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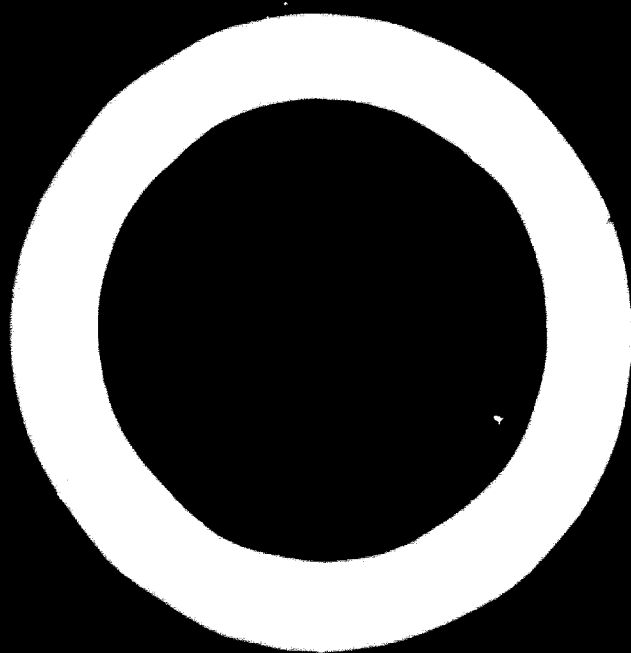
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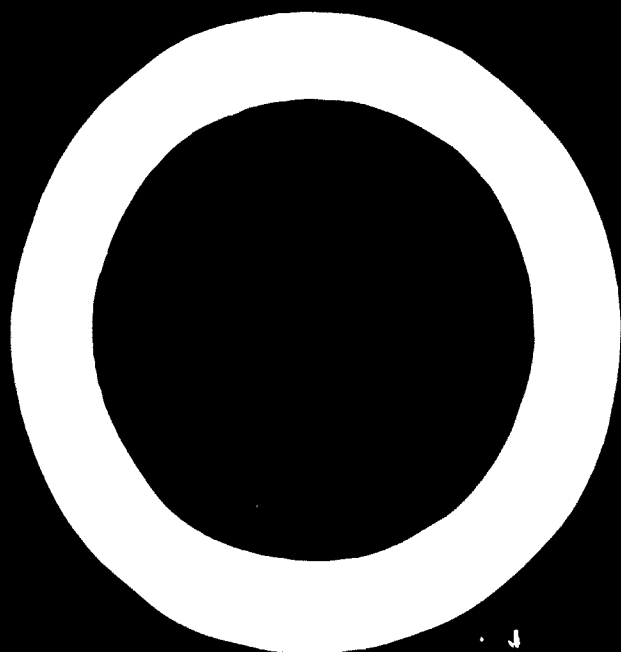
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REGIONAL SEMINAR  
ON  
MACHINE TOOLS  
IN  
DEVELOPING COUNTRIES  
OF EUROPE  
AND  
MEDITERRANEA



