,000.– 1 mach.	19,000.– 2 mach.	—	80,000.–	—	—	1,674,000.– 14 mach. + 1 at no charge	200,000.– 1 mach.
2	196,000.– 2 mach.	374,000.– 1 mach.	11,350.– 1 mach.	—	—	120,000.– 2 mach.	30,000.– 1 mach. + 1 at no charge	—	60,000.– 1 mach. + 1 at no charge	80,000.– + 1 furnace	—	—	—	—
3	—	—	—	2,400.– 1 mach.	—	2 mach. at no charge	—	—	—	—	—	—	—	—
4	86,000.– 2 mach.	—	—	—	30,000.– 1 mach.	—	—	—	—	—	100,000.– 1 mach.	100,000.– 1 mach.	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	2 mach. at no charge	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—

d. Levels of Precision, Inspection and Measurement

Under this heading we shall deal with the findings relating to precision of performance. The questions on the precision of the equipment were answered by the machine operators or foremen but the data obtained did not prove reliable so that no conclusions could be drawn from them. There was a general tendency to give an exaggerated estimate of the performance. Nevertheless, with all due reservations, it appears from the information obtained that the equipment was in good condition in relation to its age and that functionally most of it was satisfactory, thanks to the frequent overhauls carried out by many plant owners and managers, which extend the lifetime of the machines and preserve their standard of precision. This policy of carrying out frequent overhauls, on the other hand, seems to lead to technological stagnation when applied to machines which are undergoing constant developments.

The main conclusions on the industry's production capacity as regards product precision had to be drawn from the data obtained on the measurement and control methods used. It was found that almost all plants in technological group I had a special quality control department. Several plants dispose of highly accurate measuring devices and 5 well set-up measurement and control rooms were found with J.S.I.P. instruments*.

Apart from these five plants which carry out their measurements in special control rooms and calibrate their instruments none of the other plants do so or dispose of any calibrating devices. They do not seem aware of the need for accurate measurement and precision of performance. Much time is lost in fitting parts because of inaccurate tolerances and cases are known where export orders were returned because the tolerances were not as specified. All this is the direct result of the fact that the need for precision has not yet been fully realized. Apart from the 5 plants mentioned none of the others carried out any in-process inspection. Inspection methods are obsolete and lead to a large number of rejects.

e. Manpower

Table 10 shows the manpower distribution of the plants, by technological group. The manpower was divided into the following categories:

Total production personnel	– all persons employed who are directly connected with production
Engineers	– all qualified engineers
Technicians	– all qualified technicians
Administrative staff	– all members of the administrative staff directly connected with production who are not qualified technicians or engineers
Operatives	– all production personnel not belonging to any of the above categories

* J.S.I.P.'s are instruments capable of measuring up to an accuracy of 0.1 micron.

This classification was made to indicate the weight of each category in the production process since the ratio between the different categories has a direct effect on the efficiency and standard of production.

TABLE 10.

Techno-logical group	No of workers	No. of admi-nistrative staff	No. of tech-nicians	No. of engineers	Engineers / Labourers	Technicians / Labourers	Total produc-tion personnel
1	874	94	45	30	1:29	1:19.5	1043
2	744	54	17	23	1:32.5	1:43.5	838
3	657	55	3	26	1:25	-	741
4	197	13	1	7	1:28	-	218
5	198	13	6	7	1:28	1:33	224
6	66	7	-	-	-	-	73
Total	2736	236	72	93	1:32	1:37	3137

In the modern metal industry there is an accepted engineer/labour and technician/labour ratio and the figures appearing in this table, especially for technological groups 1 and 2, are far from optimal. This necessarily affects the efficiency of the plants and above all their future development prospects, all the more so since most of the technicians and engineers are employed by the major plants so that the medium and small plants practically have no technical and engineering staff.

6. ESTIMATED COST OF EQUIPMENT REPLACEMENTS

The cost of equipment replacement was estimated on the basis of several criteria :

1. The retirement age of the machine in question.
2. The average price of the machine in question according to the sub-classification shown in Appendix 9.

