PLANS FOR A COMMERCIAL FORGING PLANT IN ISRAEL

by

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Signature of Author.......................................
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ABSTRACT

PLANS FOR A COMMERCIAL DROP FORGING PLANT IN ISRAEL

by Arie Kaplan

Submitted to the Department of Business and Engineering Administration on May 12, 1952 in partial fulfillment of the requirements for the degree of Master of Science.

Study deals with problems involved in the establishment of a commercial forging plant in Israel.

Findings:

The demand for forged products in Israel amounts to about 1,600 tons annually. This tonnage is comprised of hand tools and chain links (agriculture and conveyor). A board hammer plant with equipment valued at 117-140 thousand dollars can produce hand tools at a value of about 150 thousand dollars per year (value of raw materials excluded).

Thesis Supervisor: T.M. Hill

Title: Associate Professor of Accounting

May 12, 1952
Cambridge, Massachusetts

Professor Leicester F. Hamilton
Assistant Secretary of the Faculty
Massachusetts Institute of Technology
Cambridge 39, Mass.

Dear Professor Hamilton:

In accordance with the requirements for graduation, I herewith submit a thesis entitled "Plans for a Commercial Forging Plant in Israel".

Sincerely yours,

Arie Kaplan

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VI. SUMMARY AND CONCLUSIONS

Our purpose in this paper was to evaluate some of the most important aspects concerning the establishment of a commercial drop forging plant Israel. We choose to evaluate only some of these aspects because an overall evaluation will certainly require extensive field studies in Israel; this was not possible for us. We therefore choose to concentrate on those problems that could be studied well enough from data available in the U.S. Our study covered 1) Basic developments in Israel since the establishment of the state in 1948, 2) Manufacturing conditions in Israel particularly as applied to new enterprises, 3) An analysis of the demand for forged products in Israel, 4) An estimate of the forging capacity required in Israel, followed by initial plans for a commercial plant. These plans included an estimate of the dollar investment required for the purchase of raw materials and equipment, 5) A discussion of quantity effects on conversion costs in the forging industry. These problems and sequences were chosen because we think that the success of a new enterprise and its future, depends greatly on economic and political conditions and developments in its sphere of action. We therefore started with conditions and developments in general and gradually narrowed it to some of the main problems of one single plant in a particular industry.

In a number of instances, we were forced to make assumptions, as we lacked basic data pertaining to them. The reader will realize for himself that when this was done the data and conclusions developed, are only as good as the assumptions made.

Let us now summarize our findings in the fields covered, a set of conclusions will follow after that.

BASIC DEVELOPMENTS

In this section we recognize the strive in Israel toward diversified economic development and the gathering of the Jews. We observed that the two aims are partially complimentary and partially contradictory. The first being true because the mass immigration supplies the man power necessary for the economic development, the second being true because goods and funds necessary for economic development are diversed for consumption.

We learned that since 1948, the Jewish population in Israel doubled, and that government plans provide for an additional increase by 50% at the end of 1953. It was doubted by us that this last goal will be achieved according to schedule. But we did not doubt that immigration will continue at a slower pace.

The break of economic relations between Israel and its Arab neighbors was considered to be a major setback. Because of this break, valuable trade relations in the past were concluded, and Israel lost important suppliers, sources of agricultural products and buyers for its manufacturers.

MANUFACTURING CONDITIONS IN ISRAEL

We divided this section into three sub-sections. These sections covered 1) Present and potential demand for goods, 2) Investment conditions, 3) operational problems.

Present and Potential Demand for Goods

According to data presented, economic activity in Israel was more than doubled since 1948 (measured by number of people employed). With this demand for industrial goods expanded at a parallel rate, and even more due to a greater emphasis on mechanization. Demand for consumer goods also doubled due to the doubling of the population. In addition to the increase in demand for current operations and consumption there is also a great increase in demand for investment goods, housing facilities, and durable consumer goods. The demand for the last category is expected to tapper off once the initial investment in capital goods, housing and consumer durables are completed. The expected continuity of immigration and the prevailing scarcity of all goods mean that the period of initial investments and buyings will be stretched out for a longer period than the one that could be expected at normal conditions.

Therefore Israel offers the manufacturer an expanding and hungry market for an unpredicted number of years.

Investment Conditions

We included under investment conditions investigations as to: 1) Government attitude, 2) Availability of investment capital, 3) Availability of manufacturing facilities.

Government Attitude

It was found that the government and the legislative body have a definite positive attitude toward the establishment of new productive facilities. Granted that these facilities will be complimentary to the development of a healthy economy. Thus new enterprises that their operation will result in the saving or earning of hard currencies are granted valuable rights. These rights were authorized by a special law "For the encouragement of capital investments" includes different tax exemptions, duty free import rights, right to transfer abroad 10% of foreign capital invested per year and land leases on convenient terms. In addition the law mentioned above provided for the establishment of a special governmental agency called "The Investment Center" whose duty it is to carry out this law. The records of this center point out that it is certainly trying to do its best in the way of encouraging the establishment of new productive facilities.

Availability of Invested Capital

A distinction between foreign and local capital was made. It was observed that while local capital is relatively abundant (if a fair return is expected), foreign capital is scarce and represents the limiting factor in the establishment of new enterprises. It was also observed that the inflow of foreign investment capital is on the way up, and could be expected to increase in the future due to a higher rate of exchange established for investment purposes.

Availability of Manufacturing Facilities

Data represented points out that with the exception of land, all commodities necessary for the erection of a new plant are extremely scarce. Almost the only way to get these facilities is by buying them abroad with foreign currencies supplied by foreign-investors. The government allocates some goods bought with its own foreign currencies, but this allocation is by no means enough to cover all needs. Thus the erection of a new plant could be materialized only if foreign investors could be induced to invest.

Operational Problems

Under operational problems we included 1) Raw material supplies, 2) Labor, 3) Technical and managerial know-how, 4) Auxiliary services, 5) Competition and 6) Government action.

Our study showed that raw materials are scarce in Israel as anything else. Those raw materials available are allocated by the government. There exists of course a black market where costs are sky high. New plants are advised to start operations with inventories that will suffice for one or two years of operations. In addition governments recent policy is to allocate raw materials only to those concerns that earn hard currency through the export of their goods. Israel has some resources of raw materials which include phosphates, copper, manganese, caolin, glass-sand and iron ore. Phosphates, Caolin and glass-sand are now being commercially exploited while the utilization of the other minerals is subject to further study.

Labor

There is an abundant supply of unskilled labor in Israel. Skilled and semi-skilled workers are scarce. Labor productivity is low, and this is attributed to 1) Lack of an incentive to produce, as labor is mostly on hourly rates, 2) Poor management, 3) Lack of technical knowledge.

In one case where these defficiencies were partially removed, productivity rose up to 75% of that in the U.S.A. It therefore appears that the Israeli worker could be productive if he is given an incentive and the means to be one.

Average labor rates in industry are at present about $.45 per hour. (According to the new exchange, rates for exports and investments off. ~~are~~ $1.00 = IL 1.00)

Technical and Managerial Know-how

In many cases, the industrial know-how is limited and somewhat obsolete compared to U.S. standards. This situation is changing for the better with the influx of western capitalists, technicians and capital.

Auxiliary Services

Auxiliary services lack the intensity and quality of industrial countries. Plants are thus forced to be more self-sufficient than those in the U.S.; this results of course in higher costs and lower quality of such services.

Competition

Competition for markets does not exist at present in Israel. The only competition that a manufacturer encounters is when he takes his turn as a buyer of raw materials or services.

Government Action

Government regulates many aspects of the business activity. The range of regulations involves price determination, raw material allocations, export and import licenses, electric power and many other business aspects. Due to the critical economic situation in

Israel, changes in government policy are quite frequent, radical, and sometimes disastrous to manufacturers of non-essential goods. All these regulations involve a considerable amount of red-tape which is very hard in particular on small units.

The Demand for Forged Products in Israel

The data in our possession included the demand for forged tools, chain links, and flanges only. According to this the demand in these lines amounts to about 5 million forged units with a net weight of about 1600 tons. Of these 5 million units, 2.25 million are chain links and flanges, and the rest, 1.75 million units are hand tools and tool parts. These tools are divided into more than 30 different product-lines which come all together in about 170 different varieties. (Varying in size, design and quality.) On the average, annual quantities of 10,000 units are expected for each variety. Actual figures however will run all the way from a few hundred to about 50,000 units or more.

Chain links are estimated to have higher runs as only 30 varieties were assumed, thus annual quantities will run at an average of about 100,000 units.

IV Plant Capacity and Equipment

In this section we aimed at arriving to an estimate of the size that a forging industry could achieve in

Israel at the present level of demand, and we also studied the different aspects of pertaining to the initially advisable size for a forging plant.

It was found that about 20,000 productive hours of board drop hammers are required to process assumed annual demand for forgings in Israel. This figure was doubled in order to compensate for low productivity in Israel as compared to the U.S. In addition we added about 35% of productive capacity to provide for exports of forged products. All together required productive capacity amounts to 54,000 thousand productive hammer hours. At 2,000 productive hours per hammer per year, Israel needs about 27 board drop hammers to provide for all forged tools and chain links that it needs plus 35% of it for exports.

Our next step was to determine what is the advisable initial capacity to start with and with what equipment. It was found that a plant with three board drop hammers at the sizes of 600-1,200-1,800 pounds will be the most advisable size to start with. Such a plant will be able to process about 20-30 percent of all tools required on the market. It will also be economical for that size plant to maintain its die making shop and heat treatment department. According to an estimate, the cost of new equipment for such a plant will run about $144,000-$120,000 if equipment is purchased new. In addition, a year's supply of raw materials will cost about 50,000 dollars. In case that dies have to be bought initially in the U.S.A. their cost will amount to about 37,500 dollars. If dies are sinked in Israel right from the beginning, cost of ~~raw~~ die steels will amount to about 4,500 dollars. All together, the outlay in dollars on equipment, dies, and raw materials are estimated to be $175,000 to $228,000.

V. Quantity Effects on Conversion Costs.

Based on individual studies of the operations involved in the forging process and also by the use of quantity-cost ratios developed by the drop forging association, we found that quantity cost differences disappear at runs of 100,000 units and up. From 100,000 unit runs down to 5,000 unit runs, conversion costs do not increase by more than 7 percent,[1] from 5,000 unit runs to 1,000 unit runs cost ratio increases considerably but will not exceed a ratio of 1.07:1.33 at runs of 1,000 units to 100 units, cost increase rapidly and reach a ratio of 1.33:4.40.

It was also found that conversion costs per pound increase as unit weight decreases, and that quantity - cost differentials decrease as unit weight increases. (All that was said here pertains to unit weights of 0.-60. pounds.)

(1) Figures are for 600-3,000 pound hammers.

CONCLUSIONS

Based on ourstudy, we conclude that present demand for forged tools and parts warrants the development of a forging industry in Israel at an estimated capacity of about 27 board hammers able to produce about 1,600 tons of forgings annually.

The forging unit discussed here could be considered as a "pilot plant" on which experience, a larger plant could be developed later.

It is expected that the plant discussed here will encounter many difficulties in the initial period of erection and operations. These difficulties are partially due to the rapid changes that Israel undergoes now, and partially to more basic and permanent difficulties.

It is expected that operations of the plant will prove profitable from an early stage, due to the lack of competition and scarcity of tools. There is no doubt that the plant will receive the status of an "Approved Enterprise" which is a further guarantee that operations could be conducted profitably, if not smoothly.

The establishment of the plant will be also an important contribution to ~~the~~ Israel's economy as it will result in theoretical savings of about 150,000 dollars per year (or their equivalent in other hard currencies) and guarantee a supply of badly needed hand tools, to their ultimate users. In addition through its pioneering work it might open the door to additional forging plants that will benefit from its experience.

We think that basically this branch of industry is well adapted to ~~the~~ manufacture of small quantities of tools required in Israel, as the differences in costs between a million unit run and a 10,000 unit run are relatively small and do not give the large producer an unbeatable advantage.

For these reasons, we think that it will be possible for an Isreali forging industry to compete with larger manufacturers on export ~~trade~~ markets, granted that the combination of labor cost and labor productivity will be more or less equal.

INTRODUCTION

The purpose of this work is to study some of the problems involved in establishing and operating a Commercial Forging Plant in Israel.

As commercial forging we mean a plant that will specialize in the manufacture of forgings only, selling its product either to other manufacturers, for machining and/or assembly or directly to the consumer in case that the forging does not need further processing. This study was undertaken in order to find out whether our notion that there is a place for a forging industry in Israel is valuable. It was thought that if the study will give positive results, it might lead eventually to the promotion and erection of such a plant.

In order to get reliable results, we chose to concentrate on some of the aspects of this plan, with the thought that if we will get positive indicators from these areas a more complete study will be undertaken at a latter stage. We thought that the questions to be answered before taking any further steps are the ones listed below.

1) What are general economical conditions in Israel at the present and what developments can we expect in the future, with particular emphasis on manufacturing conditions.

2) What is the present demand for forged products, in what lines and in what quantities?

3) What size of a forging industry will fit the demand in Israel? With what capacity and investment should we start?

4) How are product unit-costs affected by the relatively limited demand in Israel?

The data used in this paper was collected from the following sources:

1) Publications of the Drop Forging Association and others.

2) Visits in a number of New England forging plants.

3) Publications of the government of Israel, and others.

4) Personal contacts with businessmen, and officers of government and other organizations and institutes operating in Israel.

5) Personal acquaintance with conditions in Israel.

As the reader will find, the paper is divided into four sections, each one aimed at answering one of the four questions mentioned above. In addition, there is one section designed to give the reader some background on major developments in the state of Israel since its inauguration.

CONDITIONS IN ISRAEL - AS A BACKGROUND FOR INDUSTRIAL DEVELOPMENT

What are the economical conditions in Israel in respect to industry, and how do they affect the new and existing industrial concerns is the problem for this part.

Naturally, this object could be made into a volumous study for itself, however, an effort will be made to point out in brief only those points that have a close effect on the development and operation of industry, its opportunities and dangers.

To see what is the background for industrial development, one must consider two phases.

1) Present conditions

2) Possible developments in the future

To the extent that the past could bring some light on present and future developments this would also be brought up.

Present Conditions

Three basic developments are dominating life in Israel today.

1) Change from a colonial government to a democratic one.

2) The immigration of more than 680,000 Jews.[1]

3) The break in relations and state of war with neighboring Arab nations.

(1) Economic Horizons - Vol. 4 No. 2, Pub. by The Jewish Agency for Palestine, New York City, Feb., 1952, p-1

Let's see now what are the effects of these three major changes on the economy, and thus on industry.

OBJECTIVES AND POLICIES OF PUBLIC AND GOVERNMENT

Two objectives are leading the people's legislature(1) and government today and will probably lead them for a substantial period in the future. These objectives are:

1) Mass Jewish Immigration that will absorb as many Jews in need for a new home as possible.

2) Development of a modern democratic self-supporting and self-defending state.

These two objectives are the key to a substantial number of regulations, policies and activities taking place in Israel.

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(1) Total population is Israel (as estimated in the government's manual for 1951) was 1,429,000 people of which 1,260,000 were Jews and 169,000 Arabs and others. The Arab population in the area now designated as Israel was much greater until the end of 1948. However, the majority of them fled Israel during the war in 1948, and were not allowed to return. The number of Arabs that left Israel is a matter of debate, and is estimated to be between 450-600 thousand. Clearly enough, the Arab population has its own ideas about the future of the country, and they differ quite extensively from the one that will be expressed here.

While the parties in power might change, and thus their auxiliary objectives and means of achieving these two objectives, there is but little doubt in my mind that for the majority of people in the state, immigration and development are the yardsticks by which they will judge their government in the long run, and according to which they will choose it.

Though extensive development and mass immigration are tied up and complimentary to a certain degree, they are in some aspects mutually contradictory. Thus a need to keep a balance between the objectives arises. Naturally enough action to bring the objectives in balance is taken only after they go out of it, which means that economic and political disturbances have to arise before corrective action is initiated. A case in point is the last change in governmental policy toward immigration(1). In this case, the government established a policy of selective immigration from countries where Jews are not under danger of their life or personal freedom. Here, the restriction on the entry of non productive people is a sacrifice of the objective of free immigration for the good of the objective of achieving economic self sufficiency.

A case showing an opposite direction is the way development funds were allocated. Out of an equivalent

(1) Prime Minister's speech in parliament at the end of 1951.

of half a billion[1] dollars (41.5 percent of it in hard currencies and the remaining at the official rate of exchange (IL 1.00= $2.80). $200 million (40%) was spent on housing for the expanding population. By devoting such a share to a non-productive investment, the possible use of these funds for economical development was thussacrificed.

The rest of the funds were used as follows; $129 million (26%) on agricultural development, $70 million (14%) for industrial development, $48 million (10%) for communications and $50 million for public works.[2]

In summary - The public and government in Israel are trying to achieve both the gathering of Jews and the development of a modern democratic society able to support and defend itself. As national and international conditions change the emphasis might be shifted from the first objective to the second or vise versa. Both objectives however are kept in focus.

Let us now observe the immigration into Israel and some of the problems arising as a result.

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(1) Economic Horizons, Vol. 4 No. 2, February, 1952 The Jewish Agency for Palestine, New York City
(2) ditto

MASS IMMIGRATION

The most important development in Israel since its establishment is the mass immigration that took place from the middle of 1948 until the end of 1951. During this period, the Jewish population in Israel more than doubled itself. (From 650,000 to 1,340,000 people.)[1]

These people are coming from countries with a different economic set up from that existing or aimed at, in Israel. Of the 685,000 immigrants that entered Israel in the years 1948-1951, about 50% came from Asia and Africa, the other 50% came mostly from Europe.[2] Table I compares the occupational structure of the immigrants in the countries of their origin with that of the Israel Jewish population, in 1947 and the occupational structure planned by the government for 1953.[3]

The figures for the occupational structure of immigrants are based on data on immigrants entering Israel in 1950. Of the 169.405 people who entered that

(1) ditto p.1
(2) Government Manual, 1952, Israel Government's Printing Office, Hakirya, p.369
(3) Table compiled from Government Manual, 1952, Israel Government's Printing Office, Hakirya, Table 13 and Dr. A. L. Gruenbaum - Four Year Development Plan of Israel, 1950-1953, Prime Minister's Office, Jerusalem, April, 1951, Table 2, p.40.

year, 49,404 were gainfully occupied in their country of origin. (29.4%). However, for an additional number of 22,153 persons (13.5%) there is not any information as to their source of income in the country of origin.(1) It is very likely that part of them were dependent on others for their living while part failed to report their occupations.

(1) The rest, 57.1%, were children, housewives and other dependents.