UNITED NATIONS





**REGIONAL SEMINAR ON  
MACHINE TOOLS IN DEVELOPING COUNTRIES  
OF EUROPE AND THE MIDDLE EAST**



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION  
VIENNA

**REGIONAL SEMINAR  
ON  
MACHINE TOOLS  
IN  
DEVELOPING COUNTRIES  
OF  
EUROPE AND THE MIDDLE EAST**

*Slatni Pjassazi, Varna, Bulgaria*

*18-27 October 1971*



**UNITED NATIONS  
New York, 1972**

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## CONTENTS

	<i>Page</i>
<b>Part I REPORT OF THE SEMINAR</b>	
Letter of transmittal .....	3
Organization of the Seminar .....	5
Conclusions .....	6
Recommendations .....	10
Appendix 1 Statements to the Seminar .....	15
Appendix 2 List of participants and observers .....	19
Appendix 3 List of documents .....	26
<b>Part II PROCEEDINGS BASED ON PAPERS PRESENTED AND DISCUSSIONS</b>	
Prerequisites for machine-tool manufacture .....	31
Selection of machine tools .....	37
Utilization of machine tools .....	38
Maintenance and repair .....	40
Education and training .....	43
Market research and marketing .....	44
Numerical control of machine tools .....	45
Co-operation between the industrialized and the developing countries .....	48
<b>Part III SUMMARIES OF COUNTRY REPORTS</b>	
Bulgaria .....	53
Egypt .....	55
Hungary .....	57
Iran .....	60
Iraq .....	64
Israel .....	67
Jordan .....	70
Kuwait .....	72
People's Democratic Republic of Yemen .....	74
Poland .....	75
Romania .....	76
Saudi Arabia .....	78
Syrian Arab Republic .....	80
Turkey .....	82
Yemen .....	86
Yugoslavia .....	87

## LIST OF TABLES

	<i>Page</i>
1. Estimated world production of metalworking machine tools in 1970. . .	8
2. Machine-tool production in Egypt . . . . .	55
3. Status of machine tools in Hungary . . . . .	57
4. Imports of machine tools in Iran . . . . .	60
5. Information about Machine SAZI in Iran . . . . .	62
6. Status of machine tools in Iraq . . . . .	65
7. Status of machine tools in Israel . . . . .	68
8. Industrial capacity and employment in Israel . . . . .	68
9. Suggested five-year industrial expansion programme in Saudi Arabia . .	80
10. Engineering industry in the Syrian Arab Republic . . . . .	80
11. Proposed machine-tool manufacture in the Syrian Arab Republic . . . .	81
12. Future supply and demand of machine tools in Turkey . . . . .	83
13. Machine-tool production targets for Turkey . . . . .	83
14. Imports of machine tools in Turkey . . . . .	84
15. Production of machine tools in Yugoslavia . . . . .	88
16. Imports and exports of machine tools in Yugoslavia . . . . .	89

## EXPLANATOR / NOTES

In this publication:

“Machine tool” means “metalworking machine tool” unless otherwise stated.

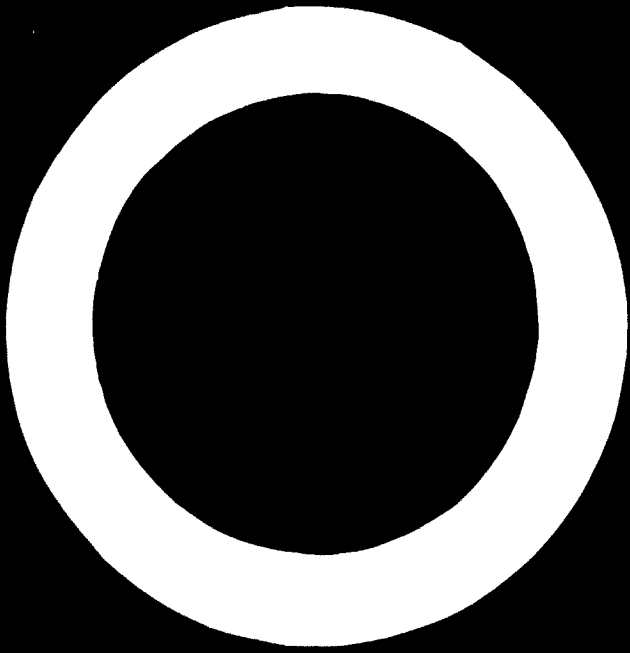
“Dollar” (\$) means the United States dollar.

“Ton” means the metric ton.

In tables, three dots (. . .) indicate that data are not available, a dash (—) that the amount is nil or negligible and a blank that the item is not applicable.

*Part I*

**REPORT OF THE SEMINAR**



## LETTER OF TRANSMITTAL

Slatni Pjassazi  
22 October 1971

The Executive Director  
United Nations Industrial Development Organization  
Vienna, Austria

We have the honour to present the conclusions and recommendations of the Regional Seminar on Machine Tools in Developing Countries of Europe and the Middle East, held in Slatni Pjassazi, near Varna, Bulgaria, from 18 to 27 October 1971, under the auspices of the United Nations Industrial Development Organization in co-operation with the Government of the People's Republic of Bulgaria as the host country.