It was found that the following machines in the sample surveyed needed replacing:

Milling Machines	after 18 years	69 pieces
Lathes	" 18 "	120 "
Grinders	" 18 "	59 "

Automats	**after 18 years**	**2 pieces**
Jig Boring Machines	**" 18 "**	**1 "**
Presses	**" 35 "**	**65 "**
Guillotines	**" 35 "**	**35 "**
Drilling Machines	**" 35 "**	**92 "**
Saws*		**25 "**
Welding Machines*		**45 "**

		IL 2,415,000. -
Lathes	-	**2,740,000. -**
Grinders	-	**1,843,500. -**
Automats	-	**53,000. -**
Jig Boring Machines	-	**36,400. -**
Presses	-	**2,242,000. -**
Guillotines	-	**1,750,000. -**
Drill Presses	-	**256,900. -**
Saws	-	**155,200. -**
Welding Machines	-	**157,500. -**
	Total	**13,349,500. -**

This estimate relates to equipment of the same size and type as that which has to be replaced. Undoubtedly the new equipment is more modern and includes many improvements that are likely to enhance the industry's performance. Yet the estimate does not take into account the future expansion of production and recent developments in the production equipment used by the modern metal industry. An equipment replacement program like the one indicated above may enable the industry to compete on the international market at present, but in a relatively short time its competitiveness is again likely to be impaired owing to a renewed technological lag, particularly of the plants in group 1. To prevent this undesirable development a new approach is required, taking into account recent innovations - numerical control machines, machining centres - as well as the present and future requirements of the industry. This will lead to a new estimate comprising new types and different quantities of machines. The entire outlay of the machinery will thus be different so that the calculation becomes highly complex.

The above estimate where every old machine is simply replaced by a new one shows that the total investment required for the plants surveyed amounts to about IL 13.5 million. It was found, however, (see preceding chapter) that the total orders placed, including those whose value is still unknown, aggregate about IL 5 million. This means that orders have been placed for only about a third of the equipment that requires replacement. Partly this may be due to the fact that many manufacturers hold up major investments in conventional machine tools until they have sufficient data to decide on the introduction of numerical control machines. At any rate, however, it is clear that investments are much lower than required.

* Owing to lack of information on over half the saws and welding machines the replacement figures were fixed arbitrarily according to the number of machines in the sample.

7. SUMMARY AND CONCLUSIONS

a. State of Equipment and Level of Technology

It was found that thanks to high maintenance standards and constant overhauls the equipment is in good operational condition and its precision of performance is adequate to its present tasks. However, of the 907 main types of machine tools in the sample (milling machines, drill presses, lathes and grinders) about 26 per cent are over 43 years old or of unknown age — usually second or third hand machines which have undergone general overhauls and work at a very low capacity and r.p.m. About 7 per cent date back to 1933 – 1939, with a similar performance level. Another 14 per cent were bought immediately after the Second World War, mainly from American military surpluses. They were originally designed for war production and are technologically obsolete and unsuited for modern carbide tools. About 32 per cent date back to the period when carbide tools were first introduced and work at low speeds (less than 1000 r.p.m.). These were bought some 7 – 13 years ago, usually from German reparations. Only 21 per cent of the machines are of up-to-date construction.

While about 53 per cent of the equipment can still be used for another 2 – 3 years, only 21 per cent will be economically serviceable after that period, producing at a reasonable unit cost.

For historical reasons and as a result of frequent unemployment in former periods, Israel's industry is geared to frequent overhauls. Since the standard in this respect is very high manufacturers tend to hold on to technologically obsolete equipment and it is difficult for new technologies to become accepted. The introduction of carbide tools furnishes a striking example. It was found in the survey that high speed tools are the dominant material and carbide tools are at best used in 30 per cent of cases, and then only are soldered tools of the older type. Up to the present day the introduction of throw-away tools with carbide inserts has been extremely slow for the simple reason that high speed machines with a sufficiently high capacity on which it would be worth while to use such tools are not available. In the rest of the world these tools are used extensively.

Major developments are now again taking place with the introduction of numerical control machines into current production. These developments must be closely followed and the introduction of such machinery should be contemplated, weighing each case on its merits.

The survey has shown that in the sample surveyed orders were placed for only one third of the estimated amount required for the replacement of old equipment by new machines of the same type and size and it is essential that the industry should as soon as possible catch up with this investment lag.

b. Measurement and Inspection

The production capacity of the metal industry is largely determined by the measurement and inspection techniques applied. It was generally found that the plants surveyed were deficient in this respect.