OCCUPATION	I OCCUPATION ABROAD IMMIGRANTS	II JEWISH OCCUPATION IN ISRAEL 1947	III OCCUPATIONAL STRUCTURE AS PLANNED BY GOVERNMENT FOR 1953	IV DIFFERENCE BETWEEN I & III (I-III)
Agriculture	5.1	12.2	21.6	-16.5
Manufacture	45.0	25.5	18.3	26.7
Building & PW	2.5	5.7	13.5	-11.0
Transportation	2.6	6.0	5.7	- 3.1
Commerce	16.0	15.2	15.6	0.4
Finance	N.A.	3.4	2.1	
Professions	9.4	10.4	8.3	1.1
Civil Service	N.A.	6.3	5.1	
Work for Armed Forces	N.A.	4.1		
Personal Services including restaurants & hotels	3.4	7.0	6.3	-2.9
Miscellaneous		4.2	3.5	
Clerical & Administrative	16.0			
Total Earners	100.0	100.0	100.0	
Earners as 1% of Population		41.0	37	
Total Jewish Population		650,000	1,800,000	

TABLE I - COMPARISON OF THE OCCUPATIONAL STRUCTURES OF THE IMMIGRANTS TO PAST (1947) AND PLANNED (1953) OCCUPATIONAL STRUCTURE IN ISRAEL

It should be noted that the figures for 1953 are according to the government plan for development and immigration.[1] This plan aimed at a total population of 1,800,000. However, if immigration continues at the current rate (I-V 1952) total population in Israel at the end of 1953 will probably be around 1,500,000 people only. Present population is more than 1,400,000.

The outstanding facts as to the changes that will have to take place in the occupational structure of the Immigrant group are:

A. A major shift to agriculture and construction work.

B. A major shift from manufacturing to other occupations.

C. A possible need for a shift from office work to other occupations.

It should be noted that around 18% of those employed in manufacture were engaged in metal, mechanical, electrical and precision machines work.

The problem is not only of adjustment from one branch of the economy to another, but also within branches, and industries as the nature of the same industry in Israel differs probably considerably from that in Saudi Arabia or other countries of origin.

As readjustments take place inefficieny, low

(1) Dr. A. L. Gruenbaum - Four Year Development Plan of Israel, 1950-1953, Prime Minister's Office, Jerusalem, April, 1951

quality is bound to occur. It is likely that full adjustment of immigrants to new conditions will be reached only after a considerable number of years, and in many cases will never be accomplished.

According to Table I, about 40% of the immigrants were employed in manufacturing. This means that a shift from manufacturing occupations into agriculture has to take place.

An analysis of the occupations, within the manufacturing branch reveals that employment was concentrated in the clothing industry (29%) and leather industry (10%), while textile, machinery, woodwork, and electrical industries represent only 4-6% each of the occupations. In other words, a selective process might take place in the clothing and leather industries while a number of other industries will have to develop and train a considerable part of their labor force.

A large segment of the immigrants are D.P. while another segment of these people come from underdeveloped areas. All together these people are extremely poor and don't have enough assets to invest in housing facilities or productive facilities, two types of investments that are a must for the economical absorption of the newcomers. While it took relatively little time to transfer the immigrants, their absorption and productivization is a harder problem, especially when it has to be done on a large scale and under conditions unfavorable because commodities and services are scarce.

The increased demand for consumer goods, together with the increased need for capital investment are exercising a tremendous pressure on the economic resources of the country, which have to be stretched in both directions. Under these conditions the satisfaction of one need increases the shortage at the other end, and thus pressure is shifted back and forth with neither requirement being completely satisfied.

Summarizing - The mass immigration into Israel which doubled its population in 3½ years brought with it the following needs.

1) Need for the expansion (doubling)of housing facilities.
2) Need for the expansion of productive facilities.
3) Need for mass transformation of workers from one economic branch or industry to another.
4) Need for integrating people coming from more than 30 countries, speaking little less than that number of languages, into one economic, cultural and political unit.(1)

Les us turn now and see what was the third consequence of the establishment of the state, namely the break in economic relations with the Arab countries.

(1) Government Manual, 1952, Israel Government's Printing Office, Hakirya, Table 7, p.369

THE BREAK OF ECONOMIC RELATIONS BETWEEN ARAB COUNTRIES AND ISRAEL

The war between the Arab countries and Israel (May, 1948-December, 1948) was not concluded by peace but by a truce, thus leaving officially a state of war between the Arab countries and Israel in tact.(1)

As a consequence, trade relations between Israel and its neighbors doesn't exist. The war of 1948 set an end to valuable trade relations that existed between the two areas before the creation of the State of Israel.(2)

Trade with the Arab neighbors (Syria, Iraq, Transjordan and Egypt) accounted in the years 1936-1939 for about 20% of imports (mainly in agricultural goods) and 12% of Palestines exports. During World War II, total imports into Palestine were cut by 50% (at 1939 prices), while exports from Palestine (at 1939 prices) rose by 79%. The change in imports and exports being the result of a reduction in shipping space, and the lengthened shipping routes as a result of the relative isolation from world trade the middle east had to draw on its own resources, and thus new opportunities were opened for agriculture, manufacturing and trade. During that period, the Arab countries accounted for about 50% of Palestines' imports and exports. While 3/5 of Palestines' exports where manufactured goods,

(1) These countries were Lebanon, Syria, Trans-Jordan, Iraq, Saudi-Arabia and Egypt.

(2) The rest of this part is condensed from R.R. Nathan O. Gass and D. Creamer - Palestine Problem and Promise Public Affairs Press, 1946, Washington, D.C. p.327-337

the majority of imports from the Arab countries were food stuffs, agricultural raw materials and oil (Iraq), thus establishing a pattern of a regional supplementary economy.

World War II developments gave an indication of Palestines' industrial potentials, and its potentials as a supplier of manufactured goods to its Arab neighbors. This development, however, was contracted to some extent after the war. As soon as world trade was restored, American, British and other goods took again their place in the Middle East, reducing the demand for Palestinian goods., apart from the habit of preference of American, English and other goods, and a hostile attitude toward goods made by the Jewish industry in Palestine. In many cases the Palestinian goods could not compete on the basis of price and/or quality, and their place was taken by superior goods. This inferiority was the result of poor equipment (improvized during the war), insufficient know-how, low efficiency, and an insufiicient emphasis on quality and cost during the war, an attitude that could not be changed overnight. However, if manufacturers were given enough time to adjust themselves to world conditions, it is very probable that exports into the Middle East countries could be developed further.

In conclusion, we may say that the war against Israel and the embargo on trade relations stopped a natural process of economical intergration in the Middle East region, separating Israel from an economy that could be complimentary to its own. As a sequence of the break in economic relations, Israel foreign trade has to be wholly concentrated in distant countries, where the advantages of short communication distances, and acquaintance with conditions was lost.

MANUFACTURING CONDITIONS IN ISRAEL

In analyzing conditions in Israel and possible developments in the future, we will concentrate mainly on economic conditions.

It should be realized that economic conditions depend to a certain degree on political factors, and a notable change in these factors and their direction will effect to a degree changes in economic conditions. The inter-connections between these factors is quite clear and does not require further explanation.

What are the things in the economy that we should look into and evaluate, for the general purpose of checking manufacturing conditions? As we see it, the points to be considered are:

1) Present and potential demand for goods

2) The possibility of establishing a new set of productive capacity for a said product. Under this topic we will have as sub topics the following points:

a) Attitude of government toward establishment of new plants.

b) Availability of capital.

c) Availability of equipment, space and other manufacturing facilities.

3) Operational problems, both in the initial period and on the long run. Under this topic we will include the following factors:

I. Availability of raw materials.

II. Availability of suitable labor at a reasonable cost

III. Availability of technical and managerial know-how.

IV. Availability of auxiliary industries, services and suppliers.

V. Competition, its nature, force and regulation.

VI. Intervention, limitations, and privileges imposed or granted by the government.

Potential Demand

For the purpose of this discussion let us assume that forged parts are mainly used in:

1. Hand tools.
2. Automotive equipment.
3. Machinery
4. Chains and plumbing supplies.

In other words mostly for production, housing and transportation purposes. What is the trend in this respect? Is activity in these fields expanding or contracting, and if expanding at what rate? Let's examine some of the indices related to such activities. The number of vehicles (motorized) increased at the following rate:(1)

(1) Government Manual, 1952, Israel Government's Printing Office, Hakirya, p.403, Table 1

March, 1949, total number of vehicles 22,403 or 100%
March, 1950, total number of vehicles 27,124 or 121%
March, 1951, total number of vehicles 33,942 or 151%

The number of farm tractors and other farm machinery increased as follows:(1)

Year	Tractors	Conbines	Drills	Boilers
1947/1948	460	260	237	173
1949/1950	3500	940	630	550
Change in %	756%	351%	266%	319%

Construction activity had the following history.(2)

1935	Construction in square meters	1,214,608
1939	" " " "	223,639
1941	" " " "	65,614
1944	" " " "	82,911
1948 last quarter	" " "	86,785
1949	" " " "	842,779
1950	" " " "	1,248,988

The boom in construction in 1935 was caused by the immigration from Germany. The low figures thereafter are the result of contraction in immigration and war years restrictions.

The construction in the years 1949 and 1948 was limited by the scarcity of cement and steel and not by the demand or availability of funds. This situation will partly

(1) Three years of Israel's statehood - Development of Agriculture, Israel Office of Information, New York April, 1951, p.4
(2) Compiled from Government Manual, 1952, Israel Government's Printing Office, Hakirya, p.392, Table 1 and Robert R. Nathan, Oscar Gass, Daniel Creamer, Palestine: Problem and Promise, Public Affairs Press, Washington, D.C., 1946, p.254

change by the end of 1953 when cement production will be increased by 200% (from 300,000 tons to 900,000 tons). Which means that as soon as more cement will be available activity in construction will increase substantially.

The examples of increased economic activity are only a few from many that could be cited. What it all amounts to, is that Israel is undergoing a substantial increase of its economy and thus markets are expanding. The best indication of this expansion is probably the increase in the number of wage earners from 360,000 at the end of 1949 to 510,000 (1) at the end of 1951. This figure however does not reveal the number of days worked, and should be used merely as an indication of employment trend and not as an accurate measure of economic growth.

Summarizing, we may conclude that the economic activity in Israel is expanding at a notable pace, and thus it is reasonable to expect a parallel trend in the need for all goods, including forged tools and parts.

One should not expect, however, such acceleration of growth for indefinite periods. Certainly after the initial economical adjustments are reached, changes and economical growth will probably proceed at a more normal and slower pace.

(1) Economic Horizons - Vol. 4, no. 2 February, 1952
Pub. by Economic Department of Jewish Agency, New York

Until that time however, the past mass immigration and potential immigration in the future are a quarantee of a rapid expansion in demand.

INVESTMENT CONDITIONS

As indicated before, in order to establish new[(1)] productive capacity we need:

1) Consent of governmental authorities.

2) Capital

3) Manufacturing facilities.

Let us examine conditions in Israel pertaining to these considerations.

Government Attitude

The official government policy toward new enterprises is incorporated in the "Law for the Encouragement of Capital Investments". This law was past by Israel Parliament on March 29, 1950. The objective of the law is to offer incentive and securities required to increase the volume of investment. This law makes the following provisions:[(2)]

1) The establishment of a governmental investment center the purpose of which will be

a. To investigate the economic value of proposed new enterprises, and to give those found valuable, the status of "Approved Enterprise".

(1) At a later stage we will discuss the requirements for the operation of such capacity.
(2) Based on the text of the "Law for the Encouragement of Capital Investment", Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, Vol.II, No. 14/15, May 19, 1950, p.15-26

b. To help "Approved Enterprise" overcome "red-tape" problems and other related difficulties.

c. Advise and help these enterprises on other matters, as it will see fit.

2) Tax exemptions and benefits

In general the idea is to grant "Approved Enterprise" for their first five years valuable tax exemptions and benefits. The most important provisions probably are the following.

I. Doubled depreciation rates for the first three years and 150% of the normal allowed depreciation rate for the next two years. Thus metal processing equipment could be depreciated at 20% in first three years and 15% during the next two years, which means that in five years 90% of the cost of machinery will be depreciated.[1]

II. Maximum personal income tax of 25% on income from approved enterprises during their first five years.[2]

III. Exemption from property taxes for the first five years of the enterprise.

3) Profit distribution in foreign currencies

In case that an investment in foreign currency was made by a non-resident, the Finance Minister may grant him permission to export in foreign currency each year

(1) ditto - Section 10
(2) ditto - Section 11

capital, interest, depreciation and profits to an amount not exceeding no more than 10% of the original investment.(1)

4) Relief from import duty

Productive equipment, auxiliary goods and raw materials and semi-manufactured goods brought in for "Approved Enterprise" may be exempted by the Minister of Finance from duty payments, fully or partially.(2)

Summary

The law for the encouragement of investments is an attempt to make investments in Israel more attractive and less risky. It provides for: A) Central agency for screening out the valuable enterprises. B) A quick write-off all assets. C) Possibility for foreign investors to get their profits, interest and capital in foreign currency. D) Valuable tax exemptions and reductions.

As it looks on its surface, this law provides valuable incentives for investments, both for local and foreign capital.

Let us examine how the law was applied and with what results. This could be best checked by the operations of the Investment Center during the past period.

(1) ditto - Section 21
(2) ditto - Section 24

Investment Center Operation

The last public report of the Investment Center[1] dates to August, 1951 and summarizes its activities from March 29, 1950 to March 31, 1951. According to this report the Investment Center granted the status of "Approved Enterprise" to 431 new concerns, and "recommended"[2] 270 others, making a total of 701 enterprises.

The total capital investments in these enterprises amounted to approximately 55 million Israeli pounds ($154 million at the official exchange rate of $2.80 = 1.00 I.L.) of this investment about 50% came from abroad in foreign currencies, of this about 2/5 of foreign investments came from the U.S. and 3/5 mainly from Europe.[3]

The status of an approval enterprise was granted to concerns when their establishment would serve either to cut imports or increase exports thus helping to balance Israel's international payments.

Special consideration was paid to enterprises "pioneering" in their field. Thus concessions made to the first enterprise in its field, were not allowed

(1) One Year Investment Center - Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya p.10
(2) A recommended enterprise is one which its limited contribution to the economy does not suffice to give the status of an "Approved Enterprise" but due to some value to the economy, it is granted some of the benefits of the law for the encouragement of investments.
(3) ditto

fully to the second or third enterprise in the same field. The investors of about 60% of the foreign capital invested in "Approved Enterprises" were granted the permission to send abroad up to 10% of their investment in foreign capital (annually). In addition, investors of 15% of total foreign investment were granted the same permission provided that they earn this currency in exports.

Concluding we might say that the status of an "Approved Enterprise" was granted to a noticeable number of enterprises (there are not any figures as to the total number of enterprises that applied for it). We can also conclude that this status is given to enterprises that improve Israel's balance of payments, and that foreign capital invested in "Approved Enterprises" represented about 50% of total capital.

All figures and discussion represented in this part were related to "Approved" and "Recommended" enterprises. These enterprises were the ones approved by the Investment Center as complimentary to Israel's economy. The status of "Approved Enterprise" enabled it all or almost all benefits of the law for the encouragement of capital investment. While a "Recommended Enterprise" got only some of these benefits. There existed, however, a third category of new enterprises, which were considered by the Investment Center as non-complimentary to the economy (i.e. a new establishment in an industry operating already below capacity). These enterprises, though allowed to establish themselves, were not encouraged, and not given any help by the Investment Center.[1]

It now remains for us to check conditions of getting investment capital and the possibilities of acquiring the necessary production facilities.

Availability of Capital

When discussing the availability of capital, we will distinguish between local currency and foreign currencies.

Local Currency

Table II provides data on total bank-notes in circulation, total bank deposits, percent of demand deposits of total deposits, discount paper, loans outstanding and the index of wholesale prices.

(1) ditto p. 7

END OF YEAR	BANK NOTES IN CIRCULATION	BANK DEPOSITS TOTAL	% DEMAND DEPOSITS OF TOTAL DEPOSITS APPROXIMATE	BILLS DISCOUNTED TREASURY BILL ADVANCES & LOANS	WHOLESALE PRICES INDEX 1936 = 100
1939	8,000	16,000	75%		107.7
1941	13,000	21,000	84%		115.4
1944	41,000	71,000	90%		127.8
1948	28,000 (1)				450 (May)
1949	46,000	77,000	92%	63,000	505 (January)
1950	72,000	119,000	88%	116,000	377 (December)
1951 (April)	81,000	137,000	89%	140,000	388

TABLE II - SUPPLY OF MONEY AND WHOLESALE PRICES (Approximate figures in money by IL) (2)

(1) Figure reduced as a result of the partition of Palestine. Not accounted money that remained in Arab Palestine.
(2) Government Manual, 1952, Israel Government's Printing Office, Hakirya, p.430, Table 6, and Robert R. Nathan, Oscar Gass, Daniel Creamer, Palestine: Problem and Promise, Public Affairs Press, Washington 8, D.C., 1946, p.302-303

This data was compiled from two sources which used a somewhat different criterion and thus represents approximate figures only.

The important facts in this table are the constant and fast increase of money in circulation paralleled by increases in deposits and loans. The lion's share of bank deposits are demand deposits, and as a result, loans outstanding will probably also be mainly in the category of short term or call loans. The index of wholesale prices rose constantly until 1949 and then dropped suddenly. This drop is a result of government price controls. Official prices, however, are charged only for allocated goods, which are insufficient in many cases. In case that extra quantities have to be bought, much higher prices are paid. If these black market prices were added to the index, it would in all probability show a remarkable and constant inflationary increase.

As a good indication of the inflation, we might take the value of the dollar on the black market. While the official rate of exchange was I.L1 = $2.80 until February 13, 1952, the black market exchange rate was I.L 1.00 = $1.00 in 1950, dropping gradually until it reached the level of I.L 1.00 = $.50 at the end of 1951. This rate dropped even further after the establishment of new exchange rates (February 13, 1952) and is at present I.L 1.00 = $.35 - $.40.

The continuous increase in money supply paralleled by a gradual inflation, forces the depositors to invest their money in goods of any kind in order to preserve its buying power. This is probably the reason that around 90% of the bank deposits are demand deposits. As far as loans from banks are concerned, it seems to us that long term loans should be relatively scarce under these conditions. It is also probable that interest rates are high so as to cover the constant decline in the actual buying power of the I.L. After the last depreciation of Israel currency (February 13, 1952) interest rates on short term loans, were reported to go up to 30% per annum.(1) These rates, however, charged on loans issued "under the table", since government regulations restrict bank loans, as an anti-inflationary measure. There is though, an exception to governmental pressure to contract loans. This exception concerns new "Approved Enterprises" or "Approved Expansions" of existing enterprises. These concerns can get up to ten year loans at 5½% interest rate, from commercial banks. Loans of this nature are quaranteed by the government to the banks.(2)

While saving accounts and long term deposits are not the common practice today, it seems to me that for the same reasons there should be enough money for direct

(1) Haarez, (Daily Newspaper) March, 1952.
(2) Economic Horizons, Pub. The Jewish Agency for Palestine, New York, Vol. 2, No. 7, July, 1950, p.3

investment, simply because direct investments successfully tend to preserve the buying and earning power of the capital more than loans or savings. The mere process of advancing inflation is a good indication that there is more money than goods. From personal observations and interviews with Israeli business men, this assumption seems to be correct.

Foreign Capital

Availability of foreign investment capital is one of the limiting factors in the industrial development of Israel. Planned investments in foreign currency rose from 50 million dollars in 1950 to 70 million dollars in 1951.(1) 61% of the planned concerns were already in the manufacturing or construction stage, while the rest 39%, were still in a bluepring form at the end of 1951. Naturally, in many cases, there is a considerable gap between the time a concern is planned and the time of its erection.