The Seminar stressed the importance of proper utilization and maintenance of machine tools in the countries of the region, of adopting modern technology in methods of manufacture, and the advantages of close co-operation between developing and developed countries.

The Seminar was the first tangible evidence of the close co-operation with the European Committee for the Co-operation of Machine Tool Industries (CECIMO) which represents 40 per cent of the world machine-tool production. The members of CECIMO presented a number of the papers for this Seminar, and its Secretary General attended the meeting, reaffirming the willingness of his organization to assist UNIDO in the future. The Seminar was also attended by a representative of the Economic Commission for Europe (ECE).

Purposeful discussions took place regarding the recent development in the techniques and processes used in the metalworking industry of the developed countries and the ways in which these developments could be most effectively applied.

Many direct contacts were established at the Seminar among members of developing and developed countries and it may be expected that these will result in mutually beneficial commercial and technical arrangements.

As shown in the Recommendations, it will be observed that many positive actions will flow from the Seminar. We sincerely hope that the draft proposals for action by UNIDO, to render assistance to certain countries of the region, namely Bulgaria, Hungary, Iran, Iraq, Israel, Jordan, Kuwait, the Syrian Arab Republic, Turkey, the Yemen Arab Republic, and the People's Democratic Republic of Yemen, will mature into actual programmes and will form a sound basis for the future work programme of UNIDO.

In order to observe the production and utilization of machine tools under workshop conditions, and to study the experience gained in the creation and

development of a machine-tool building industry, the participants visited machine-tool and equipment plants located in Kazanlık, Stara Zagora, Asenovgrad, Plovdiv and Sofia. A visit was also made to the Research and Design Institute for metal-cutting machine tools in Sofia.

On behalf of the participants, whose names appear in appendix 2 to the report, we would like to express deep appreciation to UNIDO and to the Government of the People's Republic of Bulgaria for the opportunity of attending this Seminar and for the assistance and hospitality extended to us.

Yours sincerely,

**P. Somlev,  
Chairman**

**First Deputy General Director  
State Machine Tool Building  
Corporation of the People's  
Republic of Bulgaria**

**R. Önen,  
Vice-Chairman**

**Deputy General Manager of the  
People's Bank of Turkey**

**R. Gabriel,  
Rapporteur  
Consultant  
United Kingdom**

## ORGANIZATION OF THE SEMINAR

An Interregional Symposium on the Development of Metalworking Industries in Developing Countries held in Moscow in 1966 found that the problems of the developing countries varied with the different stages of their metalworking development and that it was not possible to prescribe one formula for all countries. Therefore, it recommended that similar symposia be held in various developing regions to discuss the problems of the metalworking industries in those regions. It was felt that the machine-tool sector, as the key to the metalworking and machine-building industries, should receive special attention.

Accordingly, a Regional Seminar on Machine Tools in the Developing Countries of Europe and the Middle East was held in Slatni Pjassazi (near Varna), People's Republic of Bulgaria, from 18–27 October 1971. The Seminar, sponsored by the United Nations Industrial Development Organization (UNIDO), with the co-operation of the Ministry of Machine Building of the Government of Bulgaria, was attended by 29 delegates from 19 countries, the Economic Commission for Europe (ECE), the European Committee for Co-operation of Machine Tools Industries (CECIMO) and by representatives of UNIDO.

Mr. P. Somlev (Bulgaria) was elected Chairman, Mr. R. Önen (Turkey) Vice-Chairman, and Mr. R. Gabriel (United Kingdom) Rapporteur of the meeting. Mr. F. Norman of the Engineering Industries Section of UNIDO was Director of the Seminar.

Statements were presented by Mr. Norman, who also presented a statement by Mr. I. H. Abdel-Rahman, the Executive Director of UNIDO; by Mr. N. Guzov, Deputy Minister of Machine Building of the People's Republic of Bulgaria; Mr. N. Krainov of UNIDO; and Mr. A. Todorov, Chairman of the People's Committee of the town of Varna. (The statements of Mr. Abdel-Rahman, Mr. Guzov and Mr. Krainov are reproduced in appendix 1.)