Only the bigger plants with over 99 employees had satisfactory process and product control and even there deficiencies could be noted.

Immediate steps must be taken to introduce improved measurement and inspection techniques and to examine the introduction of new techniques, such as in-process inspection, which are a great help in rationalising production. In addition 2 - 3 central service laboratories should be set up which should be able to test gauges, hardness standards, surface quality and length measuring instruments (parallelometers, micrometers, indicators etc.) at a reasonable price and at short order. These laboratories should be equipped with temperature and humidity control (maximum 30 - 40%) installation. There are three laboratories of this kind operating at present: the Standards Institute in Tel Aviv, the National Council of Science at the Hebrew University in Jerusalem and the Laboratory of the Mechanical Engineering Faculty at the Israel Institute of Technology in Haifa, but their services are used by a very small number of plants. There are at least another three laboratories capable of offering the necessary services, in the Israel Aircraft Co., at Amcor Ltd. and the Leyland factory in Ashdod. During the initial stage a fixed price list should be worked out and the industry should be induced by means of various incentives to make use of the services offered by the existing laboratories.

c. Manpower

The survey indicates that there is a shortage of qualified technicians and engineers. Plant managers, mainly in the bigger undertakings, complained that they had great difficulty in obtaining this type of staff. The division of jobs and authorities between engineers and technicians thus becomes unbalanced and this has a bad effect on the industry as a whole.

There is a high proportion of workers who have undergone two, three or four years training in a vocational school as well as skilled workers with about 8 years experience in a specialised field. Altogether these skilled workers constitute about 50 per cent of all the operatives in the sample but only a minor proportion is skilled enough to be able to operate modern machinery after a short period of training. It is therefore necessary to train a cadre of skilled workers capable of operating modern machinery.

The present curriculum of the technical schools should also be improved and more engineers should be directed towards production by expanding the training offered in design, production, industrial engineering and administration at the Technion in Haifa.

8. REFERENCES

1. T. Vietorisz et al. The Planning of Production and Exports in the Metal Working Industries, Report, Feb. 1967.

2. A. Ber, Some Aspects of the Analysis of the Metal Working Industry, Report, Faculty of Mechanical Engineering, Technion, Israel Institute of Technology, Haifa, Israel, 1967.

9. APPENDIXES

Appendix No. 1 — List of plants included in the sample.
2 — General questionnaire for managers and engineers.
3 — Questionnaire on milling machine.
4 — " on lathes.
5 — " on drill presses.
6 — " on grinders
7 — " on shapers.
8 — Standard machine questionnaire.
9 — Machine prices.

Appendix No. 1

LIST OF PLANTS IN SAMPLE (omitted from English translation)

Appendix No. 2

TO THE MANAGER 1.1–0

a) Organization Name of enterprise ____________________

No. of management staff

No. of junior management staff

No. of engineers ____________________

No. of clerical and administrative staff ____________________

No. of production workers ____________________

Departmental division

Department	Field

b) What are the future development plans (if any) – relating to products – expansion of output ____________________

What are the immediate development plans relating to products – expansion of output ____________________

Remarks ____________________

CONFIDENTIAL

PLANT – GENERAL 1.2–0
CHIEF ENGINEER **Date:**

a) Name of enterprise ______________________
address: ______________________
type of ownership: company/public/Histadrut/private

Products ______________________
____
____
____
____

Total area of plant: ______________________

b) Raw materials

1. **Source:** ______________________
2. **Type** ______________________
3. **Whether** purchased according to specification ______________________
4. **Form** of purchase: bars/semi-finished/ingots/sheets
5. **Material** preparation by: operator/storeman/special department
6. **Order** for series placed by: order + drawing/written order/verbal order
7. **Conveyance** of material to work station: (means of conveyance) ______________________

c) Tools

1. **Place** of purchase: Israel/abroad
2. **Type** of tools used (material, form, type) ______________________
3. **Shape** of tool designed by: ______________________
4. **Shape** ground by: plant/the manufacturer ______________________
5. **Tools** of the plant ground by: operator/tool room ______________________
6. **Work** tool selected by: operator/designer/foreman ______________________
7. **Type** of tools used for machining

HSS __________ % of tools used in the plant ______________________
welded carbide __________ % " " " " " ______________________
Throw-away carbide __________ % " " " " " ______________________
ceramics __________ % " " " " " ______________________
diamond __________ % " " " " " ______________________

CONTROL AND MEASUREMENTS 2.1–8.