Unfortunately, the present role of foreign investments is by no means sufficient to take care of all development needs, so that the economical development of the country is not gaining the momentum desirable. There exists a number of investments companies, and to overcome the lack of foreign investments, the government is engaged since May 1, 1951 in the sale of a $500,000,000

(1) Economic Horizons, Pub. The Jewish Agency for Palestine, New York, February, 1952. p.2

(4% Independence Bond Issue) to be sold mainly in the U.S.A. During the first four months, (May 1, 1951 - September 1, 1951) $50,000,000. worth of bonds were sold.[1] At the end of March 1952, an additional sum of about 70 million dollars was subscribed but not fully paid in. It is expected that payments on subscriptions will be made at a later date. As to the balance of the issue, there is no way to forecast whether the issue will be sold or not, and how long it will take to sell the maximum amount of it.

The insufficient amount of foreign investments has its roots for the following reasons:

1) Uncertainty as to the ability of Israel to establish a healthy and stable economy.

2) World tensions that jeoperdize the peace and freedom in the Middle East.

3) The general tendency of American capital to stay at home. (It was already mentioned that 3/5 of foreign investments came mainly from Europe).

4) The depreciated value of foreign currency when transferred and exchanged at $2.80 = I.L. 1.00

Clearly the only disturbances that depend on Israel are the first and the fourth ones, and ironically enough the ability of Israel to create a stable economy will depend very much on the availability of foreign capital.

(1) E. Kaplan, Minister of Finance, Report on the use and distribution of the Israel Bond Receipts, American Financial and Development Corp., New York, September 12, 1951, p.1

As to the rate of exchange, the government undertook to give the investors more favorable terms. Thus, since February 13, 1952, Israel has had the following three different exchange rates.

1) $2.80 = I.L 1.00 for essential food stuffs.

2) $1.40 = I.L 1.00 for all imports and some of the exports.

3) $1.00 = I.L 1.00 for investment capital, tourists and most of the exports.

It thus appears that the foreign investor will have from now on better exchange terms, and the rate of investments is expected in increase.

Conclusion

It seems that local capital for direct investments is relatively abundant in Israel. Long and short term loans are less available due to government restrictions and the small percentage of long term deposits. However, for "Approved Enterprises" there are provisions for up to ten year loans at 5½% interest.

Foreign capital is far from satisfying the demand for it, and thus represents a limiting factor in the development of the economy. (1)

AVAILABILITY OF MANUFACTURING FACILITIES

Probably the most important facilities necessary for the establishment of a new manufacturing unit is land,

(1) A further explanation of this point is given below in the parts on Equipment and Raw Materials.

buildings and manufacturing and auxiliary equipment. (Needs for the operation of a manufacturing unit will be discussed later) Thus, our discussion will be centered around these three factors.

Land

Land ownership in Israel is divided among Government, National Funds, Private Capital, Municipalities and a few other organizations.

A major part of the land in the industrial centers is privately owned, and therefore will have to be bought, in case that a new establishment insists upon being located at these places. However, land is made available for industrial purposes by government and other public institutions and funds. This land is made available on a lease basis, granted free, or sold at convenient terms to establishments ready to locate themselves according to regional planning principles.(1)

Buildings

Industrial buildings ready for new users are almost non-existing in Israel. Furthermore, due to an acute shortage of building materials, the construction of new buildings is a complicated problem, as building materials allocations are insufficient and do not arrive on time

(1) Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, Vol. II, No. 5-6, January 18, 1950.

and in the quantities needed, and construction work is halted many times for lack of materials. The head of the Investment Center stated: "The Investment Center is trying to establish a system where this condition could be improved, but there is no hope for a complete change until the shortage of raw materials will disappear." (1) As stated before, the supply of cement will be increased by about 300% at the end of 1953, as the result of a new cement manufacturing facilities being installed now. Equipment for a steel rolling mill (2) has already been ordered in the U.S.A. and thus it is very probable that in the future raw materials for construction will be more plentiful, making construction work a less complicated affair.

Manufacturing Equipment

Until now almost all manufacturing equipment had to be brought from abroad. As the purchase of equipment is a major chunk of the costs of new factories, the lack of foreign currencies is a serious drawback, and could be regarded as the limiting factor for the establishment of new facilities. Foreign capital requirements for this purpose must, for most concerns, come from foreign investors. The government, however, in certain cases, supplements this supply of money with allocation of

(1) Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, Vol. II, No. 14/15, August, 1951, p.9
(2) ditto, Vol. II, No. 18, July 10, 1950, p.8

foreign currency from its own funds. Thus, the government allocated 20 million dollars to 300 industrial concerns from the proceedings of U.S. Export Import Bank loan,[1] (total loan was 100 million dollars), 13 million dollars[2] was allocated from the proceedings of the Independence Bond Issue. It is likely that additional sums were allocated from other sources but no indication of this could be found in the material which was used by us. Putting actual foreign investments in Israel during 1948-1951 at around 120-150 million dollars,[3] the share of government[4] in the supply of foreign currency is remarkable but not the major one. It thus means that for most cases, equipment will be available only if foreign capital could be interested in the enterprise.

Conclusions

We considered in this part government attitude, capital supply and availability of manufacturing facilities as the basic factors in establishing a new concern. Our survey of conditions showed that government exercises a positive and encouraging attitude toward the establishment of new manufacturing facilities, which are complimentary to the Israeli economy. To

(1) Three Years of Israel's Statehood, Israel Office of Information, New York, Paril, 1951, p.1
(2) E. Kaplan, Minister of Finance, Report on the use and distribution of the first $50,000,000 of Israel Land Receipts, American Financial and Development Corp. for Israel, New York, September, 1951.
(3) 1950 - $50 million, 1951 - $70 million, 1948 & 1949 figures not available.
(4) Estimated at above 33 million dollars during 1949 - 1951

encourage new facilities the government has made and is ready to make substantial concessions that could be valued in dollars and cents, and tend to decrease some of the risks involved in investments in Israel. We also saw that local investment capital is relatively large. However, foreign capital continues to be scarce though it showed a remarkable increase from 1950 to 1951.

As far as the actual establishment of manufacturing facilities is concerned, we may conclude that land is available, and in many cases could be obtained on very liberal terms.

Buildings, on the other hand, represent a problem and are difficult to be obtained on contract. There is, however, a prospect for substantial improvements in the future as additional cement manufacturing facilities and a steel mill will start production in 1953 and 1954 respectively.

The problem of getting the necessary production equipment is probably the most important one, since almost all of it has to come from abroad and be paid by foreign currencies, which are scarce. Unfortunately, Israel exports, (including invisible export) can pay for only less than 15-20 percent of Israel imports, thus the development and even survival of the country depends to an alarming degree on foreign investments, loans and donations.

Operational Problems

While operational problems could cover an endless list of items, we will confine ourselves to a limited number of them, which we believe to be the most important ones.

We will thus cover the problems of:

1) Raw materials
2) Labor
3) Technical and managerial know-how
4) Auxiliary services
5) competition
6) Governmental action influencing operations

Raw Materials

At present, local resources for raw materials are scarce and Israel has to import almost all industrial raw materials. Thus metals, chemicals and agricultural raw materials, as well as all fuels are brought from abroad. During the years 1949 and 1950, raw materials (excluding those for agriculture) accounted for 26.3%[1] of total imports. At the same time export of goods were only about 11-12 percent of imports, plus invisible exports which accounted for an additional sum of 4-8% of exports, while the rest came from foreign loans, National Funds and amortization of foreign balances. All this amounts to an extreme dependence of Israel's

(1) Government Manual, 1952, Israel Government's Printing Office, Hakirya, p.20

economy on foreign help, credits, and investments. In addition, the foreign help in all its forms plus the income from exports, suffice only to pay for the most important goods and even these at very limited quantities, so that Israel cannot fully satisfy its needs. Results are shortages in every field, including the purchase of raw materials. Visualizing the situation, the Investment[1] Center takes steps to warn new enterprises of expected difficulties in getting raw materials and recommends to them the purchase of raw materials for one or two years with their own foreign funds. As to the future, there are certain developments that might change this situation substantially. After intermine research and exploration work in Israel, discoveries of valuable raw materials were made. Up till now, the list contains phosphates, kaolin and glass sand, peat, copper, manganese, bituminous lime stone and iron ore. According to geologists, there is also a good chance for the discovery of oil. Of this list, only the first two are commercially exploited by now. Exploitation of the rest of the minerals is still subject to further research and planning.

Summarizing it all up, we may say that raw materials are extremely scarce in Israel, and new enterprises

(1) Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, Vol. II, No. 14-15, August, 1951, p.9

should take care to supply themselves with one to two years supply of raw materials. There are some indications, though, that this situation might be improved in the future due to discoveries of certain minerals, and an improvement in Israel's labances of payment as industry and agriculture grow up.

Labor

The two main factors (besides availability) that we should be concerned with are labor costs and labor productivity.

Before getting to these points, let us first consider availability. As indicated in the section on immigration, about 45% of immigrants gainfully occupied in their countries of origin, were employed in manufacturing. (This figure includes handicrafts.) As industrial employment in Israel accounts for almost 20% of total,(1) there seems to be a surplus of industrial workers. This conclusion might be true in relation to unskilled workers, however, the Israeli press and private individuals are constantly reporting an acute shortage of skilled (2) workers, in almost all industries. This situation will probably remain so for a considerable number of years, before a sufficient adjustment will be reached. To supplement the slow growth of skilled workers, the

(1) Facts and Figures, 1951, Government Printer, Israel p.29

(2) Haarez Manual, 1950/51, Tel Aviv, p.485

government and others have initiated training programs for immigrants. It is too early, however, to judge their effect by now.

Wages

Before the last devaluation of the I.L in February, 1952, wage rates in Israel were comparatively high. The average worker in industry was earning during 1949 around I.L 0.309 per hour[1] ($0.85 at the official exchange rate) a rate which is probably a high one relative to European wages. Needless to say, this rate was more the result of inflation than a high standard of living. Since the devaluation of the I.L, the exchange rate was changed for exports to I.L 100= $1.00 and for most imports to I.L 1.00= $1.40. If this change will not result in an extreme increase of the cost of living index, (which automatically raises wages), the wage rate will probably approach closer to those of the European countries. For example, let us assume that the devaluation will raise C.L. Index by 50%, this would raise wages to around I.L 0.450 per hour which at the new exchange rate for exports equals only $.45 per hour. It is thus hoped that through this device Israel goods will have a better chance to stand competition abroad.

Efficiency

Efficiency of labor is probably the most important

(1) Mostly straight wages

factor in determining the products cost. There is a general agreement among unions, manufacturers, government officials and many others that productivity in Israel is low, and an immediate change is necessary.[1]

The problem is to determine what is the cause for low productivity. Is it a basic inferiority of the worker, or is it due to conditions which could be eliminated or improved? From studies made by efficiency teams and industrial engineers,[2] low productivity could be attributed to the following reasons.

1) Lack of incentive to produce
2) Inefficient utilization of equipment
3) Inefficient management

Until now, most factory workers work on a fixed hourly pay. Subsequently, there is no good reason for them to make an effort to produce more. Realizing this defficiency, union officials, government representatives and industrialist are trying hard to convince workers to accept the piece rate or other incentive systems. These efforts are gradually bearing fruit. At the same time pressure is inserted by government and union on industrialists to improve their technical and managerial methods. Since April, 1952, government plans to allocate raw materials according to a system that

(1) Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, March 1951, Vol. II, no. 10, p.5
(2) ditto, Vol. III, No. 8-9, February, 1951, p.1-5

will favor efficient enterprises. Whether effective or not, this plan represents the seriousness and attention paid to the problem. In addition, productivity boards have been established in many concerns.[1] An interesting example is a textile productivity group that visited the U.S.A. and upon its return, succeeded in raising labor efficiency by 25%.[2] These improvements, due mainly to technical changes and elimination of unnecessary supervisions and workers, left efficiency at about 25% behind that of the American worker. It was hoped, however, that when a premium system will be introduced, efficiency will increase by an additional 18%.

Another case is told by an industrial engineer[3] who undertook to reorganize a metal processing concern. In that case, by introducing managerial and technical improvements plus a piece rate system, output per man increased by 300-400%. It seems, though that for a substantial period, the Israeli worker will not be able to be as efficient as the American worker even when utilizing the same productive facilities and managerial systems. The reasons, as I see them, are the much lower standard of living whose major phenomena are poor accomodation facilities, poor transportation, and insufficient nutrition. While the American worker spends little energy in getting to and from his plant,

(1) From the press
(2) The Trade Union Monthly, Tel Aviv, January, 1951
(3) A. Halperin, Economic News, Vol. IV, p.1-2, Tel-Aviv, 1951

the Israeli worker has to spend in many cases two to three hours on transportation in gruelling conditions. At the same time he is badly fed and sleeps in a crowded room, with possibly two more people. An additional factor is that he works 47 hours a week as against 40 hours in the U.S.A. thus his physical condition is probably below that of an American worker. In addition the opportunity of the worker to spend extra money is limited due to the austerity conditions. This of course reduces the eagerness to make money.

It might be interesting to note that conditions in Britain are similar as was reported by the British productivity Team "At the present time the purchasing power of money is limited by the scarcity of goods.... high prices.....purchase tax....incidence of high income tax. The Team considers this state of affairs to be detrimental to high productivity...."[1]

In conclusion, we can say that the present low productivity of the Israeli worker is not a result of mental or physical inability. By providing incentives for work, plus better technical and managerial help, output could be substantially increased. It seems, however, that even under best plant conditions, there will remain a certain gap in efficiency between the American and the Israeli worker, due to a substantial

(1) Productivity Team Report - Drop Forging - Anglo American Council on Productivity, New York, April, 1950 p.7

difference in the standards of living, and the value to the worker of extra money.

Technical and Managerial Know-How

Very little generalization could be made in this respect. Though there exists some concentration of Jews in certain industries in foreign countries.(1) This concentration is reflected in the occupational structure of the immigrants, whether daily workers or management people. Out of 24,000 immigrants formerly employed in industry (entered Israel in 1950) around 29% were employed in the clothing industry and about 10% were employed in the leather industry. Textile, machinery, woodwork, and fine mechanics (including watchmaking and jewelry) represented only 4.5-6.0 percent each. Furthermore, the majority of these people came from Eastern-European countries or Asia and Africa. In general, these countries are not regarded as the ones with the most advanced industries and highest rate of output.

It thus appears, that acquired know-how is concentrated in few industries, and thus does not possess in most cases, the latest developments in industry.

There is a trend though, to change this situation considerably. Most foreign investors are coming from

(1) Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, Vol. III, No. 14/15, August, 1951, p.7

Western Europe or the U.S.A. In many cases, these investors are operating or connected with certain industries, the result of course is a trial on the part of foreign investors to connect Israeli industrial firms with similar establishments in the U.S.A. or Western Europe. This connection can take the forms of partnerships, leases, or fixed fees and results in a flow of know-how into the Israeli industry. It also establishes a permanent system for the communication of new developments in their respective fields. This type of arrangement is not covering all industry, and there is a considerable lack of know-how which is reflected in high costs and low quality.

It seems to me reasonable to assume that the process of acquiring advanced know-how will be a slow and costly one, and that there are not too many devices of achieving it sufficiently at a short time.

Auxiliary Industries and Services

The extent to which a concern can rely on other firms for the supply of certain goods and services, has an important bearing on its operations and set up. In most instances, the availability of goods and services from outside sources, means that specialization of both the supplier and the buyer could take place, with all the benefits in cost and quality resulting.

Generally speaking, conditions in Israel in this respect are far from satisfactory. This is partly due to the small scale of industry which limits the specialization and development of auxiliary units. On the other hand, however, there are repetitive claims in trade magazines and economicsupplements and in the daily newspapers that even the possible amount of specialization has not been reached.

What all this amounts to is the fact that a concern when outlying plans for operations, must be prepared to be more independent than the average productive unit in the U.S.A. This situation covers supply of raw materials, replacement parts, semi-finished products, industrial processes, technical and managerial services and consultation.

Competition

At the present "seller's market" in Israel there is but little sales' competition. Furthermore, the list of products manufactured in Israel includes about 200 lines of products only.(1) For example, under electrical appliances the following lines are manufactured: Refrigerators, radios, desk fans, cookers, thermostats, soldering irons, sterilizers, sterilizators, tea kettles, immersion heaters, toasters, switches, plugs and washing machines. Though the list is not complete, it very

(1) Israel Exports - List of products available from Israel - Ministry of Trade and Industry, November, 1951, Jerusalem.

probably represents the majority of products made.

It is thus apparent that very few products are made in Israel and for the majority of products there isn't local competition at all. The last assumption is true for a general application, There are however, branches of industry in which competition existed in the past and not at the present because of a chronic lack of raw materials. Among the most important branches of industry in this category are textiles (cotton), candies, food, soap, clothing, construction materials and possibly a few others. This situation existed before the beginning of mass immigration in 1948-49.

For the mass of products, competition from abroad has a significant effect though it may not be detrimental. Competition with foreigh products is based on price and quality, the two appearing together or separately. Thus American or English cigarets are bought at premium prices because of their supposed quality.

Governmental policy in general is to avoid allocation of foreign currency for the purchase of goods that are brought by foreign investors and paid for with their own funds, the necessity to get an import license and high duties imposed on goods that are locally manufactured, provide considerable protection to the local manufacturer.

Government policy toward the establishment or operation of competitive units is not similar in all cases and contradictory action could be found in many cases.

In general "....the Israel Government does not grant monopoly rights" but "only in very special cases, where the existence of another project or even its approval, would harm the national economy e.g. by jeopardizing the first more serious plan, did the center (Investment Center) deviate from the line of policy."(1) It thus appears that the government at least tries to avoid the granting of monopolies.

However, in all cases where the supply of raw materials is insufficient and allocations are necessary, these allocations are based on percentage of total consumption in previous years. Naturally this puts the new concern into an immediate disadvantage. On the part of the government, we might say that it is not interested in increased capacity in industries operating under it.

Clearly enough, this situation breeded inefficiency in many industries, finally the government undertook to(2) change the situation by establishing a system in which goods are allocated to the more efficient producers

(1) Israel Economic Bulletin, Pub. Ministry of Trade and Industry, Hakirya, Vol. III, No. 14-15, August 1951, p.8
(2) Prime Ministers Declaration on a New Governmental Policies, February 13, 1952.

and those who manage to export part of their product. Exactly what is this system and how it works is not clear to us. It indicates though, that more efficient enterprises, and those able to export goods will have a better chance to get allocations of raw materials, and thus to sell goods.

Concluding we could say that at the present "Seller's Market" sales' competition is not a serious problem. Furthermore, relatively few products are manufactured in Israel so that local competition for the majority of products does not exist at all. Competition begins to exist in getting raw materials allocations. A concern has a chance to get ahead in this race, if it is relatively efficient and/or able to export part of its product.

Governmental Action in Respect to Operations

Governmental action and regulations appear in many phases of operations. Besides normal interference of government in business operations and conduct required in a modern state, there is the additional aspects of a "guided" and in some phases "planned" economy. (Especially agriculture, transportation and mining are planned.)

Government regulations are involved in pricing, and product standards, raw material allocation, imports and exports, employment, overtime and incentives, not to mention others, only these that seem more important and not present under all operating conditions in an economy under balanced conditions.