GENERAL

1. How is the control carried out during the stages of production (except by the operator): ____________
2. With what instruments are the parts inspected: ____________

3. Is there a control room in the plant: Yes/No
4. Are the measuring instruments periodically checked: Yes/No
5. By what means are the instruments tested and where: ____________
6. Is there a slip-gauge system in the plant: Yes/No
7. What type, grade and number of pieces: ____________
8. When was the system bought (year) ____________
9. If the system is over 3 years old, has it been calibrated, when and where ____________
10. Does the plant use standard gauges (go – not go): Yes/No
11. Who builds the gauges – other manufacturers/the plant
12. After how many measurements is the gauge calibrated ____________

MEASURING ROOM (IF ANY)

1. Is the room air conditioned: Yes/No

   Temperature regulation ____________ ____________

   Humidity control % ____________
2. (Note additional particulars about the room)

   ____
3. Equipment of measuring room

   Slip gauges ____________

   Granite flats ____________

   Hardness testing equipment ____________

   Precise measurement profile projector ____________

   What equipment do you need which for some reason is not being acquired ____________

What machines have you ordered that have not yet been delivered

Type	size or model	name of manufacturer	approximate price	replacing –	in addition to –
Lathe					
1.					
2.					
3.					
4.					
5.					
Milling machine					
1.					
2.					
3.					
Shapers					
1.					
2.					
Grinders					
1.					
2.					
Drill presses					
1.					
2.					
3.					
Automatics					
1.					
2.					
Special machinery					
1.					
2.					
3.					
Miscellaneous					
1.					
2.					
3.					
4.					

What machines would you like to buy during the next 1–3 years but are not buying for various reasons

Type	size or model	name of manufacturer	approximate price	replacing –	in addition to –
Lathe					
1.					
2.					
3.					
4.					
5.					
Milling machine					
1.					
2.					
3.					
Shapers					
1.					
2.					
Grinders					
1.					
2.					
Drill presses					
1.					
2.					
3.					
Automatics					
1.					
2.					
Special machinery					
1.					
2.					
3.					
Miscellaneous					
1.					
2.					
3.					
4.					

Appendix No. 3

CONFIDENTIAL M 1-1

Date ______________ No. of plant ______________ No. of machine ______________

Type of machine: Milling Machine

a) General data

1. Name of manufacturer ______________
2. Country of origin ______________
3. Name of model ______________
4. Year of manufacture ______________
5. Year of purchase ______________ from ______________
6. State of maintenance ______________ Remarks regarding maintenance ______________
   Scale

7. When was the last complete overhaul ______________
8. When was the last partial overhaul (which components) ______________

b) Technical data

Drive System

1. Power of main motor ______________ r. p. m. ______________
2. " " " " ______________ " ______________
3. " " cooling pump motor ______________ " ______________
4. Additional motors - indicate function, power, r. p. m. and voltage ______________

5. Type of cutter clamping ______________
6. Spindle sizes (Diameters) ______________
7. Spindle's r. p. m. ______________

TABLE M - 1 - 9

Table dimensions for clamping ______________________
Number of T slots ______________________
Effective longitudinal stroke ______________________
Effective cross stroke ______________________
Vertical movement of the table ______________________
Table feeds from ____________ **mm/min. up to** ____________ **mm/min.**
Total number of feeds
Height speed reversing feed ____________ **mm/min.**
Other special data ______________________
____

HEAD

Range of r. p. m. from ____________ **to** ____________
Total number of speeds ____________

CUTTING TOOLS

Circular saws, face milling cutters, staggered, cylindrical cutters, end cutters ______________________
____

(indicate appropriate tool and add if needed)

HARD-METAL

Indicate what types of tools with a hard-metal cutting edge are used.