In general terms, government policies are directed on the long run toward absorption of immigrants and the development of modern state able to support and defend itself. At the present time, however, the most pressing concern is the improvement of Israel's trade balance. This improvement can come through increased exports, decreased imports and increased foreign investments. Basically, a major part of government policies are directed toward the accomplishment of these goals. Naturally, industries or concerns that cannot fulfill one or more of these requirements are doomed to be restricted and wiped out by regulations and prevailing conditions.

In its new economic policy since February 13, 1952, the government terminated all allocation of raw materials to consumer goods manufacturers that are not of a first necessity to the population. The only allocation of raw materials for "luxury" goods were made to manufacturers that had orders from abroad. This act caused a lay-off of about 15% of all industrial employees and temporary or permanent closes of plants producing "luxury" goods.

The last illustration was brought to pointout that under the conditions in which industry operates at the present, it is extremely important for the enterprise to be of such a nature that its existence is of great value to the betterment of the economical conditions. And even then the concern should plan to earn its raw materials by exporting its products.

POTENTIAL DEMAND FOR FORGED PRODUCTS IN ISRAEL

In this part we will discuss the market potentials for forged parts in Israel. At first we want to know what products and what product lines are required, and in what quantities. After that we will classify this demand into annual amounts required from each product variety, and the approximate weight of these products. Clearly the annual amounts required of each variety will determine the size of production runs and will have a major effect on production costs.

TOTAL POTENTIAL DEMAND

The market for drop forgings could be divided into the following classes.

1) Finished products - In this case no further processing is necessary, on the finished forged part(1). Examples are certain types of diesels for pneumatic tools, picks, certain types of hammers, etc.

2) Semi-finished products, where additional machining and processing has to be performed. This class probably constitutes the majority of forgings.

Forgings are also classified into:

1) Autonomus products - like open end wrenches.

(1) A finished forged part will include besides forging heat treatment and cleaning operation.

2) Assembly parts - like automobile connecting rods, gears, pipe wrenches, etc.

While the production of autonomus forgings could start as soon as there is a sufficient demand for them, production of assembly parts must await until the assembly of the finished products takes place in Israel, or until the need for replacement parts warrants efficient manufacture of these parts. For example, standard gear sets might be needed for replacements in enough volume even before any large scale assembly operations take place.

At the present, the majority of imported machinery, transportation equipment, agricultural implements and other equipment is brought assembled from abroad.

This means that the need for forged assembly parts is relatively small.

This situation, however, is by no means a permanent one. There are reasons to believe that as time goes by, assembly operations will be developed in Israel itself, opening possibilities for the manufacturing of forged assembly parts.

Some indication of such possibilities and developments are the assembly plants already existing in the country i.e., an affiliate company of Kaizer-Frazer operates an assembly plant whose products are estimated to be 8000 annually.

Philco too, operates such a plant for electric refrigerators.[1]

Plans are ready for the assembly of tractors, and farm implements, and though future developments are extremely important for us, no one can allow himself to start a plant based on possible development in the future. So our present problem is to determine what is the actual demand for forgings, what types of forgings are on demand, and in what quantities.

Fortunately, The Investment Center of the Ministry of Trade and Industry took the trouble to find out what is the present potential market for forgings[2] mainly in tools and other autonomeus parts.

(1) The Israel Daily Press
(2) State of Israel - Ministry of Trade and Industry Investment Center - Drop Forging Factories - September 1, 1951

TABLE III - THE DEMAND FOR FORGED PRODUCTS

Pliers - assorted	600,000	pieces
Shears - bench, plate, wire	20,000	"
Bolt Cutters	10,000	"
Wood chisels	100,000	"
Wrenches, open end (single and double)	200,000	"
Socket wrenches	30,000	"
Shovels - solid sockets	50,000	"
Spades, solid sockets	10,000	"
Mattocks	50,000	"
Forks - solid sockets	15,000	"
Cultivators	5,000	"
Sickles and pruning hooks	15,000	"
Picks - heavy and light	30,000	"
Axes up to 2 kg.	30,000	"
Hammers - 1-2 kg	70,000	"
Hammers - 3-12 kg	35,000	"
Hammers - stone cutters - 4-10 kg	20,000	"
Hammers - assorted	25,000	"
Chains - farm machinery (links only)	1,500,000	"
Chains - conveyor (links only)	1,000,000	"
Flanges - assorted	500,000	"
Chains - assorted (links only)	250,000	"
Chains - assorted	30,000	"
Rock drill bits	30,000	"
Assorted chisels for pneumatic tools	10,000	"

Drill heads (for drill bits)	20,000	pieces
Breast drills	25,000	"
Angle brace drills	15,000	"
Drill sockets	10,000	"
Nippers, pincers, side cutters	50,000	"
Scissors - assorted	100,000	"
Screw drivers - assorted	150,000	"
Adjustable wrenches	20,000	"
Pipe wrenches	30,000	"
Hammers - up to .90 kg	100,000	"

TABLE III - THE DEMAND FOR FORGED PRODUCTS (continued)

Table III indicates that:

1) Around 5 million forged units are needed yearly, at the present level of economical activity.

2) Of these 5 million units, about 50% are chain links, 10% flanges, 40% tools and accessories.

3) Thirty six different lines are required, each line having a number of varieties in design, size, use and material.

4) Demand for some product lines and their varieties is high enough to warrant relatively long runs. Pliers, wrenches, chain links, flanges and screw-drivers are in this category.

5) Demand for some products, when taking into account a number of variations, appears to be low. i.e., bolt cutters, spades, hammers - assorted, pipe wrenches etc.

6) It should be noted that:

a) the figures are estimates of possible demand and not of present consumption.

b) figures represent estimates of present potential demand. It is believed however, that the fields in which these items are used will expand in the future, creating a much larger market.

In the report's own words "The list, therefore, is only valid as of today and represents only a portion of the demand, say, within a year of the erection of the factory which will produce the items shown. In addition to this, obviously, there will be many more items not even listed which the factory will be able to produce and market in the country. Export figures are not even estimated, but we believe that they may be considerable."

Though one might agree with the beliefs of the writer and his expectations, we should give some consideration to the fact that some of the present consumption is due to the initial needs of the productive-units recently established, as well as to the extensive housing and irrigation projects. Once these needs willbe initially satisfied, demand might drop considerably below the levels indicated or at least decrease its pace of growth.

It seems, that for the purpose of this study, the accuracy of the quantities and types of forgings that were discussed is quite sufficient (particularly since these are the only figures available).

In the next section we will analyze Table III as to the number of varieties (size, design etc.) in each line (wrenches, hammers, etc.) and the approximate weight of the products in each line. These figures are required for the estimation of the size of runs that we will presumably have, number and size of hammers that could be utilized, and total approximate weight of forgings required in these lines.

DEMAND CLASSIFIED AS TO WEIGHT AND NUMBER OF VARIETIES

Since the data presented in Table III contains all we know about the demand in Israel, we will have to assume that this data is sufficiently correct and make the best possible use of it.

Our next step is to analyze the demand (Table III) as to varieties of products and their weights per units. We will later see in more detail, that the number of units per run, the ultimate quantities and the unit's net weight are among the most important factors in determining manufacturing costs. In this section we will try to find out what are these values in our case.

The data for this purpose was compiled from the Sears, Roebuck and Co. Spring, 1952 catalog. We believe that it will give us a fairly reasonable information. The catalog contains the essential types, sizes and qualities of most of the lines with which we are concerned. It will be difficult however, to find the relative size of the quantities required in each variety i.e. in the case of pipe wrenches, the catalog offers them under two trade marks differing in design, quality and price. While the expensive wrenches sell in six different sizes from 8" length to 36", the inexpensive ones sell only in three sizes 10", 14", and 18". However, during interviews with people familiar in this trade, they pointed out that:

1) for each expensive wrench, with replaceable jaws, about 6-10 Stillson (inexpensive) wrenches are sold.

2) the majority of wrenches in both price ranges, are sold in the sizes 10", 14" and 18".

It thus appears that one can't just take the required number of a certain line of products and divide it by the number of varieties existing in it to get the quantities required of each of the different sizes and designs in that line.

It is, therefore, necessary to distinguish between the popularity of the different designs and sizes and assign them some percentage of total demand. Unfortunately, we have no data on which such differentiation could be done, and thus the only way is to use the average number of units required of each variety in these lines.

It is believed that in spite of inaccuracies and misjudgments that will occur in Table IV, it will give us some idea as to the quantities and weights that we should expect in each variety, so that we will be able to estimate the magnitude of the problem.

TABLE IV - DEMAND CLASSIFIED (Quantities per year)

LINE 1	TOTAL DEMAND 2	NO. OF VARIETIES 3	APPROXIMATE AVERAGE NO. PER VARIETY 4	APPROXIMATE WEIGHT PER UNIT (lbs.) 5	TOTAL WEIGHT (1X4)(lbs.) 6
1) Pliers	600.000	15	40.000	10/16	375.000
2) Shears	20.000	N.A.	N.A.	N.A.	N.A.
3) Bolt Cutters (Cutting Tool)	10.000	3	3.300	N.A.	
4) Wood Chisels	100.000	8	12.250	3/16	18.760
5) Wrenches open end	200.000	9	22.200	4/16	50.000
6) Socket Wrenches	30.000	18	1.600	1/16	1.800
7) Shovels - Solid Sockets	50.000	6	8.300	2	100.000
8) Spades	10.000	1	10.000	2	20.000
9) Mattocks	50.000	1	50.000	3	150.000
10) Forks - Solid Sockets	15.000	3	5.000	1	15.000
11) Cultivators	5.000	1	5.000	12/16	3.740
12) Sickles and Pruning Hocks	15.000	5	3.000	2	30.000
13) Picks - heavy, light	30.000	3	10.000	5	150.000
14) Axes - up to 8 lbs.	30.000	6	5.000	6	120.000

TABLE IV - DEMAND CLASSIFIED (Quantities per year) - continued

	1	2	3	4	5	6
15)	Hammers 2-4 lbs.	70.000	20	3.500	1	70.000
16)	Hammers 6-24 lbs.	35.000	10	3.500	10	350.000
17)	Hammers - Stone Cutters	20.000	7	3.000	10	200.000
18)	Hammers - Assorted	25.000	N.A.	---	6/16	12.500
19)	Chains Farm Machinery	1.500.000	10	150.000	6/16	561.000
20)	Chains - Conveyors	1.000.000	10	100.000	10/16	625.000
21)	Chains - Assorted	250.000	10	50.000	2/16	39.000
22)	Clamps - Assorted	30.000	10	3.000	2	60.000
23)	Flanges	500.000	10	50.000	2/16	78.000
24)	Rock drill bits	30.000			1	30.000
25)	Drill heads	20.000	N.A.	----	N.A.	
26)	Breast Drills	25.000	N.A.	----	N.A.	
27)	Angle Brace Drills	15.000	N.A.	----	N.A.	
28)	Drill Sockets	10.000	N.A.	----	N.A.	
29)	Nippers, Pincers Side Cutters	50.000	15	10.000	6/16	18.800
30)	Scissors - Assorted	100.000	15	6.500	3/16	18.800

1	2	3	4	5	6
31) Screw Drivers	150.000	15	10.000	3/16	28.200
32) Adjustable Wrenches	20.000	5	4.000	1½	30.000
33) Pipe Wrenches	30.000	6	5.000	2½	75.000
34) Hammers - up to 2 lbs.	100.000	N.A.		1	100.000
TOTALS	5.082.000	212			3.389.300

TABLE - IV DEMAND CLASSIFIED (Quantities per year) - continued

Table IV indicates that in most cases annual requirements for individual products will run somewhere between 2-10 thousand, provided that the customer will have as wide a choice as the American citizen buying from a mail order house. However, at the present time and probably for the next decade or so, scarcity of raw materials will probably force the manufacturer and customer to concentrate when buying or making tools on the all-purpose tools instead of specialized tools. This in turn will reduce the number of varieties and increase the size of production runs. While for the majority of products, the average annual quantities required will run below 10,000, there are a few products in which average quantities required will be much higher, and will probably be within the limits of 10-100 thousand units of one product. In the case of chain links and flanges, the number of identical units required might even exceed the 100,000 figure.

If however we will consider the possibility that actually some of the varieties in each line will have a greater demand than others in the same line, the list of products lines in which demand will exceed 10,000 units per annum could be increased and will probably reach about 15-20 different lines each one of them containing one or more varieties with a demand of 10,000 or more.

It should be remembered that the list of products is incomplete, and that the present market for forgings includes probably a fair number of standard replacement parts i.e. gears, connecting rods, etc., that were not even mentioned.

Also of importance is the fact that in certain cases, the same products could be made by other processes than forging, i.e. handles for pipe wrenches can be either cast (mallable) or forged, shovels can be forged or stumped.

In total, the number of units required is above 5 million with a total estimated weight of about 3.5 million pounds annually or about 1600 tons, of finished products. Actual figures might vary quite widely from those calculatted here. This being so because actual magnitude of certain factors was unknown and had to be assumed. We tried to be careful and take low estimates as to the weight of the products, thus it seems to us that the estimate of about 1600 tons of products would prove to be too low. On the other hand, it is a safe bet to say that not all varieties will be worth manufacturing commercially, thus decreasing estimated quantities.

An additional factor for inaccuracy is the fact that no estimate has been made as to the probable export volume of forge products.

We think that figures pertaining to all products, except for links and flanges, are quite reliable. In the case of flanges and links, however, there seems to be a considerable possibility of a major miscalculation due to lack of safe, reliable,information as to the exact types and sizes of links and flanges required. This led to the necessity of choosing an almost arbitrary average weights figure.

Summarizing Table IV, we may say that according to available information, we think that an annual demand of about 5 million forged units is expected in Israel. Of these 3.25 million units are chain links and flanges. The remaining 1.75 million units include about thirty different lines of products, all of them hand tools or tool parts. These lines are subdivided into about 170 product varieties as to size, quality and design. In the case of flanges and links there is a good reason to expect the annual demand per variety to run at above 50,000 units. For 20-15 lines of tools and parts the demand for certain types and sizes could be expected to be somewhere between 10,000 to 50,000. For the rest of the tools annual demand will be between 2,000 to 10,000. Total tonage expected is about 1600 tons of finished products.

IV. PLANT CAPACITY AND EQUIPMENT

Now that we know what is the potential demand for forgings, we should translate these figures in terms of manufacturing capacity required to satisfy the assumed potential market.

Only after arriving to an estimate of the total possible size of a forging industry in Israel, can we start to evaluate the different factors to be considered when making plans for our own forging plant.

REQUIRED PRODUCTIVE CAPACITY

Our purpose in this section is to estimate total productive capacity required to satisfy the needs of the market in Israel.

We need this information for the purpose of determining the possible size of a forging industry so that we will be able to develop satisfactory plans for our own project with some view on possible growth in the future, and in order to exercise a certain degree of caution in case our calculations were too optimistic.

Naturally, we don't want to engage ourselves in a detailed study of production facilities required to satisfy total demand. What we want is to translate demand into terms of productive facilities, so that the possible magnitude of a forging industry could be determined.

The best way to measure this capacity is by the number and size of forging units as upon that will depend the size of the industry.

To be sure, actual equipment output depends considerably upon many factors as labor efficiency, management, method of processing employed, type of raw material [(1)] and many other factors. This of course will give our estimate a considerably wide range for error. How wide could this error be will be estimated later.

A further limitation is the variety of equipment that could be employed for the same purpose. However, for reasons that will be discussed in the next section, we will make our calculations as if we are going to use Board drop hammers only.

Table V compares the size of the hammer (Board drop hammer) to the average net pounds per piece forged in it and average number of pieces produced per hammer hour. Last figures show the difference obtained in output when using cold or hot trimming and when using one or two helpers (in addition to the hammer man). The last four columns provide information as to the percent of jobs made in each of the previously indicated forms.

(1) W. Naujaks and D. C. Fabel - "Forging Handbook" - The American Society for Metals., Cleveland, 1939, p.20

HAMMER WEIGHT	NET POUNDS PER PIECE FORGED	AVERAGE PIECES PER HOUR COLD TRIM One Helpers	AVERAGE PIECES PER HOUR COLD TRIM Two Helpers	AVERAGE PIECES PER HOUR HOT TRIM One Helpers	AVERAGE PIECES PER HOUR HOT TRIM Two Helpers	APPROXIMATE PERCENTAGE OF JOBS MADE IN EACH CLASSIFICATION (Very few jobs are made without a helper or with three helpers) COLD TRIM One Helpers	COLD TRIM Two Helpers	HOT TRIM One Helpers	HOT TRIM Two Helpers
600	.3					100			
800	.3	458		221		94		6	
1000	.4	313		193		88		12	
1200	.5	271		169	229	82		11	7
1400	.8	242		151	191	76		11	13
1500	1.0	228	281	143	176	74		9	17
1600	1.2	216	238	136	163	71		9	20
1700	1.5	206	208	130	153	33	32	8	27
1800	1.7	197	185	125	143	31	28	8	33
2000	2.2.	178	149	114	126	25	19	6	50
2500	3.8	142	102	94	98	20	9	4	67
2700	4.5	129	90	88	90	15		2	83
3000	5.7	112	77	81	80				100
3500	7.8	89		70	68				100
4000	10.4				59				100
5000	16.3	46							100
6500									

TABLE V,(1) HAMMER SIZE AND AVERAGE WEIGHTS, AND NUMBER OF PIECES PRODUCED PER MACHINE HOUR

(1) H. Kilburn -Board Hammer Production Analysis - Drop Forging Assoc., 1939, Tables M, N and O

Table V which was compiled from data submitted by twenty drop forge shops,gives a good idea as to the difference in output between different hammer sizes. However, in order to use it for our purpose, we should consolidate these figures into one average figure of units per hour, per size of hammer.

This will be done in the following way:

Example-

Hammer weight - 1700 lbs.

Average pieces per hour	206	208	130	153
Percentage of job made in each classification	33	32	8	27

In order to get the average output per machine under these conditions, let us assume that hammer worked:

33% of an hour at 206 units per hour	68
32% of an hour at 208 units per hour	67
8% of an hour at 130 units per hour	10
27% of an hour at 153 units per hour	41
Total	186

We thus find that on the average a 1700 lbs. hammer output is 186 pieces per hour with an average weight of 1.5 pounds. This figure is received on the assumption that the average number of units in jobs processed in the four different categories is the same.

Table VI represents the same values as in the example above for all hammer sizes.

Let us now apply data from Table VI to that in Table IV in the preceeding Chapter. Out purpose will be to find out how many productive hours of hammers (Board) and in what sizes, are required to process all the forgings listed in Table IV.

This would be done by deciding the total number of units required, by the output per hour of their respective hammers. The hammers will be assigned to their jobs according to the approximate weight of the units. Since the approximate weight of the units was determined according to what we thought would be a dominating type and weight of a product, it is hoped that errors will neutralize each other to a certain extent, thus reducing the final inaccuracy that is bound to occur.

Table VII includes the application of Table IV to VI, and the total number of units required in each line of products. The size of hammer assigned to it (according to net weight of products), the number of operating hours required to process each line, the total number of hours that each size of hammer could be employed and total number of machine hours required to process all potential demand.

As chain links and flanges represent a category for themselves, data will be separated into two groups. A. Hand tools, and tool parts and B. Chain links, flanges and tools whose approximate weight could not be determined.

HAMMER WEIGHT (lbs.)	NET POUNDS PER PIECE FORGED	PIECES PER HOUR (average)[1]	POUNDS PROCESSED PER HOUR
800	.3	440	132
1000	.4	300	120
1200	.5	250	125
1400	.8	225	178
1500	1.0	205	205
1600	1.2	200	240
1700	1.5	190	285
1800	1.7	170	290
2000	2.2	140	308
2500	3.3	110	374
2700	4.5	95	427
3000	5.7	80	455
3500	7.8	70	545
4000	10.4	60	624
5000	16.3	45	735

TABLE VI. AVERAGE OUTPUT PER HAMMER (consolidated from Table V.)

(1) Figures to the nearest 5 or 10.

1 LINE AND HAMMER	2 TOTAL QUANTITY	3 HAMMER OPERATING HOURS REQUIRED TO PROCESS QUANTITY	4 APPROXIMATE WEIGHT OF PRODUCT	5 OUTPUT PER HOUR (pieces)
800 pound hammer	[illegible]			440
Wood Chisels	100.000	227	3/16	
Wrenches open &	200.000	454	4/16	
Socket Wrenches	30.000	68	1/16	
Scissors Assodal	100.000	227	3/16	
Screw Drivers	150.000	341	3/16	
Nippers, Pincers, Side Cutters	50.000	114		
Total 800 pound Hammer	630.000	1431		
1200 pound hammer				250
Hammers, Assorted	25.000	100	8/16	
Pliers	600.000	2400	10/16	
Total 1200 pound Hammer	625.000	2500		
1400 pound Hammer				225
Cultivators	5.000	22	12.16	
Total 1200 pound Hammer	5.000	22		

TABLE VII. BOARD DROP HAMMER HOURS REQUIRED TO PROCESS ASSUMED DEMAND IN TOOLS, CHAIN LINKS AND FLANGES.

1	2	3	4	5
1500 pound Hammer				205
Forks Solid Socket	15.000	73	1	
Rock drill bits	30.000	146	1	
Hammers, up to two parts	100.000	487	1	
Total 1500 pound Hammer	145.000	706		
1700 pound Hammer				190
Adjustable Wrenches	20,000	110	1 8/16	
Total 1700 pound Hammer	20,000	110		
1800 pound Hammer				170
Shovels	50.000	292	2	
Clamps, Assorted	30.000	177	2	
Sickles, Pruning Hooks	15.000	88	2	
Spades	10.000	59	2	
Shovels, Solid Sockets	50.000	292		
Total 1800 pound Hammer	155.000	908		
2000 pound Hammer				140
Pipe Wrenches	30.000	212	2 ½	
Total 2000 pound Hammer	30.000	212		

TABLE VII. BOARD DROP HAMMER HOURS REQUIRED TO PROCESS ASSUMED DEMAND IN TOOLS, CHAIN LINKS AND FLANGES. continued

1	2	3	4	5
2500 pound Hammer				110
Mattocks	50.000	455		
Total 2500 pound Hammer	50.000	455		
3000 pound Hammer				80
Picks, Heavy & Light	30.000	372	5	
Axes up to 8 lbs.	30.000	372	6	
Total 3000 pound Hammer	60.000	744		
3500 pound Hammer				70
Hammers, 6-24 lbs.	35.000	500		
Hammers, Stone Cutters	20.000	286		
Total 3500 pound Hammer	55.000	786		
X pound Hammer				Assumed to be 300
Drill heads, Shears, Bolt Cutters, Breast Drills, angle Brace, Drills, Drill Sockets,	100.000	332	N.A.	
Total X pound Hammer	100.000	332		
SUB-TOTALS FOR TOOLS	1,875.000	8206		229

TABLE VII. BOARD DROP HAMMER HOURS REQUIRED TO PROCESS ASSUMED DEMAND IN TOOLS, CHAIN LINKS AND FLANGES. continued

1	2	3	4	5
1000 pound Hammer				300
Chains, Farm machinery (Links)	1.500.000	5000	6/16	
Total 1000 pound Hammer	1.500.000	5000		
1400 pound Hammer				225
Chains-Conveyors	1.000.000	4450	10/16	
Total 1400 pound Hammer	1.000.000	4450		
800 pound Hammer				440
Assorted Chain Links	250.000	675	2/16	
Flanges	500.000	1350	2/16	
Total 800 pound Hammer	750.000	2025		
SUB TOTAL	3.250.000-11.475			
TOTALS FOR TABLE VII	5.125.000-19.681			262

TABLE VII. BOARD DROP HAMMER HOURS REQUIRED TO PROCESS ASSUMED DEMAND IN TOOLS, CHAIN LINKS AND FLANGES. continued

As we see from Table VII, to process total demand listed in Table IV will take about 19.681 operating hours of B.D.H. (Board Drop Hammers). Given that productivity will equal that of the U.S.A. average.

Next - we want to find how many hammers are necessary to perform this operation, and what adjustments are necessary to arrive to a figure that will pay consideration to manufacturing conditions in Israel.

The first factor to be considered is the part of hammer productive time as percent of total hammer time. According to the Drop Forging Association[1], shipments as percent of machine capacity reached their peak (1940-1950) in 1943 and were then at about 70% of capacity.[2] A second table[3] gives the cumulative average of productive operating hours (1921-1948) as 1350 per year. The highest number of operating hours that was achieved through that period was 2600 hours (1942-1943). Both sources show that about 2600 productive operating hours are about the maximum that was achieved until now. It seems to us that for periods longer than a year and under conditions in Israel, it will be more reasonable to expect not more than a yearly average of 2000 productive operating hours per hammer. (This is the average for the years 1940-1946 in U.S.A.)

(1) Drop Forging Association, Pub. No. 4665, 1949
(2) Capacity - $2\frac{1}{2}$ shifts (5000 shop hours) for all machines. 5000 shop hours will yield 4000 productive hours.
(3) Drop Forging Association, No. 4666, 1949

Our next step is to allow for a difference in the efficiency of the Israeli worker as compared to that of the American one. As the study of twenty job sheets shows, "It can be said that the American forge will produce up to 400 percent more forgings per hour than its British counterpart". What was said on the productivity of the British forge will probably apply also in our case.

Low productivity was attributed only partly to the worker(1), while the rest was attributed to such factors as insufficient safety devices, inadequate methods in the employment of men and machines and other changeable and improvable factors.

We think that if the right managerial and technical methods will be employed, we should be able to achieve, let us say, a productivity rate of about 50% of that achieved in the U.S.A. This will very probably apply for the first years of operation until more experience will be gained by plant personnel.

It seems to us that we have now the two basic assumptions necessary to estimate total number of hammers that could take care of the indicated demand.

We may thus conclude that though according to U.S. rates, about 19.681 productive hammer hours are necessary. In Israel it will take about twice as much which makes it

(1) Productivity Team Report - Drop Forging - Anglo American Council on Productivity, New York, 1950 p.6

39.362 hours. As we expect about 2000 productive hammer hours a year, it means that about 20 hammers are necessary for the present (assumed) market.

This figure seems to us the most conservative (for our data). There is, however, the possibility that productivity and productive hours assumptions are too high, in which case the number of necessary hammers might be well above 20 and could probably reach a much higher figure.

Furthermore, it is very likely that the industry will be obliged to export enough forgings to cover the requirements of hard currencies for raw materials.(1) Assuming that raw materials represent about one-third of total manufacturing costs, industry will have to export about 33 percent of its products in order to get enough raw materials for its capacity. In this case, we ought to increase productive capacity by a third, which makes a total number of hammers of about 27 or more.

It should be noted that of this capacity, about 3/5 will be engaged in the processing of chain links and flanges, and only 2/5 in the processing of tools and tool parts.(2)

<u>Summary</u> - In this section we aimed at estimating the total productive capacity required to satisfy demand

(1) see section on raw materials in Chapter II
(2) see Table VII

for forging products in Israel. Assumed demand figures covered tools, tool parts, chain links and flanges. We assumed that the output per hammerman in Israel will be 50% less than that in the U.S.A. (A figure that seems to be somewhat optimistic.) We also assumed that an average of 2000 productive hammer hours will be derived per hammer annually. Based on this assumption, we found that about twenty Board drop hammers can do the job. We stated that in order to get raw materials, the industry will have to export about one-third of its production. To coverthis extra need the number of hammers will have to be increased to about 27 hammers.

This number will be required if it will be commercially feasible to manufacture every item on the list, in each variety required. However, it won't be surprising at all if we will find that about 20-50 percent of total demand is not worth manufacturing on a commercial basis, because of low volume. On the other hand, not all types of forgings with a possible demand were listed i.e. gears, plumbing supplies etc. We may thus assume that the number of 27 Board drop hammers or their equivalent in productive capacity is a farily reasonable figure, representing potential capacity of a drop forging industry in Israel.

INITIAL ADVISABLE CAPACITY AND EQUIPMENT

We are taking up this discussion in order to find out how much foreign currency is going to be required, in equipment and raw materials as an initial investment. We also want to know what type of equipment we are going to use so that our later discussion about production costs could be centered around a specific type of equipment.

Considering with what size of plant we want to start, we should analyze the following points.

1) Share of Market
2) Size of plant that will provide for efficient operation.
3) Size of plant that will be the least risky to start with.

1) Share of market

In the first part of this paper,we described the difficult economic conditions in Israel. Under such conditions, the relatively large enterprise is able to overcome difficulties and shortages more successfully than the small one. The large enterprise can afford to devote more time and effort to overcome difficulties on one hand, and on the other hand, its relative greater importance tends to attract more governmental attention and consideration, a fact that has a considerable amount of importance when allocation of raw materials, and foreign currency is concerned.

On the other hand, there is some advantage for an enterprise in being small at the initial stage, for the simple reason that no one can determine accurately what is actually the size of the market for forgings and how are operating conditions going to be. Under such conditions of uncertainty, it seems more advantageous to start at a small scale until operating conditions become clearer, due to practical experience.

Taking all this into consideration, it seems to us that from the standpoint of occupying a substantial place in the market, about a third of total potential productive capacity as an initial stage, could give us this position. A third of total capacity will require the employment of around 9 hammers, assuming that each hammer requires about 10 employees[1] (two shifts) total plant employment will be around 90 people. Such a plant in Israel is by all means a noticeable and respectable unit.

On the other hand, however, it seems to us that to start a new plant under untried conditions at that capacity is somewhat hazardous. It looks as if it will be much better if a plant could start from a nucleus and develop itself, gradually, into a more substantial unit.

(1) Productivity Team Report - Drop Forging - Anglo American Council on Productivity, New York, 1950, p. 49

What lines of products are we going to process is an additional factor to be considered. Figures in Table VII indicate that the production capacity will be divided approximately as follows:

Chain links - Farm machinery	25.3%
Chain links - Conveyors	22.4%
Pliers	12.1%
Flanges	6.8%
Hammers	5.4%
Wrenches - open end	2.3%
All other lines	25.7%
Total	100.0%

According to latest figures, chain links represent the largest single line (about 50%), the other 50% of required productive capacity is distributed among different tool lines. Of these tool lines, pliers, hammers and open end wrenches are the most important among them, and account for about 20% of total capacity.

As it appears to us, the manufacture of chain links offers important advantages over the rest of the products. The main features of this line are:

1) Relatively large volumes, which will give us larger runs.
2) A relatively small number of varieties, thus it will be much easier to acquaint new personnel with their work. It also provides for larger runs.

3) Product seems to be relatively simple in design tolerances and finishing operations. This will enable us to get satisfactory work at earlier stages than in the case of tools.

It seems clear that the manufacture of chain links offers many of the benefits of mass production and standardization. From the above mentioned considerations, it appears that it will be much easier to start forging operations with the processing of ~~tool~~links. This line of action might be very well the one that we would recommend as a practical step toward successful operations.

In this paper, however, we are also interested in studying the problems of small volume manufacture, as encountered in the forging industry. Therefore, we should prefer to continue our work with the thought of going into the production of tools. This will give us a better opportunity to study the problems of small volume production.

1) Size of plant for efficient operation.

Plant efficiency and smoothness of operations depend on internal as well as external factors. In Chapter II we mentioned the incompleteness of auxiliary services and industries in Israel, which means that to the extent that services etc. are necessary for the manufacturer, he himself has to supply them. In our case, for instance, there are no closed die makers for forgings[1] which means

(1) Tools and Die Factory - State of Israel, Ministry of Trade and Industry, Investment Center, 1951, p.1

that the plant will either have to import them or to make them itself. Naturally, to import dies from abroad for all kinds of jobs will cause considerable delays and could not be considered an efficient way to get them. We will therefore have to maintain a die shop for the plant's use. Such a die shop, with its equipment, is an expensive proposition and has to be employed at capacity in order to justify its costs. This in turn means that a certain volume of production is required in order to utilize efficiently the capacity of the die making equipment. How much should this volume be is not easy for us to say. However, we consulted Mr. Sault, President of Porter Forge and Furnace Co., Somerville, Mass., and in his opinion, three hammers could efficiently employ at least one die sinking machine. At his plant, which has three hammers, they use efficiently two die sinking machines. As this plant processed mainly special work with close tolerances and a high amortization of dies, he believes that one die sinking machine should normally suffice for our purposes. We should note that while the die sinking machines were employed in this plant solely for forging dies, the rest of the standard equipment i.e. lathes, shapers etc., was used for maintenance work and for tool-making destined to another plant in the same building.[1] It thus seems to us that while die sinking

(1) H.K. Porter

equipment could be satisfactorily employes with 3-4 hammers, the rest of the equipment needs a larger volume of work for its full utilization.

Besides its hammers, a forging plant has tobe equipped with a considerable amount of other types of equipment. The full utilization of such equipment is an additional factor when efficient operation is considered. Unfortunately, no study was made in this aspect and thus we have no means of determining how much forging capacity is needed in order to bring auxiliary facilities into full play.

The size of the plant will also have an effect on the managerial and technical talent that could be employed.

We assume(1) that at the initial stage, we will need an experienced foreman or plant superintendent, a very good die maker, and an experienced engineer to take over the technical and managerial guidance. These men should be experienced people from the U.S.A., at least for an initial period. This number of people could probably be justified at a plant with about 30-50 employees or 3-5 hammers.

The same thing also pertains to specialization among the labor force. We certainly want to reach a stage where some specialization among employees will take place.

(1) The following was suggested by Mr. R. G. Sault, President, Porter Forge and Furnace Co., Inc.

We assume that such initial specialization could take place at a plant with 25-35 employees.

In conclusion, we can say that a plant with about nine hammers could be large enough to occupy a substantial part of the market (about one third) and also be considered as a sizeable enterprise, by the government and by the public. On the other hand, our desire to maintain a die shop of our own, and gain some benefits of specialization, could be economically justified with 3 or 4 hammers. A plant of this size will employ about 35 to 50 people in two shifts, and will occupy about 11 to 15 percent of potential productive capacity (machine hours) or twice as much if we consider only the manufacturing of tools.

It seems to us that even if we could not reach an efficient level of operations with such capacity, it is worthwhile to start with limited capacity, and develop it gradually into a larger plant, if conditions will justify such a development.

The reason for it is that initial operations when on a pilot-plant basis, are generally the less expensive way to start a new plant under conditions not wholly explored.

Equipment Required for the Plant.

Our purpose in this section is to determine with what equipment should the plant be provided if we want it to produce finished forgings with the right physical and structural properties.

It should be clear, however, that we will discuss only that equipment necessary for the production of finished forgings. Equipment necessary for the machining of these products will not be discussed here. We do so because this paper confines itself only to problems involved in the forging operations and those connected with them. In addition, machining work could be done by machine shops already existing in the country so that there is no need to import such equipment. If practical experience at a later stage will prove that the adding of a machining department could justify itself by reducing the cost of the finished product, such a department could be added then.

Unfortunately, our acquaintance with the technical side of the forging plant equipment is quite limited. Thus any attempt on our side to work out a detailed plan for such equipment is bound to be of little value. Therefore, we will have to discuss these problems in general lines, with the purpose of outlining equipment needs only.

Forging and Related Equipment

"....equipment in the forging industry may be classified into several general groups which classifies this equipment according to the purpose for which it is generally used, and such a grouping results in the following; (1) Die Making (2) Forging (3) Shearing and Cutting (4) Power Press (5) Cleaning (6) Handling and Conveying, and (7) Furnace and Heating." (1)

Die Making Equipment

"The well equipped die and machine department contains one or more planers, depending upon the size and capacity of the department. There is usually an assortment of shapers, one or more lathes, drill presses, boring mills and bench vises.....

Die Sinking Machine - The machine tool that is generally distinctive in the die department is the vertical milling machine, designed primarily for sinking dies for the forging equipment, and is generally known as the 'die sinking machine'.

Although some of the forging dies are machined without the use of this machine, the majority of drop forging, forging machine, and press forging dies and tools have some part or all of the impression machined in this tool."(2)

(1) W. Naujaks and D. C. Fabel - Forging Handbook - The American Society for Metals, Cleveland, 1939, p.20
(2) ditto

Summarizing what was said above, the minimum equipment for die sinking in a 3-4 hammer plant will be comprised of:

1-2 Die sinking machines

1 Planer

1 Shaper

1 Lathe

1-2 Drill presses

1-2 Boring Mills

Plus the different equipment that goes with it, and an assortment of hand tools. When making the choice among die sinking machines, we should evaluate the possibility of buying automatically controlled machines. Though these machines are more expensive, than hand-controlled equipment, they probably require a less experienced operator which might prove to be an important advantage during the initial years of operations.

Hammers

"The modern forging hammers are usually divided into two groups, namely the drop hammer and the steam hammer."(1)

Drop Hammer - "The drop hammer is the principal forging unit for the duplication of forged parts in the hammer field. These hammers are fitted with suitable drop forging dies to perform their work. Drop hammers are

(1) ditto p.29

classified either as the steam drop or the board drop depending upon the method of power transmition. The air drop hammer is identical with the steam drop hammer except that air under pressure replaces the steam pressure as the power medium."(1) Let us now see what differences exist between board drop hammers and steam drop hammers.

Board Drop Hammers -"The characteristic traits of the board drop hammer are the methods of power application in its function as a drop hammer. The use of maple boards for the transmission of energy from the motor or lineshaft to the ram is distinctive and unique, yet this method has proved satisfactory and practical for many years.

The outstanding advantage of the board drop hammer is the fact that no steam plant or compressed air plant is required for its operation which avoids heavy investment in auxiliary equipment. Its limitation is that it lacks the flexibility of the steam drop hammer and is limited in the types of forgings it will commercially produce.

The board drop hammer is a good commercial unit on the general run of simple and moderately difficult forgings which contain relatively uniform sections and which are not too thin at any points. Forgings that require edging and finishing; edging, blocking and

(1) ditto p.30

finishing; edging, bending, blocking, and finishing are the types of forgings that may be considered for the board drop unit. If the forging material is not of the extremely difficult plastic deformation type; if the forging does not contain deep holes or high plugs; if the sections are not extremely thin or very unsymmetrical; then the forging may be suitable for board hammer production. Since the impact blows in the board drop hammer are of equal intensities at all times, a sufficient body of metal must be under the dies to take up the impact pressure without imparting too much of the impact pressure to the hammer to be absorbed there. A general "rule of thumb" among some of the forgers is that the forging must be completed before the temperature of the flash metal drops below a fairly visible red.

Fullering, as a general rule, is not a practical board hammer operation. For some special cases, it may be reasonable to provide a fuller which serves satisfactorily, but for the bulk of the forgings requiring a fullering operation, the steam hammer is preferred where it is available.