OTHER DATA

1. Floor area (net) ______________________
2. Machine height ______________________
3. Machine weight ______________________
4. Accessories and special tools ______________________

____

5. Adaptations and special arrangements on the machine (indicate if achieved in the plant or in another one and which one)

____
____

M 1 – 3

c. Machine operation

1. Is there one regular operator: Yes/No
2. Professional education – what and where? ______________________________

____
3. General education (if not in an apprentice school) ______________________________
4. How long is he engaged in this profession? ______________________________
5. Average weight of parts: ______________________________
6. Maximum weight of parts: ______________________________
7. Operations on part begin and end on this machine Yes/No

IF NOT

Last operation is made on machine No. ______________________________

Next " " " " " " ______________________________
8. Operator has the part's drawing – Yes/No/Sometimes

If not how does he get instructions? ______________________________
9. Are tolerances indicated? ______________________________
10. What is the closest tolerance? ______________________________
11. " " " normal " ? ______________________________
12. Which measuring tools does the operator use regularly ______________________________
13. What inspection tools are available to the operator? ______________________________

Has he a micrometer or anything more precise? ______________________________
14. Are measuring tools adjusted Yes/No
15. In what periods ______________________________
16. Engagement of machine (per cents or hours) ______________________________
17. Materials machined and in what tools ______________________________

Appendix No. 4

M 3 – 1

CONFIDENTIAL

Date: ______________ No. of plant ______________ No. of machine ______________

Type of machine: lathe

a) General data

1. Name of manufacturer ______________
2. Country of origin ______________
3. Name of model ______________
4. Year of manufacture ______________
5. Year of purchase ______________ from ______________
6. State of maintenance ______________ Remarks regarding maintenance ______________
   Score

7. When was the last complete overhaul ______________
8. When was the last partial overhaul (which components) ______________

b) Technical data

1. Power of main motor ______________ r. p. m. ______________
2. Power of cooling pump motor ______________ r. p. m. ______________
3. Additional motors ______________ function ______________
4. Number of steps of spindle r. p. m. ______________ from ______________ to ______________
5. Number of longitudinal feeds ______________ from ______________ mm/revolution to ______________ mm/revolution
6. Number of cross feeds ______________ from ______________ mm/revolution to ______________ mm/revolution
7. Number of thread notches ______________
   metric ______________ from ______________ mm to ______________ mm ______________
   inch ______________ " ______________ " " ______________ " ______________
8. Cone in the main spindle: ______________ (indicate type and number)
9. Cone in the tailstock: ______________ (" " ")
10. Movement of the spindle in the tailstock ______________ mm
11. Distance between centers ______________ "
12. Height of the centers from bed ______________ "
13. Center height for plane turning (after removing the bridge) ______________ "
14. Diameter of the bore in the spindle ______________ "
15. Movement of the cross slide ______________ "
16. Movement of the compound rest ______________ "
17. Length and width of the machine (floor area) ______________
18. Weight of the machine ______________
19. Additional Data ______________

c) Cutting Tools

1. Clamping system of the tools ______________
2. Types of tools used ______________
   (if hard-metal tools are used, indicate if soldered or throw-away)

M 1 – 8

c. Machine operation

1. Is there one regular operator: Yes/No
2. Professional education – what and where? ____________________

____

3. General education (if not in an apprentice school) ____________________
4. How long is he engaged in this profession? ____________________
5. Average weight of parts: ____________________
6. Maximum weight of parts: ____________________
7. Operations on part begin and end on this machine Yes/No

   IF NOT

   Last operation is made on machine No. ____________________

   Next " " " " " " ____________________
8. Operator has the part's drawing – Yes/No/Sometimes

   If not how does he get instructions? ____________________

9. Are tolerances indicated? ____________________
10. What is the closest tolerance? ____________________
11. " " " normal " ? ____________________
12. Which measuring tools does the operator use regularly ____________________
13. What inspection tools are available to the operator? ____________________

    Has he a micrometer or anything more precise? ____________________
14. Are measuring tools adjusted Yes/No
15. In what periods ____________________
16. Engagement of machine (per cents or hours) ____________________
17. Materials machined and in what tools ____________________