The board drop hammer produces most of the drop forgings from the smallest, which may weigh less than an ounce, to those up to about five pounds in weight.

Forgings from about five pounds to those about fifteen pounds are about evenly divided between the board drop and the steam drop hammer, and drop forgings over fifteen pounds in weight begin to fall more into the steam drop hammer class. Commercially, the board drop hammer may produce drop forgings of a suitable nature up to about 100 pounds which is generally considered the upper limit for the largest board drop hammers in the commercial shops.

The board drop hammer finds frequent service as a restriking unit for straightening and aligning forgings which require a straightening operation after heat treatment. The striking operation may be a cold or a hot operation, depending upon the nature of the operation and the type of the material. On large, heavy sections and on some types of ductile material, the restriking operation may be used to obtain closer tolerances than are practical in the forging operation.

Forging in the Steam Drop Hammer. The steam drop hammer obtains its energy through the medium of steam under pressure. The energy contained in the steam pressure is imparted to the piston in two ways. First, it lifts the ram after a blow has been struck, performing the same function that the energy delivered to the board drop hammer performs. Second, it increases or decreases the intensity of the hammer blow due to the falling weight of the ram and the reciprocating parts. This peculiar advantage over the board drop hammer enables the operator to strike a blow of any desired intensity from a very light tap to the full power of the hammer. The delivered blow is a so-called "live blow" which delivers its impact pressure and the ram snaps back, while in the board drop hammer the blow is termed a "dead blow" where the upper die seems to rest momentarily upon the forging before the ram returns to a striking position again. It goes without saying that any board drop hammer forging may be forged inthe steam drop hammer, but not always as economically. Any of the preliminary operations such as edging, fullering, drawing, bending, flattening, and blocking are readily performed in the steam drop hammer.

The installation of steam drop hammers necessitates the use of a steam power plant for the source of steam power and generally the steam drop hammer shop or the shop employing both board and steam drop units are equipped with power plants. In some of the plants compressed air is substituted for steam which eliminates the steam power plant. Generally, compressed air will operate the hammer as well as steam and the choice of power medium usually resolves itself into a matter of economy as to whether steam or air will be used.

The successful performance of the steam drop hammer probably depends to a greater degree upon the skill of the hammerman than does the board drop hammer performance. Both types of units require equal skill in setting up the die equipment, and in some of the other factors, but production in the board drop hammer is more nearly fixed because the unit operates at a uniform rate. On the steam drop hammer a highly skilled operator may coax much greater speed out of a given unit than can the ordinary hammerman and at the same time he maintains the quality. The skilled operator is also easier on the dies.

The steam drop hammer is much more adapted for the less plastic metals. High carbon steels, high carbon alloy steels, stainless steels and irons, monel metal, and other alloys with a high specific resistance to deformation are usually forged in the steam drop hammer. Forgings with irregular shapes, thin or unsymmetrical sections are usually steam drop forgings. Some forgings may be forged in the board drop hammer but because of the greater ease in handling and better production are placed in the steam drop hammer."(1)

We thus see that the practice in U.S.A. is to employ almost exclusively Board drop hammers for forgings below the weight of 5 pounds, while forging weighing

(1) ditto pp. 134-140

between 5 to 15 pounds are evenly divided between Steam and Board hammers.

The British productivity team visiting in the U.S.A. had this to say on Board drop hammers.

"The major part of American production of small forgings is made on board hammers. The tup weights range from 400 lbs. to 5,000 lbs. and forgings produced range from a few ounces to approximately 12 lbs. The board hammer is therefore regarded as a most important item of forging equipment, and the very high standard of production obtained from it contributes to a very large extent to the American reputation for high output.

It was apparent to the Team that the board hammer, properly used, was capable of producing, economically, a much wider range of work than has hitherto been thought practicable on this type of hammer in Britain. The limitations normally associated with board hammers are:

a) The stroke can be only varied by altering the mechanism. It is impossible to obtain a short blow followed by a long blow.

b) The short life of the boards.

The fixed stroke as a limiting factor has been eliminated to a great extent in America by suitable die design. The fundamental rule for die design has been that best use should be made of each blow, extensive pre-forging, not requiring the full weight of each blow, being avoided. It was found to be the almost invariable practice to use a hammer which had a larger tup weight than would be used in Britain when producing the same forging. This was, of course, of great benefit to the plant, as it was not overloaded, and, combined with the comparatively short and rapid blows delivered by the board hammer, enabled the metal to be forged quickly and in its most plastic state. From observations made it was doubtful if any other type of hammer could be proved to surpass the board hammer in efficiency and low cost per piece.

The main problem in the use of the board hammer was the supply of suitable boards. Board life was given as 16 to 24 hours, when excessive suction had the effect of retarding the lift, and 56 to 112 hours on plain flat work. One forge, using laminated boards resin bonded, claimed to obtain very much higher board life and quoted figures as high as 300 hours, with 200 hours as an average. The boards had a very short working life on a time basis, but it should be borne in mind when making any comparison, that during their working life, American boards would have delivered more blows than most boards in Britain. The boards were normally changed by the hammer crews, and although this was done with all possible speed, the loss of production was between a half and one hour. This loss, when the board life, with deep section forgings, was only two shifts, was a considerable item.

The material used for the hammer boards was American rock maple, made up eigher from solid pieces or two plies. In quality, the boards appeared to be superior to the normal British variety which is, of course, imported. The American boards had a closer grain, were harder, and had less than 5% moisture content, and their superior quality contributed in no small degree to the snappy action on American hammers. It was reported that the quality of American boards had deteriorated considerably during the past few years. Considerable research had been undertaken to improve the quality and a make was seen in which maple in transverse lamination was resin bonded. Although more expensive than the plain boards it was claimed that they had a longer life, and were therefore, more economical."(1)

In this report, the group points out again that the board drop hammer is the main producer of light forgings, and is used up to weights of 12 lbs.

The major drawback that the group finds in this type of hammer is the extensive replacement of boards. Beside the cost of new boards, there is also the labor

(1) Productivity Team Report - Drop Forging - Anglo American Council on Productivity, New York, 1950, Sections 85-88.

cost of replacing them, plus the loss of productive time. The team also mentions the fact that the supply of good boards creates a problem even in U.S.A. and that boards imported to Britain are of an inferior quality.

The British team and the forging handbook are both mentioning the high costs of operating steam hammers. Tables VIII, IX give details as to the average Burden rates in June, 1949., for board drop hammers, steam drop hammers. Figures are sample averages of the U.S.A. Forging Industry(1) and based on 1350 productive hours per year.

The last column in each table was compiled by us. In adding up we used cold trimming rates for board hammers up to 2000 pounds, and steam hammers up to 1000 pounds inclusively. For heavier hammers we used hot trimming rates.

(1) Average Burden Rates, Drop Forging Assoc., N4888, 1949

SIZE	MACHINE	FURNACE	TRIM PRESSES Hot	Cold	TOTAL
400	2.24	1.08	1.00	1.33	4.65
500	2.45	1.19	1.04	1.37	5.01
600	2.65	1.30	1.07	1.40	5.35
800	3.06	1.52	1.14	1.48	6.06
1000	3.46	1.74	1.21	1.55	6.75
1200	3.87	1.95	1.27	1.62	7.44
1400	4.27	2.17	1.34	1.69	8.13
1500	4.48	2.28	1.37	1.72	8.48
1600	4.68	2.39	1.41	1.76	8.83
1800	5.09	2.61	1.48	1.83	9.53
2000	5.49	2.83	1.54	1.90	10.22
2500	6.51	3.37	1.71	2.08	11.59
2750	7.02	3.65	1.80	2.17	12.47
3000	7.52	3.92	1.88	2.26	13.32
3500	8.54	4.46	2.05	2.44	15.05
4000	9.55	5.01	2.22	2.61	16.78
5000	11.60	6.10	2.56	2.97	20.26
6500	14.60	7.74	3.07		24.41

TABLE VIII BOARD HAMMER BURDEN RATES

SIZE	MACHINE	FURNACE	TRIM PRESSES Hot	Cold	TOTAL
500	6.39	1.50	.85	1.68	9.57
600	6.71	1.63	.88	1.72	10.06
800	7.36	1.89	.95	1.80	11.05
1000	8.01	2.14	1.02	1.88	12.03
1200	8.66	2.40	1.08	1.96	12.14
1250	8.82	2.46	1.10	1.98	12.38
1500	9.64	2.78	1.19	2.09	13.61
2000	11.30	3.42	1.35	2.29	16.07
2500	12.90	4.06	1.52	2.49	18.48
3000	14.50	4.70	1.69	2.70	20.89
3500	16.00	5.34	1.86	2.90	23.20
4000	16.70	5.63	2.03	3.10	24.36
5000	18.30	6.19	2.37	3.51	
6000	19.80	6.76	2.71	3.91	
7000	21.40	7.33	3.04	4.32	
7500	22.10	7.62	3.21	4.52	
8000	22.90	7.90	3.38	4.73	
9000	24.40	8.47	3.72		
10000	26.00	9.04	4.06		
11000	27.50	9.61	4.39		
12000	29.10	10.20	4.73		
14000	32.10	11.30	5.41		
15000	33.70	11.90	5.75		
16000	35.20	12.20	6.08		

18000	38.30	12.50	6.76
20000	41.40	12.80	7.44
25000	49.10	13.60	9.12
30000	56.80	14.40	10.80
35000	64.50	15.20	12.50

TABLE IX STEAM HAMMERS BURDEN RATES

The best way to compare cost of steam and board hammers operations is probably according to cost per unit forged. Unfortunately, we have no data that could lead to such a comparison. The data in our possession enables us to compare the hammers according to weight of unit forged. In other words, we will compare the costs of the two hammers forging the same product.

Due to the added force of the steam pressure, a steam hammer (with the same ram weight as a board hammer) can deliver heavier blows, and thus forge heavier parts. Table X compares the size (ram weight) of steam, and board hammers capable of doing the same (given in gross weight of metal forged), with the Burden cost of the hammer, and to total Burden costs of hammer, furnace and trimming.

Sizes of hammers chosen for each job are according to recommendations of the drop forging association.[1] (This hammer size is recommended for work on easy to forge metals as SAE 1020).

(1) Selection of Hammer Sizes - Drop Forging Assoc., N.4614, 1948

UNIT GROSS WEIGHT (lbs.)	BOARD HAMMER	STEAM HAMMER	BOARD HAMMER BURDEN		STEAM HAMMER BURDEN		TOTAL BURDEN BOARD HAMMER		TOTAL BURDEN STEAM HAMMER	
			$	%	$	%	$	%	$	%of BDH
0.6	1000	500	3.46	100	6.34	178	6.75	100	9.57	140
1.7	1500	800	4.48	100	7.36	164	8.48	100	11.05	130
2.3	2000	1000	5.49	100	8.01	146	10.22	100	12.03	118
3.2	2500	1250	6.51	100	8.82	135	11.59	100	12.38	107
4.5	3000	1500	7.52	100	9.64	198	13.32	100	13.61	102
7.0	3500	2000	8.54	100	11.30	132	15.05	100	16.07	107
10.0	4000	2500	9.55	100	12.90	135	16.78	100	18.48	110
13.4	5000	3000	11.60	100	14.50	125	20.26	100	20.89	102
22.0	6500	4000	14.60	100	16.70	114	24.41	100	24.36	100

TABLE X - COMPARISON OF BURDEN RATES AT EQUAL WORK

Table X reveals that machine Burden Rates have a greater tendency to differ from each other than Total Burden Rates. In other words, Burden Rates for furnace and trimming are lower for steam hammers than for board hammers; these facts tend to decrease the difference between total Burden Rates for board drop hammers (B.D.H.) and steam drop hammers (S.D.H.).

In general the difference between B.D.H. and S.D.H. tends to decrease as their sizes increase. This pertains both to total Burden Rates and to hammer Burden Rates.

Summarizing, we can say that the board drop hammer is significantly cheaper to operate up to the size of 4000 pounds; above this size, the difference almost disappears (for total Burden Rates) while hammer Burden Rates remain significantly lower for B.D.H. even at 6500 pounds.

Though Burden Rates per hour are significantly lower for B.D.H., it is not clear that they are lower also per unit forged. It was mentioned already that steam hammers have a higher output if used by a competent operator.

As already mentioned, the practice of American forgers is that units up to 5 pounds gross weight are forged by B.D.H. while as to units between 5-15 pounds there is no common practice and both B.D.H. and S.D.H. do the job. This might be an indication that for B.D.H. up to about

3000 pounds are supreme to their equivalent in S.D.H. of 1500 pounds while above this weight opinion as to superiority of hammers is divided.

According to data in Table VII,[1] the productive forging capacity for tools should be distributed approximately as in the following schedule.

600 pound B.D.H.	2,862	productive	hours
1200 " "	5,000	"	"
1400 " "	44	"	"
1500 " "	1,412	"	"
1700 " "	220	"	"
1800 " "	1,816	"	"
2000 " "	424	"	"
2500 " "	910	"	"
3000 " "	1,488	"	"
3500 " "	1,572	"	"
Unknown "	664	"	"
Total	16,412		

At 2,000 productive hours per year we could use the following quantities of hammers.

1.4 of a 600 pound hammer
2.5 " " 1200 " "
0.7 " " 1500 " "
0.1 " " 1700 " "
0.9 " " 1800 " "
0.2 " " 2000 " "
0.4 " " 2500 " "

(1) All hour numbers are double those in Table VII to compensate for lower productivity.

0.7 of a 2000 pound hammer

0.8 " " 2500 " "

0.3 " " unknown "

The last figures show that demand for forgings usually made by 600 pound hammers, 1200 pound hammers, 1800 pound hammers and 3000 pound hammers, is large enough to use these hammers in the most efficient way.

Hammers of other sizes than those mentioned above will not have enough production volume, in the type of work to which they are best adapted. There will be a need to employ hammers for work which they are not best adapted to; this of course will result in higher costs.

What sizes of hammers could be best employed by us, and how many in each size is our problem now. As we can see from the last figures, we could use efficiently one 600 pound hammer, two 1200 pound hammers, one 1800 pound hammer and one 3000 or 3500 pound hammer. All-together, it makes five hammers that could be employed on work to which they are especially adapted.

Our initial plans are to start with 3-4 hammers. We thus have to choose among sizes of hammers. The first question to answer is whether we want to spread our hammer sizes from the lightest to the heaviest required, or if we prefer to concentrate on a limited area.

In case we want to spread our range, we should use hammers from 600 pounds to 3500 pounds; while if we want to concentrate in a certain field we will have to do it in the lightest hammer sizes, as only the demand for their product is sufficient to allow for such concentration.

In general, spreading our hammer range will give us all the benefits and drawbacks arising from versatility. The most important benefit would be the flexibility of the plant to do all types of work. This is an important factor as we are unable to forecast now what type of forging will prove to be the best to go into. On the other hand, the great variety of products in which we will be lead by this versatility will certainly increase our operational problems, in almost all fields. Considering the little knowledge and experience that the personnel will have during the initial years, versatility is certainly going to be as much of a handicap as an advantage.

An additional factor is raw materials considerations. The smaller hammers use less raw materials per productive hour than the larger ones. According to data in Table VI, (Chapter IV), finished products processed per productive hour are as follows.

600 pound B.D.H. processes an average of 132 pound per hour
1200 " " " " " " 125 " " "
1800 " " " " " " 290 " " "
3000 " " " " " " 455 " " "
3500 " " " " " " 545 " " "

In Chapter II, we mentioned the insecure supply of raw materials, and the necessity for new enterprises to buy raw materials supplies with their own foreign currencies. Generally given that we will have to stock inventories for one or two years, the quantity of raw materials processed per productive hour is of great significance, i.e. at .05¢ per pound of steel, a year's supply of steel for the different size hammers will be as follows.

600 pound hammers - value of raw materials per year $19,800
1200 " " " " " " " " 18,700
1800 " " " " " " " " 43,500
3000 " " " " " " " " 67,500
3500 " " " " " " " " 81,000

The way we arrived at these figures was by multiplying the weight of finished products processed per hour, by 2000 productive hours, by .05¢ and by 1.5. (Weight net product per hour x 2000 x 5 x 1.5)

The 1.5 figure gives us the gross weight of metal processed.[1]

(1) The ratio of gross material fabricated to net shipments was 1.8 to 1.0 in Dec. 1948. (Figures are reported from Drop Forging Industry Con. Report, Dec., 1948) We used a ratio of 1.5 for the sake of consecration.

It is clear now that the employment of lighter hammers could mean a considerable reduction in the cost of inventories, and in hard currency investments. Considering what was said above, it will be logical to concentrate on the lighter products and hammers. By doing so we will gain some of the benefits of specialization and lower the amount of hard currency necessary as an initial investment.

According to that we assume that the best hammers to be used by us are:

One 600 pound hammer.

One or two 1200 pound hammers.

One 1800 pound hammer.

This initial variety and size will give us the 3-4 hammer plant that was discussed in the section on Size of Plant for Efficient Operation.

Products that could be processed through such a plant will include[(1)] 1) Wood chisels, 2) Open end wrenches, 3) Socket wrenches, 4) scissors, 5) Screw drivers, 6) Hammers, 7) Pliers, 8) Cultivators, 9) Solid socket forks, 10) Rock drill bits, 11) Adjustable wrenches, 12) Clamps, 13) Spades, 14) Pipe wrenches, 15) Drill heads, 16) Drill sockets, 17) Breast drills, and 18) Angle brace drills.

(1) Table VII

Potential capacity for these products, including that of intermediate size hammers will be about 12,000 productive hours. We should expect,however, that for commercial reasons, we will be able to use only 30-50 percent of that capacity. This is due to the fact that it probably won't be commercially feasible to make all sizes, grades and lines required in the market.

This leaves us with a required capacity of about 6,000 to 8,000 productive hours. A plant with 3-4 hammers will be capable of producing all these requirements. In addition, as a safety factor, we will have additional demand of the assumed export trade, which will bring required capacity up to about 8,000 - 10,000 hours. It does seem to us that a tool forging plant with 3-4 hammer is not too large for Israel, and will probably be able to expand operations at a later stage. We might reduce, though, the numberto three hammers so that there won't be any danger of over capacity at the beginning.

Shearing and Cutting Equipment

"The raw materials in the forge plant usually consists of bars and billets and these must be cut into shorter lengths for forging purposes. The shearing equipment usually consists of two types of shears, the vertical shears and the alligator shears. As a general rule the vertical shears are used to cut up the forging stock and the alligator shears are used for cutting up the flashings, although they may be used for the smaller sizes of bar stock.....

Frequently high speed cold cutting saws supplement the shears. Certain types of stock do not lend themselves to cold or hot shearing and must be sawed."(1)

Based on what was said above, we will need for the beginning

1-2 Vertical shears

1 Alligator shear

There might also be a need for a high speed saw.

Power Press Equipment

"Power presses constitute the main supplementary equipment for the processing of forgings by performing such operations as trimming, forming, bending, straightening, planishing, punching, and the like, which converts a rough forging into a finished forging ready for the machine shop or for use without further processing, except possibly for cleaning or heat treating. Most of the presses are of the mechanical type where energy is stored in the flywheel to aid in turning the crank when exerting pressure. The presses are used for hot and cold trimming, hot and cold punching, forming,

(1) W. Naujoks and D. C. Fabel - Forging Handbook - The American Society for Metals, Cleveland, 1939, p.47

planishing, and other general processes required in the processing of a forging. Such presses may range in size from the small press of 20 or 25 tons to the large press of 500 tons or more as used in some of the largest forging plants. The length of stroke is also dependent upon the particular requirements of the press.