Appendix No. 8

M 8 - 1

CONFIDENTIAL

No. of plant ______________________ **No. of machine** ______________________

Type of machine: drilling machine

types: Bench drill/column drill/radial drill
(indicate type)

a) General data

1. Name of manufacturer ______________________
2. Country of origin ______________________
3. Name of model ______________________
4. Year of manufacture ______________________
5. Year of purchase __________ from ______________________
6. State of maintenance __________ (Score) Remarks regarding maintenance ______________________
7. When was the last complete overhaul ______________________
8. When was the last partial overhaul (which components) ______________________

b) Technical data

Drive system

Power of main motor __________ r. p. m. __________

voltage __________

Type of drive: gear box/belt drive

Number of speed steps of spindle ______________________

Maximum r. p. m. of spindle ______________________

Power feed: Yes/No

Feeds ______, ______, ______, ______ mm/revolution ______

Drill diameter: Maximum ______ mm Minimum ______ mm ______

Taper of the spindle ______________________

Movement of the spindle __________ mm ______

Distance between table and end of spindle Maximum ______ mm ______

Minimum ______ mm ______

Horizontal distance between center of column and center of table __________ mm

Movement of drill head on the arm __________ mm

Movement of arm on the column __________ mm

Is it possible to remove the table (radial drilling machine)? Yes/No

Height of the machine __________ mm

Floor dimensions: Length ______ mm Width ______ mm

Column Diameter __________ mm

Weight of the machine __________ kg

M 1 – 3

c. **Machine operation**

1. **Is there one regular operator: Yes/No**
2. **Professional education – what and where?** ______________________________
   ____
3. General education (if not in an apprentice school) ______________________________
4. How long is he engaged in this profession? ______________________________
5. Average weight of parts: ______________________________
6. Maximum weight of parts: ______________________________
7. Operations on part begin and end on this machine Yes/No

   IF NOT

   Last operation is made on machine No. ______________________________
   Next " " " " " ______________________________
8. Operator has the part's drawing – Yes/No/Sometimes
   If not how does he get instructions? ______________________________
9. Are tolerances indicated? ______________________________
10. What is the closest tolerance? ______________________________
11. " " " normal " ? ______________________________
12. Which measuring tools does the operator use regularly ______________________________
13. What inspection tools are available to the operator? ______________________________
    Has he a micrometer or anything more precise? ______________________________
14. Are measuring tools adjusted Yes/No
15. In what periods ______________________________
16. Engagement of machine (per cents or hours) ______________________________
17. Materials machined and in what tools ______________________________

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2 OF 2

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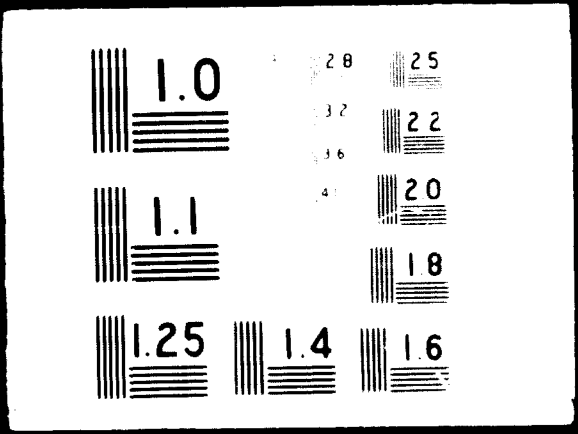

Appendix No. 6

M 4 – 1

CONFIDENTIAL

No. of plant ____________________ No. of machine ____________________

Type of machine: Grinder/cylindrical/surface/thread

a) General data

1. Name of manufacturer
2. Country of origin
3. Name of model
4. Year of manufacture
5. Year of purchase ____________________ from ____________________
6. State of maintenance ____________ Score ____________ Remarks regarding maintenance ____________________

____
7. When was the last complete overhaul ____________________
8. When was the last partial overhaul (which components) ____________________

b) Technical data

Motor of the spindle: ____ Power

____________________ r. p. m.

____________________ voltage

r. p. m. of the spindle: ________ / ________ / ________ / ________ / ________

________ / ________ / ________ / ________ / ________ / ________ / ________

Drive of table feeds: Mechanical Hydraulic

Cross feed from ____________ to ____________

Longitudinal feed: from ____________ to ____________

Spindle bearing ____________________

Motor for workpiece rotation: Power ____________________

r. p. m. ____________________

Stroke of the table (longitudinal) ____________ mm

Cross movement of the table ____________ mm

Dimensions of magnetic chuck ____________

Center height of the workpiece ____________ mm

Diameter of grinding wheel: Maximum ____________ mm

Minimum ____________ mm

Maximum height of spindle from magnetic chuck ____________ mm

Vertical movement of the table ____________ mm

Floor dimensions ____________________

Machine height ____________________

Weight of machine ____________________

Accessories ____________________

____

c. **Machine operation**

1. Is there one regular operator: Yes/No
2. Professional education – what and where? ______
3. General education (if not in an apprentice school) ______
4. How long is he engaged in this profession? ______
5. Average weight of parts: ______
6. Maximum weight of parts: ______
7. Operations on part begin and end on this machine Yes/No