The coining or sizing press is a special press designed particularly for exerting a heavy pressure over relatively small areas, whereby portions of the forging may be sized to closer tolerances than can be obtained in the forging dies. Tolerances of 0.002 inch and even 0.001 inch may be obtained upon certain sections with suitable sizing equipment, although for the general run of sizing work tolerances of 0.005 to 0.010 inch are used. In many cases, the use of the coining press entirely eliminates machining and produces a product of high dimensional accuracy".[1]

We thus need general purpose presses for trimming, punching, forming and planishing, and in addition a special purpose press for coining. The general practice in the industry is to have one press per hammer. Coining presses, however, are used according to the character of the product; for our purposes we assume that we will need one coining press plus three regular presses of suitable sizes.

(1) ditto p. 47-49

Cleaning Equipment

The removal of the oxide film on forgings, commonly known as scale, and which is formed by the heating of the metal, necessitates the use of some method for removing this scale. The forging plant may use one or more of the three common and general methods, that of pickling, blast cleaning, and tumbling.

Pickling is a chemical action method whereby the scale is loosened from the forging by immersion of the forging in some suitable pickling solution, usually an acid. The acid is placed in some suitable container or tank, either made of wood, or of steel and lined with some acid resisting substance.

The blast cleaning method is one where the scale is removed by the action of sand or shot striking the forging at high velocity. The sharp corners of the sand or steel grit cut away the scale. The blast machine for small and medium sized forgings consists of a closed vessel with suitable access for loading and unloading of forgings. The velocity imparted to the sand or steel particles may be due to high pressure air or to the action of the machine in the newer airless types of blast cleaners. For forgings too large for the closed, revolving type of machine, the table type of blast cleaner may be used, where the operator sprays the forgings with the blast through a hose. In either type of machine, the operator is protected from the blast."[1]

We thus have to choose one or two methods of cleaning. Tumbling or sand blasting have an advantage over pickling, since the last one requires considerable amounts of sulphoric acid. This acid is imported to Israel, and as all other imported goods, its supply is limited.

Handling and Conveying Equipment

The equipment for handling the work in process depends, in general, upon the requirements of the individual forging shop. Most everyone is familiar with the various types of hoisting equipment such as chain lifts, electric and air lifts; and the moving lifting equipment such as span and monorail cranes, locomotive cranes, portable cranes; and the hand apparatus such as dollies, hand trucks, and wheelbarrows. The hot pieces of metal at the forging and heat treating furnaces are handled with tongs, porter bars, handles of various kinds, with or without the aid of hoists or trolleys.

Probably the most characteristic portable container for movement of hot and cold forgings is the steel tote

(1) ditto p.50-55

box. This container is made of either heavy corrugated sheet steel or of structural material, such as steel angles and channels, and riveted together. The tote box has legs of sufficient height to permit an electric or hand lift truck to move underneath it and pick it from the floor for conveyance to another place or department. Suitable eye handles permit the use of an overhead crane where it is so desired."(1)

From observations in forging plants, it looks as if the heaviest equipment required is a fork lift. This unit is of great help not only in conveying materials but also helps to position the heavy dies in the hammers, which results in a considerable saving in die setting time.

In addition to the fork lift it will probably be advisable to use one or two battery driven carriages. Needless to say, tote boxes will be also required.

It looks, however, as if an overhead crane is a luxury for our case and will be of little value.

Furnaces

"Furnaces are a part of the basic equipment in the forge plant. Many types and styles of furnaces are in use, depending upon the individual needs of the particular shop and the kind of forgings produced. Possibly the forge furnaces may be considered in three general

(1) ditto p.55-56

groups, the box or batch type of furnace, the rotary furnace, and the continuous furnace, all of which are used to heat metal for forging purposes.

For the general, all-around furnace, the box furnace finds great favor. It is also called the batch furnace, in-and-out furnace, or the slot furnace. This type is indeed a large box on legs, with firebrick lining on the inside. The front of the furnace has a long narrow slot for loading stock and unloading for the forging operation. Heat is supplied by one or more burners placed on the side of the furnace, and the temperature may be hand or pyrometer controlled. The framework of the furnace may be of cast iron, cast steel, or structural steel shapes. The number of burners and the size of the slot opening are dependent upon the capacity of the furnace and the maximum size of stock it is required to heat.

Rotary furnaces are generally a design of furnace where the hearth rotates. The speed of the hearth is relatively slow, making one revolution in five, ten, or sixty minutes. Furnaces of this type are used for forge heating and heat treating. The stock for heating in these furnaces is limited as to length and cross section area for efficient heating. The clearance space between the hearth and the furnace side is usually sealed by a water or sand seal. The sealing is for the purpose of avoiding cold areas in the furnace and permitting better atmosphere control.

The continuous type of furnace for forge heating may be one of several designs. Probably the pusher design is most used, and this design may be either of the gravity type or the mechanical pusher type. In the gravity continuous furnace, the long hearth is built with a slope. Round stock is fed into the furnace at the high end, and after the furnace is loaded, the removal of a piece of stock at the lower end moves the entire row downward one piece. This furnace is only applicable to round stock.

The mechanical pusher furnace moves the row of stock from the loading end to the removing end by pushing against the stock. Upon moving the row of stock forward for the definite interval, the pusher arm recedes and another piece of stock is placed in the vacant space for the arm again to push against. In one design of pusher furnace, the stock is placed sideways against each other on rails and moves forward by sliding along the rails. In the second design, the hearth is provided with a "V" slot in which the stock is placed end to end and moved forward. The use of the rails limits the size of the stock to square billets of about 3-inch square or larger, and of sufficient length to span the two rails on which the stock slides. In the "V" groove, the stock may be either round or square, and of any length.

Where the forge plant contains a production heat treating department, underfired box type furnaces with sliding doors are used for the general heat treating. Continuous types of furnaces may be of various design, such as the rotary furnace, the chain grate furnace, the car hearth type furnace, and similar designs. Heat treating furnaces are usually of the indirect fired type, with the newer furnaces atmospherically controlled."(1)

For our purposes the slot furnace is the simplest and least expensive to construct. Its wide use among forging plants indicates that the furnace is adapted to its purposes.

The general industry practice is to use one slot furnace per hammer, thus we will need three slot furnaces for the plant.

In addition to the slot furnace we will need one or more box type furnaces of the indirect fire type and atmospherically controlled.

As the reader realizes we tend to use furnaces which are commonly used and require a relatively small initial investment. As this is done without a sufficient study of other possibilities, we should check this decision at a later stage.

(1) ditto p.56-58

Forging Rolls

"Forging rolls are required primarily for reducing short thick sections into long slender sections. Their action is similar to that in the rolling mills where steel ingots are reduced by rolls into billets and bars. There is, however, one major difference between the steel mill rolls and the forging rolls. The steel mill rolls reduce throughout the entire revolution of the rolls so that the bar being reduced enters the rolls on one side of the roll stand and emerges on the other side. The forging rolls make use of only a portion of the revolution to reduce stock and the remainder of the revolution on the rolls provides a blank clearance space. The operator has his position at the back, or emerging side of the rolls, and when the open space appears, the stock is placed in to the blank space so that when the reducing portion of the rolls commences its part of the revolution, the stock is reduced in cross section area on the desired portion of the bar and ejected from the pass. At the next open portion of the revolution, the stock is again inserted between the rolls for the second reducing pass. By this method only as much of the piece of forging stock is reduced in cross section area as is necessary. The operator's position is in back of the rolls whem compared to the position of the operator in the steel mill rolls; and because of this, the forging rolls are sometimes termed "back-rolls". Similar to the steel mill rolls, the forging rolls contain a series of passes, the number of passes depending upon the amount of reduction required. The ratio of reduction for each pass is not as much as can be obtained in steel mill practice. Twenty-five to thirty percent reduction for a pass is considered good practice for the forging rolls while in steel mill practice it is not uncommon to have pass reduction of forty-five to fifty percent. The speed of an average set of forging rolls is about sixty revolutions a minute.

For long, straight and uniform sections, the forgings rolls can perform the drawing operations more easily and quicker than can the drop or trip hammer. They are in use in the forging plants specializing in rear axle shafts, gear shift levers, long bolts, stems of special nature, and spring leaves. Forging roll sizes are designated by numbers, the standard numbers ranging from No. 0 to No. 4. No. 5 machines have been built but they are generally classed as special equipment and are usually built for special requirements. On the No. 0 machine, the approximate length of taper is about 11 inches and this taper increases to about 55 inches for the No. 4 machine"(1)

(1) ditto, p.43-45

Since the above section was written, the National Machinery Co. (Tiffin, Ohio) came out with an improved forging roll called "Reduceroll". This unit is adapted to quick retooling, and could perform a considerable number of rolling operations.

Advantages of this unit as claimed by the makers are:

1) Increases production by eliminating time-consuming fullering, edging, and forming operations.

2) Distributes metal accurately, assuring uniformly superior forgings and reducing wear-and-tear on more expensive finish-forging equipment.

3) Requires no operating skill. Properly designed guides, tongs and stock gauges working in conjunction with the automatic stock gauge trip unit, assurefast, accurate feeding and exceptional blank uniformity.

4) Produces a clean, descaled blank for finish-forging.

5) Reduces flash, increasing forging die life.

6) Increases versatility of finish-forging equipment.

7) Uses low-cost, quickly interchangeable rolls, making short runs practical and economical.

8) Requires no foundation or permanent mounting; machine is portable, can "team up" anywhere.(1)

According to the makers, the typical job of Reduceroll are the preparation of stock for wrenches,

(1) Reduceroll, The National Machinery Co., Tiffin, Ohio p.2

connecting rods, conveyor flights and tractor crank shifts. Thus the variety of work performed is remarkable and could be of great help to us.

Mr. W. Motherwell (Works Manager of Wayman-Gordon, Worcester, Mass.) suggested to us that the plant be equipped with a Reduceroll. In his opinion, the use of a Reduceroll will increase the hammer output (no blows will be wasted on the preparation of stock).

Since the preparation of stock will be done on the Reduceroll, the number of impressions on each die will be reduced, and could be limited in many cases to blocking and finishing impressions only, instead of the additional fullering or edging impression otherwise necessary.

Based on what was said above, it should be advantageous to install at least one Reduceroll until experience will indicate whether the purchase of additional units would be advisable.

Equipment Costs

The following estimate of equipment costs was obtained from Mr. R. G. Sault, President and General Manager of the Porter Forge and Furnace Inc., Somerville, Mass. In addition to cost estimates, Mr. Sault also advised us on the sizes and type of equipment that will suit the planned hammer sizes.

Cost Estimate

Board Drop Hammers

One 600 pound B.D.H.	$ 5,500.
" 1200 " "	9,000
" 1800 " "	13,000.
Sub Total	27,500

Trimming Presses

One 35 ton cold trimming press	$ 2,800.
" 25 " hot " "	2,000.
" 40 " " " "	2,500.
" 60 " cold " "	5,000.
Sub Total	12,300.

Furnaces

One 2.0 x 2.0 x 2.5 slot furnace (1"burner)	$ 600.
" 2.5 x 2.0 x 2.5 " " (2"burner)	750.
" 3.0 x 3.0 x 2.5 " " (2¼"burner)	850.
Sub Total	2,200.

Cleaning Equipment

Sand Blast	
Wheelabrator and dust collector	$ 7,500.
or	
Tumbling barrels (small cost)	N.A.
Sub Total	7,500. -N.A.

<u>Material Handling Equipment</u>	
One fork lift (3000 pounds)	$ 3,000.
Six Hand Trucks	240.
One Hundred Fifty Tote Box	500.
Sub Total	3,740.
<u>Shearing and Cutting Equipment</u>	
One power saw	$ 4,000.
One 2" bar stock shear	12,000.
or	
One Alligator shear	3,000
Sub Total	7,000. or16,000
<u>Die Making Equipment</u>	
Two Pratt and Whitney No. 2 Die Sinking machines	$10,000
1 planer 5-6 'bed 1 shaper 12-14" cut 1 lathe 21" swing 1 drill press 1.5" 1 cut off saw 1 surface grinder 1 tool grinder Milling tools	20,000 or 30,000 (1)
Sub Total	20,000 or 30,000.
Equipment not classified	10,000 to 15,000.
Heat Treatment Equipment	20,000
TOTAL EQUIPMENT COSTS	144,000 or120,000.

(1) Figure received from machine tool dealers.

Initial Investment in Dies and Raw Materials

In addition to the investment in equipment, we also have to consider the initial investment in dies and raw materials.

Initial Investment in Dies

Assuming that the plant will process units with a gross weight below 3 pounds, total number of tool varieties that could be produced will amount to about 120. As plant capacity amounts to about 50% of that required in this range of hammers, we can safely say that there won't be a need to process more than 60 varieties. To be sure that this number could be reduced further if plant will concentrate on the processing of those tools thatare in great demand. Let's assume that by doing so a number of varieties processed will be reduced to 40. We therefore need about 50 die sets. These die sets valued at an average of about $750 a set, will cost in the U.S. around $47,500. In case that die sinking could be done in Israel before operations start, the cost of the steel for these dies will amount to about $4,500 only (at 16¢ a pound and 600 pounds per set of dies). Assuming that each set of dies will give us 25,000 forgings (if it will be resinked twice) we can get from 50 dies about 1.25 million units as our plant capacity is about 900,000 units (according to data in Table VII), we can safely assume that a $4,500 supply of die steels or 50 dies will last for a whole year.

Raw Material Supplies

According to average figures for the drop forging industry,[1] a 600 and 1,200 pound hammer process 180 pounds of metal per productive hours. With an 1,800 pound hammer, 415 pounds of metal are processed. Assuming that this hammer will process only half of these quantities, their annual output of 2,000 productive hours will be 775,000 gross pounds. At 6.5 cents a pound for carbon steel, this will amount to $50,400 dollars worth of raw materials per year.

According to industry averages,[2] conversion costs per pound (gross weight) in this range of weights amounts to about 20 cents (gross weight). Therefore the value of plant operations in U.S. prices will be about $155,000.

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(1) H. Kilborn - Board Hammer Production Analysis - Drop Forging Association - 1939, Table P
(2) Drop Forging industry Report for 1951

Summary

The estimate of equipment and costs was based on a plant which is autonomus in its operations, and it has die making and heat treatment departments. Equipment values of such a shop are estimated to be around 140-120 thousand dollars without installation or transportation costs. All prices are for new equipment, but in case that used equipment is suitable for reconditioning, it will be available to us and the total cost will be reduced considerably.

In addition to the outlay in equipment, plant will have to be provided with about 50,400 dollars worth of raw materials plus 37,500 dollars for dies to be bought in the U.S.A.; in case that dies could be initially in Israel raw materials for dies will amount to 4,500 dollars.

The total outlay in dollars for such a plant will therefore be in the range of 174,900-227,900 dollars if new equipment is to be purchased. With this initial investment, the plant will perform operations that will result in a hard currency saving of about $150,000 annually.

V. QUANTITY EFFECTS ON CONVERSION COSTS

In the coming pages we will concern ourselves with the effects of short runs on conversion costs per unit. We think that any plan to establish a certain industry in Israel should be evaluated as to its adaptability to small volume manufacturing.

It is a known fact that in certain industries the economies of mass production are so high that any attempt to go into such an activity at a low volume is an act of economic suicide. (Granted that competitive conditions exist either directly or indirectly) In general, the unit cost for industrial products is affected favorably if produced in quantity. However, the magnitude of such favorable quantities varies considerably. Certain products reach low unit costs at relatively small quantities after which any additional increase in quantities product results in small or no gains per unit cost.

Due to the limited demand in Israel, the quantity factor acquires major importance in determining conversion costs. Therefore we should check very carefully quantity effects on unit cost, before deciding whether the forging process is one that couldbe economically adapted in Israel, and stand on its own feet after the initial period.

Let us now turn to see what are the conversion cost components and how they are affected by quantity changes.

CONVERSION COST COMPONENTS

The following operations are included in the forging process(1) 1) stock cutting, 2) heating, 3) forging, 4) trimming and punching, 5) coining, 6) heat treating, 7) cleaning, 8) straightening, 9) grinding, 10) inspection, 11) handling, 12) shipping.

A forged product could be subjected to all or part of these operations, depending on the requirements. In addition, directly connected with each job and run are the die making and die set ups. Let us now study these operations and see in which of them are costs per unit affected by quantity differences.

Stock Cutting

Stock cutting is generally performed by a vertical or alligator shear. No data could be obtained as to cost variances in this operation. It is our estimate that starting from runs of 100 pieces, quantity effects would not be too great, particularly when considering their effect on total costs.

Heating

Heating of stock for forging is "synchronized" with hammer output, and units are placed in the slot

(1) From job estimate sheets of The Forging Industry

furnace according to hammer requirements, therefore; whatever effect which quantity will have on hammer output, the same affect will be on furnace output.

Forging

The effect of quantities on forging costs per unit, are the result of few factors.

1) "Warming up" and experience of the operator. Naturally, it takes a certain time until the hammerman gets into the act and establishes a certain pace and rhythm after which production will be relatively constant. The number of productive hours that elapse until such a rhythm is developed depends upon the job and the skill of the worker.(1)

2) Method of forging - The method of forging depends to a degree on the quantity per run and ultimate quantity expected. As W. Naujoks points out "On very small quantities, such as up to 200 or 300 pieces at a time with infrequent orders, the method of production may be different from that where larger quantities are ordered, and again on very high production quantities the method of producing the forgings may vary somewhat from the saml or medium quantity procedure. For very small quantities it may be economical to use the cheapest possible dies, possibly with only the finishing impression

(1) Summary from an interview with Mr. Arnold, Foreman, Forging Department, Trimcent Mfg. Co.

in them, and to perform the preliminary operations, if any, on flat dies. This procedure increases the cost of the individual forging, of course, but where 500, 1000, or possibly 2000 pieces cover five years or longer requirements, the least expensive dies are the most economical. When the quantities are very large, it is good economy to make and use the best possible tooling since the cost of the elaborate dies and tools are spread over so many pieces that the additional tooling cost is but a fraction of the tooling cost for each piece, and the metal saved or production gained is much more."(1)

According to the above, considerable differences in method of production appear in accordance with the ultimate quantities expected. It is important for us to note that under conditions of small quantities, total conversion costs could be reduced by economizing in die-making at the expense of forging operation costs.

Die Set-up Cost and Die Wear

Die set-up and costs and the accelerated wearing of the finishing impression are the third factor, according to W. Naujoks.

"The cost of setting the dies and tools into the forging equipment is a relatively fixed item, regardless of whether fifty or fifty thousand forgings are required.