   IF NOT

   Last operation is made on machine No. ______
   Next " " " " " " ______
8. Operator has the part's drawing – Yes/No/Sometimes
   If not how does he get instructions? ______
9. Are tolerances indicated? ______
10. What is the closest tolerance? ______
11. " " " normal " ? ______
12. Which measuring tools does the operator use regularly ______
13. What inspection tools are available to the operator? ______
    Has he a micrometer or anything more precise? ______
14. Are measuring tools adjusted Yes/No
15. In what periods ______
16. Engagement of machine (per cents or hours) ______
17. Materials machined and in what tools ______

Appendix No. 7

M 1 – 5

CONFIDENTIAL

No. of plant ______________________ **No. of machine** ______________________

Type of machine: Shaper/Planing machine

a) General data

1. **Name** of manufacturer ______________________
2. Country of origin ______________________
3. **Name** of model ______________________
4. **Year** of manufacture ______________________
5. **Year** of purchase ____________ from ____________
6. **State** of maintenance ____________ Remarks regarding maintenance ____________
   Score
   ____
7. **When** was the last complete overhaul ______________________
8. **When** was the last partial overhaul (which components) ______________________

Technical data

Main Motor: Power ____________ r. p. m. ____________
Feed Motor: " ____________ " ____________
Cooling Pump Motor: " ____________ " ____________
Strokes per minute of the head ______________________
" " " " " table ______________________
Cross feeds of the table: from ____________ mm/stroke to ____________ mm/stroke
" " " " head " ____________ " " ____________ "
Table dimensions: Length ____________ mm Width ____________ mm
Movement of the table: cross ____________ mm Vertical ____________ mm
Stroke of the table (planing machine) ______________________ mm
Movement of the head (planing machine): cross ____________ mm Vertical ____________ **mm**

Floor dimensions ______________________
Height of the machine ______________________
Weight " " ______________________

Accessories: ______________________
____

c. **Machine operation**

1. Is there one regular operator: Yes/No
2. Professional education – what and where?
3. General education (if not in an apprentice school)
4. How long is he engaged in this profession?
5. Average weight of parts
6. Maximum weight of parts
7. Operations on part begin and end on this machine Yes/No

   IF NOT

   Last operation is made on machine No.
   Next " " " " "
8. Operator has the part's drawing – Yes/No Sometimes
   If not how does he get instructions?
9. Are tolerances indicated?
10. What is the closest tolerance?
11. " " " normal "?
12. Which measuring tools does the operator use regularly
13. What inspection tools are available to the operator?
    Has he a micrometer or anything more precise?
14. Are measuring tools adjusted Yes/No
15. In what periods
16. Engagement of machine (per cents or hours)
17. Materials machined and in what tools

Appendix No. 8

CONFIDENTIAL

Date: ______________________ **No. of plant** ______________ **No. of machine** ____________

Type of machine: Press

eccentric/hydraulic/disc

a) General data

1. Name of manufacturer ______________________________
2. Country of origin ______________________________
3. Name of model ______________________________
4. Year of manufacture ______________________________
5. Year of purchase ______________ from ______________
6. State of maintenance ______ Score ______ Remarks regarding maintenance ______________

____

7. When was the last complete overhaul ______________________________
8. When was the last partial overhaul (which components) ______________________________

____

____

Table area ______________________________

Power ______________ ton ______________

Number of strokes per minute ______________

Floor dimensions ______________________________

Where are the dies produced?

Israel: ______________________________

Abroad: ______________________________

Power Metal Saws

Producer ______________________________

Product of ______________________________

Type of saw: Bandsaw/hacksaw/

c. Machine operation

1. Is there one regular operator: Yes/No
2. Professional education – what and where? ______________________________

3. General education (if not in an apprentice school) ______________________
4. How long is he engaged in this profession? ______________________
5. Average weight of parts: ______________________
6. Maximum weight of parts: ______________________
7. Operations on part begin and end on this machine Yes/No

   IF NOT

   Last operation is made on machine No. ______________________
   Next " " " " " " ______________________
8. Operator has the part's drawing – Yes/No/Sometimes
   If not how does he get instructions? ______________________

9. Are tolerances indicated? ______________________
10. What is the closest tolerance? ______________________
11. " " " normal " ? ______________________
12. Which measuring tools does the operator use regularly ______________________
13. What inspection tools are available to the operator? ______________________
    Has he a micrometer or anything more precise? ______________________
14. Are measuring tools adjusted Yes/No
15. In what periods ______________________
16. Engagement of machine (per cents or hours) ______________________
17. Materials machined and in what tools ______________________

Appendix No. 9 **Equipment Prices**

UNIVERSAL MILLING MACHINES:

Table size 800 x 200 mm 3 HP	$ 6,500.–
1000 x 220 mm 4 HP	9,000.–
1500 x 300 mm 7 HP	10,500.–
2000 x 500 mm 25 HP	22,000.–

JIG BORING MACHINES:

Deckel LKB, table size 650 x 300 mm	$ 11,000.–
Hauser 3BA	9,800.–

GUILLOTINE SHEARS:

1850 x 2,5 mm	$ 11,000.–
10' x 3/16"	14,500.–
10' x 3/8"	20,400.–
10' x ½"	28,500.–

POWER PRESSES:

25 Tons	$ 4,500.–
40 "	5,300.–
60 "	7,000.–
100 "	14,000.–
150 "	27,000.–
200 "	31,000.–

POWER DRIVEN SCREW PRESSES:

Spindle dia. 130 mm	$ 16,000.–
150 mm	21,000.–
200 mm	28,000.–

UNIVERSAL IRON WORKER:

For plates 11 mm, angle iron 80 mm	$ 2,500.–
13 mm 100 mm	4,000.–

PRESS BRAKES:

1500 mm length, 40 tons	$ 6,000.–
3000 mm " 135 "	13,200.–
3000 mm " 225 "	20,500.–
3000 mm " 400 "	30,500.–
3000 mm " 250 "	27,000.–

HACKSAWING MACHINES:

300 mm	$ [illegible]
400 mm	[illegible]
500 mm	[illegible]

BANDSAWING MACHINES:

For toolroom	$ [illegible]

CIRCULAR SAW:

Dia. of saw blade 500 mm	$ [illegible]
600 mm	4,400.–
700 mm	[illegible]

DRILLING MACHINES:

Bench type 5 mm	$ 180.–
8 mm	200.–
13 mm	220.–
With coolant 18 mm	500.–
25 mm	670.–
32 mm	1,300.–
40 mm	2,310.–
50 mm	2,465.–
Radial drilling machines, capacity 1½", distance between column and spindle 1000 mm	3,700.–
Capacity 2", distance " 1400 mm	4,500.–
3.1/4" " " 2000 mm	8,280.–

S AND SC LATHES

11" swing, distance betw. centres	60"	$ 2,000.–
17"	60"	6,660.–
21"	60"	7,900.–
21"	84"	8,200.–

TURRET LATHES:

45 mm hole	$ 7,000.–
61 mm	7,500.–

6-SPINDLE AUTOMATICS:

1" capacity	$ 17,200.–
2"	28,500.–
3.1/4"	38,440.–

SINGLE SPINDLE AUTOMATICS:	
½" capacity	$ 5,150.–
3/4"	5,400.–
1"	5,550.–
2.3/32"	10,650.–
2.1/4"	10,950.–
VERTICAL MILL 36"	$ 17,850.–
73"	26,250.–
UNIVERSAL GRINDING MACHINES:	
14 x 39"	$ 15,800.–
14 x 51"	17,200.–
18 x 75"	20,100.–
24 x 75"	20,250.–
SURFACE GRINDERS:	
18 x 6"	$ 2,550.–
24 x 8"	4,400.–
32 x 12"	5,100.–
TOOL AND CUTTER GRINDERS:	
No. 1	$ 2,100.–
No. 2	3,200.–
THREAD GRINDERS:	
Matrix	$ 25,000.–
CENTRELESS GRINDER No. 2 50 mm	$ 12,000.–
WORM GRINDING MACHINE "Matrix"	$ 27,000.–
SHAPING MACHINES 300 mm stroke	$ 1,950.–

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