(1) W. Naujoks, and D. C. Fabel - Forging Handbook - The American Society for Metals, Cleveland, 1939, p.523-524

On large quantities, the cost of die setup is but a small fraction of the cost in each forging, but where the quantity is small, it may reach a fairly substantial percentage of the forging cost. It is readily seen that the quantity of forgings produced at one setting of the dies has a definite influence upon the three tangible items, that of production, that of material price, and that of die and tool setup cost. There is another item, not t8 readily calculated, which is that of die wear. It is a known fact that if a set of dies are placed in the forging unit, such as a drop hammer, more pieces will be produced from the finishing impression before machining on the impression is necessary, if the dies areused continuously until the impression is worn out, than if the dies are used to make a few hundred pieces, removed and set up later for another similar run. The life of the dies on short run orders may be reduced as much as 75 percent when compared to continued usage until the impression is worn out. The reason is probably that the first few hundred pieces, in warming the dies to regular production temperature, take as much life out of the impression as do the next few thousand pieces, in a similar manner that an automobile motor receives as much wear warming up in the first few minutes as it does the next hour or two. Since the life of the impression determines largely the amount of die replacement necessary in the estimate, the die replacement factor depends upon the quantity forged at one time."(1)

In order to overcome some of the expenses due to set up time and economize in die blocks, the insert die might be used. This is a "small die containing a portion or all of the impression of a forging and which is fastened to a master (die) block for use in a forging unit". (2) Due to its relatively light weight and easier fastening devices, set up time could be reduced considerably, as well as the cost of die blocks. "Due to its low height, resinking of the impressions is impractical, thus such dies are used mainly when ultimate quantities expected can be forged during the life of the first impression."(3)

For our purpose the insert die has a remarkable value as it represents one of the valuable adjustments to low quantity manufacture.

The drop forging association conducted a study of die wear rates, when die is used for shorter runs than the maximum number of forgings that could be obtained at a continuous use. According to this study, a die with a maximum life expectancy of 15,000 units if used continuously, will have alife expectancy of 13,500 units

(1) ditto p.524
(2) ditto p.580
(3) Mr. F. C. Esty Wayman Gordon, Worcester, Mass.

if used at runs of 5,000 units. When used at runs of 1000 units per time, its life expectancy will be reduced to 8,800 units, and at 100 units runs its life expectancy will be reduced to 1800 units.(1)

We thus see that short runs have a definite effect on forging cost, by not allowing the hammerman enough time to get into the "act", by providing a smaller spread for set up cost, and by excessivedie wear. By using insert dies and less impressions per die, some of these higher costs could be eliminated. But we cannot expect a full remedy to these extra costs.

Trimming and Punching

Hot trimming and punching is done immediately after the forging, and thus the output depends on that of the hammer. Cold trimming is independent of the forging pace, and thus, has its own ratios as to quantity effects on trimming costs. The ratios between cold trimming costs at different quantities for 2.75 pound units (gross weight) is given, as 1.0-1.2-1.4 per pound when(2) quantities of 10,000-2,000-1,000 units were processed respectively. This ratio however is taken from one job estimate and was brought up because of lack of more valuable information.

We, therefore, conclude that variances in quantity hot trimming and punching costs parallel hammer output variances. Cold trimming and punching quantiry cost variances are autonomus and, considerably high.

(1) For full information look up The Guide to Increased Die Replacement Factors due to Short Runs in the Appendix
(2) W. Naujoks and D. C. Fabel - Forging Handbook - The American Society for Metals, Cleveland, 1939, p.532

Coining

We do not possess any factual information about quantity effects on coining operations. However, due to the similarity of equipment between coining and trimming (they use almost identical processes) the ratios of quantity effects in coining are probably along the lines of cold trimming.

Materials Handling and Shipping Costs

According to studies of the Drop Forging Association(1) the cost ratio per pound varied considerably with quantities processed at a time. Below is a sample of such cost ratios.(2)

Net Weight Pounds	Number of Pieces per run				
	100	500	1,000	10,000	100,000
0.3	3.50	1.50	1.30	1.10	1.00
0.7	2.80	1.36	1.21	1.07	1.00
2.0	1.92	1.18	1.11	1.03	1.00
7.0	1.32	1.06	1.04	1.01	1.00

According to data presented, handling cost differentials tend to decrease as unit weights increase. (This is a sequence of the increase in total weight per pound.) For quantities above 1,000 units, differentials are below 30 percent while for quantities below 1,000 unit differences go up to 350 percent.

(1) Halloway Kilburn - Material Handling Ratio Table - Drop Forging Association, 1946 - No. 3879
(2) For a more complete ratio table see Appendix - Material Handling Ratio Table

Heat Treating

No direct information is available as to quantity effects on heat treatment costs. We can assume, though, that to the extent that material handling is involved, costs will parallel those of handling ratios costs. As to the rest of the cost components, we lack any information that could lead even to the roughest assumption.

Cleaning, Straightening, Inspection

No information as to these operations was available to us. We assume that due to the handling process involved, costs will partly follow the pattern of material handling.

Grinding

According to a single job estimate,[1] that was available to us, grinding cost ratios were as follows:

	Units		
	10,000	2,000	1,000
Cost ratio	1.00	1.20	1.50

These ratios should be considered as trend indicators only. Due to the fact that the above data represents ratios used in one plant only, we should consider them as trend indicators only.

Summary

According to data available to us, conversion cost

(1) W. Naujoks and D. C. Fabel - Forging Handbook - The American Society for Metals - Cleveland, Ohio, p. 532

per unit are higher for runs of 1,000 units than for runs of 100,000. The difference in conversion costs per unit is reduced considerably when runs of 10,000 units are compared to runs of 100,000 units. The difference in conversion costs, among different quantities also decreases as the product weight increases.

QUANTITY RATIO TABLES

The accounting committee of the Drop Forging Association developed "Quantity Ratios" that aim at[1] giving the approximate conversion cost differential, once costs per one specific quantity were determined.

These ratios are based on an industry wide study.[2] The basic data for this study were job sheets, representing jobs that of average difficulty, and using S.A.E. 1010-1030 carbon steel. Costs covered included manufacturing plus administrative and selling costs except excluded raw material charges. As a result of this study, it was found that when 60 pound gross weight forgings were processed in runs of 10,000 units, the lowest conversion cost per pound was achieved. Thus, the conversion cost of a 60 pound unit when processed is 10,000 unit runs, was established as unity. Conversion costs for heavier or lighter products at smaller or larger runs were then given as a percent of the conversion cost per pound of

(1) Estimating Manual for Closed Die Forgings - Drop Forging Association - p.49-50
(2) ditto p.38

a 60 pound unit at runs of 10,000 units. Table XI represents conversion cost ratios per gross pound of unit forged. For each weight we tabulated two ratios, the upper one represents the ratio to a 60 pound unit forged (see above) and the lower one represents ratios within the weight class. The particular weights were chosen since the first three represent the capacity of our planned hammer sizes; the last two were chosen for comparison.

Data in Table XI reveals that:

A. Total conversion cost per pound are identical for 100,000 unit runs and for 1,000,000 unit runs.

B. The increase in conversion costs for 10,000 unit runs is very slight, and thus not run above 3 percent (for indicated weights).

C. For runs of 3,000 units increase costs per pound is substantial and will run up 15 percent.

D. For 1,000 unit runs the increase in conversion costs will run up 33 percent and for runs of 100 units cost will double, triple and quadruple.

E. As weight increases, the cost ratio differentials decrease. Therefore it is more economical to process short runs of heavy weight products than those of light ones.

HAMMER SIZE	PRODUCT GROSS WEIGHT lbs.	QUANTITY 100	1000	3000	5000	10,000	100,000	1 mil.
600	0.37	16.53	5.01	4.16	3.98	3.86	3.74	3.73
		4.40	1.33	1.15	1.07	1.03	1.00	1.00
1200	0.7	11.01	3.47	2.91	2.81	2.72	2.64	2.64
		4.16	1.31	1.10	1.07	1.03	1.00	1.00
1800	2.4	5.25	1.93	1.69	1.64	1.60	1.57	1.57
		3.32	1.23	1.08	1.04	1.02	1.00	1.00
2,000	3.70	4.13	1.64	1.16	1.42	1.39	1.37	1.37
		3.02	1.20	1.06	1.04	1.01	1.00	1.00
3,000	7.00	2.97	1.35	1.23	1.21	1.19	1.17	1.17
		2.56	1.15	1.05	1.03	1.02	1.00	1.00

TABLE XI - QUANTITY COST RATIOS PER GROSS POUND[1]

Upper figure for each gross weight represents cost ratio to a 60 pound unit at 10,000 unit runs.

(1) See Appendix for a more complete set of ratios.

F. The lighter the unit, the greater are its conversion costs per pound. For example, see vertical relations of upper rows in Table XI. According to the table, conversion costs per pound are 3.5 times higher for a 0.37 pound unit than for a 60 pound unit.

For our particular situation, we can say that the last figures certainly indicate that conversion cost quantity differentials are of a moderate nature up to runs of 3,000 units. Below this number differentials accelerate quite rapidly and make runs below 1,000 units very costly. According to our estimates, in the section on demand, for most products we will have an annual demand of about 3,000 to 50,000 units. Such quantities could provide for an economical production of forgings.

It is true that some differential in conversion costs will exist between high and low volume runs. However, this differential of 5-15 percent is relatively small when compared to mass production economies in other industries.

Additional Cost Factors

In addition to increased conversion costs for short runs, we should also consider increased die costs. Due to the increased interest or profit charges accumulated on such dies i.e. if a die worth $1,000 is depreciated in one month, interest (or profit) charge on the initial investment in this die will be $\frac{1}{12}$ of the yearly interest rate expected from the investment. If, however, the die will be depreciated in the course of three years, the interest charge will be 36/12 of the yearly interest rate, divided by two (the value of the investment in the die at the end of the third year is assumed to be zero. Thus average investment will be only $500.)at an interest (or profit) rate of 10%,the total cost of the die (initial cost plus interest) in the first case will be about &1,008., while at the second case it will be $1,150, or 14 percent higher. Assuming for a moment that die charges amount to 10-20 percent of total product costs (including raw materials), the cost of the finished unit will be increased by about 1.4 or 2.8 percent.

APPENDIX

FORGING DEFINITIONS

These definitions are in general use in the forging industry, and, in many instances, have been given meanings peculiar to the field of forging. Where a word or an expression may have a meaning different to the one given it when used in connection with another industry or field, no attempt has been made to define it for that field.

AUXILIARY OPERATIONS - Additional processing to the forging to obtain shapes, surface conditions, or other properties not obtainable in the regular forging operation.

BILLET - Steel with a round cornered square or rectangular cross section, to which further processing, such as forging or rolling, is given.

BLAST CLEANING - A process for removing the oxide surface, or scale, from forgings by propelling grit or shot at high velocity at the work in order to clean it.

BLOCKING - A forging operation which imparts to the forging its general but not exact or final shape.

BLOW - The impact or other pressure produced by the moving part of any forging unit.

CLEAN - The operation of removing the oxide coating, or scale, from the surface of the forging.

COINING - The operation of applying heavy pressure to a relatively small surface to obtain closer tolerances. In the strict sense, the termused should be sizing.

COLD TRIM - Removing the flash, or excess metal, from a forging after it has been cooled to room temperature.

DIES - Steel blocks into which desired impressions are machined and from which forgings are produced. Forging dies usually come in pairs, with part of the impression in one of the blocks and the balance of the impression in the other block.

DROP FORGING - The shape obtained by working metal in a pair of dies to produce the form in the finishing impression under a drop hammer.

FLASH - The metal that is in excess of that required to fill out the final impression in a pair of dies and moves out as a thin plate around the parting line of the dies. Also called fin.

FORGING - Metal which has been worked to some definite predetermined shape by a process of hammering, upsetting, or pressing, either hot or cold, or by a combination of several of these processes.

HEAT TREAT - Any operation or operations of heating metal and cooling it in order to bring out desired physical properties.

HOT TRIM - Removing the flash or excess metal on a forging in a trimming press while the forging is hot.

INSERT DIES - A small die containing a portion or all of the impression of a forging and which is fastened in a block for use in a forging unit.

MASTER BLOCK - A die block primarily used to hold insert dies.

RAM - The moving part of a drop hammer or a press to which one of the dies is fastened.

SANDBLAST - A term used to designate the cleaning of forgings by propelling sand at high velocity by air pressure.

TRIMMER - The dies used to remove the flash or excess stock from the forging.

TUMBLING - A process for removing scale from forgings by impact with each other, together with jacks, sawdust, and abrasive material, in a rotating container.

GUIDE TO INCREASED DIE REPLACEMENT FACTORS DUE TO SHORT RUNS

Actual Run	One-run Life - Thousands 1	2	3	4	5	6	8	10	12	15	20	25
100	1.45	1.95	2.45	2.95	3.45	3.95	4.95	5.95	6.95	8.45	11.0	13.4
200	1.20	1.45	1.70	1.95	2.20	2.45	2.95	3.45	3.95	4.70	5.95	7.20
300	1.12	1.28	1.45	1.62	1.78	1.95	2.28	2.62	2.95	3.45	4.28	5.12
400	1.08	1.20	1.32	1.45	1.58	1.70	1.95	2.20	2.45	2.82	3.45	4.08
500	1.05	1.15	1.25	1.35	1.45	1.55	1.75	1.95	2.15	2.45	2.95	3.45
600	1.03	1.12	1.20	1.28	1.37	1.45	1.62	1.78	1.95	2.20	2.62	3.03
700	1.02	1.09	1.16	1.24	1.31	1.38	1.52	1.66	1.81	2.02	2.38	2.74
800	1.01	1.08	1.14	1.20	1.26	1.32	1.45	1.58	1.70	1.89	2.20	2.51
900	1.01	1.06	1.12	1.17	1.23	1.28	1.39	1.51	1.62	1.78	2.06	2.34
1,000	1.00	1.05	1.10	1.15	1.20	1.25	1.35	1.45	1.55	1.70	1.95	2.20
2,000		1.00	1.02	1.05	1.08	1.10	1.15	1.20	1.25	1.32	1.45	1.58
3,000			1.00	1.02	1.03	1.05	1.08	1.12	1.15	1.20	1.28	1.37
4,000				1.00	1.01	1.02	1.05	1.08	1.10	1.14	1.20	1.26
5,000					1.00	1.01	1.03	1.05	1.07	1.10	1.15	1.20

6,000	1.00	1.02	1.03	1.05	1.08	1.12	1.16
7,000		1.01	1.02	1.04	1.06	1.09	1.13
8,000		1.00	1.01	1.02	1.04	1.08	1.11
9,000			1.01	1.02	1.03	1.06	1.09
10,000			1.00	1.01	1.02	1.05	1.08

In the table the column captions show the estimated one-run life. This is the expected life if the dies were run out on the first run. In the stub are actual runs. At the intersection will be found a factor by which the one-run die replacement.factor should be multiplied to compensate for the decreased life of dies on short runs.

Suppose it were estimated that the one-run life would be 10,000 forgings and the replacement factor amounted to $2.00 per 100 forgings. Then the approximate replacement factor for a run of 1000 forgings would be "2.oo x 1.45 = $2.90 per 100 forgings. This increase due to short runs is entirely independent from and in addition to any change in die life due to any other cause.

MATERIAL HANDLING RATIO TABLE

Raw Material Handling, Product Handling and Shipping

A table of ratios (not dollars and cents) designed for use in estimating to determine the varying costs of <u>handling of light and heavy forgings in small and large runs</u>

Number of Pieces in run

Net Pounds Each

100	200	300	400	500	1000	10M	100M
.032	.020	.016	.014	.013	.010	.008	.008
.033	.021	.017	.015	.013	.011	.009	.009
.034	.022	.018	.016	.014	.012	.010	.010
.035	.023	.019	.017	.015	.013	.011	.010
.036	.024	.020	.018	.016	.014	.012	.011
.037	.025	.021	.019	.017	.015	.013	.012
.038	.026	.022	.020	.018	.016	.014	.013
.039	.027	.023	.021	.019	.017	.015	.014
.040	.028	.024	.022	.020	.018	.016	.015
.041	.029	.025	.023	.021	.019	.017	.016
.042	.030	.026	.024	.022	.020	.018	.017
.052	.040	.036	.034	.032	.030	.028	.027
.062	.050	.046	.044	.042	.040	.038	.037
.072	.060	.056	.054	.052	.050	.048	.047
.082	.070	.066	.064	.062	.060	.058	.057
.092	.080	.076	.074	.072	.070	.068	.067
.102	.090	.086	.084	.082	.080	.078	.077
.112	.100	.096	.094	.092	.090	.088	.087
.122	.110	.106	.104	.102	.100	.098	.097

QUANTITY RATIOS - Q

All Hammers

Divide the "a" Value by the quantity and add the "b" value. For instance, 1000 pieces weighing 10 gross pounds each has a quantity ratio of $\frac{142}{1000}$ 1.10 = 1.24

P*	a	b	P	a	b	P	a	b	P	a	b
			.40	1220	3.58	.80	766	2.48	3.0	317	1.46
.01	14200	70.6	.41	1200	3.51	.81	759	2.46	3.1	310	1.45
.02	8950	35.6	.42	1180	3.48	.82	754	2.45	3.2	304	1.43
.03	6830	24.4	.43	1160	3.42	.83	747	2.43	3.3	298	1.42
.04	5650	18.9	.44	1140	3.39	.84	742	2.42	3.4	292	1.41
.05	4860	15.6	.45	1120	3.33	.85	735	2.40	3.5	286	1.39
.06	4300	13.4	.46	1110	3.30	.86	730	2.39	3.6	281	1.38
.07	3890	11.8	.47	1090	3.26	.87	724	2.38	3.7	276	1.37
.08	3550	10.6	.48	1080	3.23	.88	718	2.36	3.8	271	1.36
.09	3290	9.71	.49	1060	3.18	.89	713	2.35	3.9	267	1.35
.10	3060	8.97	.50	1050	3.16	.90	708	2.34	4.0	263	1.34
.11	2870	8.35	.51	1030	3.12	.91	703	2.33	4.1	259	1.33
.12	2720	7.83	.52	1020	3.08	.92	698	2.32	4.2	254	1.32
.13	2570	7.39	.53	1010	3.06	.93	692	2.31	4.3	249	1.32
.14	2450	7.01	.54	994	3.02	.94	688	2.30	4.4	245	1.31
.15	2340	6.67	.55	984	3.00	.95	683	2.29	4.5	242	1.30
.16	2240	6.38	.56	971	2.96	.96	678	2.27	4.6	239	1.29
.17	2150	6.12	.57	960	2.93	.97	673	2.26	4.7	236	1.29

* Gross

FIELD INTERVIEWS SCHEDULE

Porter Forge and Furnace, Inc.

79 Foley St., Somerville 43, Mass.

Person Interviewed - Mr. R. G. Sault

Position - President and General Manager

No. of interviews - 3

Trimont Manufacturing Co.

55 Amory St., Boston, Mass.

Person Interviewed - Mr. F. P. Aiton

Position - Vice President

No. of interviews - 3

Person Interviewed - Mr. G. Calalo

Position - Plant Superintendent

No. of interviews - 2

Wymun Gordon Co.

105 Madison St., Worcester, Mass.

Person Interviewed - Mr. W. Motherwell

Position - Manager

No. of interviews - 1

Person Interviewed - Mr. F. C. Esty

Position - Engineering Dept.

No. of interviews - 1

FIELD INTERVIEWS SCHEDULE - continued

Moore Drop Forging Company

Springfield, Mass.

Person Interviewed - Mr. C. R. Crunander

Position - Vice President in charge of operations

No. of interviews - 1

Person Interviewed - Mr. J. Jameston

Position - Cost Accounting Department

No. of interviews - 1

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