A Committee was appointed to draft the report of the Seminar, consisting of Messrs. Somlev, Önen, Al Khateeb, Champetier and Gabriel.

The purpose of the Seminar was to provide (through the presentation of papers, films, discussions and factory visits) a comprehensive review and analysis of the technical and economic problems involved in the selection, utilization and repair of machine tools and the establishment and development of a machine-tool industry in the developing countries of the region. Papers were presented by internationally recognized experts in the field, by UNIDO staff and by delegates attending the Seminar. The presentation of each paper was followed by intensive discussion on the possible application of the subject matter to the

developing countries of the region in general and, specifically, to the countries participating in the Seminar.

The Seminar accepted the definition of a machine tool adopted by CECIMO which reads:

"A metalworking machine tool is a power-driven machine, not portable by hand while in operation, which works metal by cutting, forming, physico-chemical processing, or a combination of these techniques."

In addition to the presentation of the papers and the ensuing discussions, visits were arranged by courtesy of the Bulgarian Government to machine-tool building and other engineering plants to study the production and utilization of machine tools under workshop conditions.

The conclusions and recommendations of the Seminar, approved at the meeting on Friday, 22 October 1971, are presented below.

At the conclusion of the Seminar, lectures arranged by UNIDO were delivered by representatives of industrialized countries to more than 100 Bulgarian engineers and technicians at the Machine-Tool Research Institute in Sofia. The lectures were followed by a film produced by the British Machine-Tool Industry showing the advantages of numerically controlled machine tools.

## CONCLUSIONS

The following general conclusions are drawn from the papers presented by the experts at the Seminar, from the country study reports and from the general discussions that followed their presentation.

### INDUSTRIAL GROWTH

The growth of industries using machine tools is one of the most important factors in the industrial development and in the increase of national income and employment in developing countries.

### STAGES OF DEVELOPMENT

A country developing its metalworking industry appears to go through three typical stages:

- (a) The installation, maintenance and repair of metalworking and other machines;
- (b) The manufacturing of metalworking machines for local consumption; and
- (c) The manufacture of complicated machines, for domestic use, for export to other developing countries and, ultimately, to the highly industrialized countries of the world.



For countries that are still at stage (a), the most pressing problems may be organizational rather than technical. Thus, when considering the conditions necessary for establishing a machine-tool industry in a country, the background of the country and its stage of development must be carefully examined. Co-operation with industrialized countries may enable the developing country to by-pass many trial stages, e.g. through the acquisition of manufacturing drawings and technical know-how.

#### SIGNIFICANCE OF THE MACHINE-TOOL INDUSTRY TO THE REGION

The machine-tool sector of the metalworking industry plays a key role in the expansion of world industrial production, since nearly all other products are manufactured by machine tools or by machinery that has been produced with such tools. This is true for items as diverse in size and function as cigarette lighters and aircraft. And the ubiquitous automobile could not be produced without machine tools. It is impossible to study the history of technology without becoming aware of the crucially important part played by machine tools.

The volume of machine-tool production may be used as a yardstick for measuring the industrial development of a country. In 1970, Western Europe accounted for more than 39 per cent of the world output, the United States for 18.6 per cent, the USSR for 15 per cent, Japan for 14 per cent and Eastern Europe for about 10 per cent. The estimated production of 29 countries in that year is shown in Table 1.

The last survey made of the countries of the region showed that Egypt, Iran, Israel and Turkey are embarking on machine-tool production. The expansion of these countries' production will be of great importance to the progress of the region as a whole.

#### STATISTICS

Statistics on machine tools should be maintained by each of the countries of the region, preferably in accordance with the Brussels nomenclature, which is the classification used by most machine-tool producing countries. The statistics should cover imported and locally manufactured machines and should include full details of the age and quality of the existing park of machine tools.

This information will be of great value in assessing and planning machine replacement and rebuilding programmes as well as machine utilization.

#### EDUCATION AND TRAINING

The skills necessary for the operation of machine tools must be of a very high order if effective operation is to be achieved and if damage to the machines due to negligent handling is to be avoided. Special attention must therefore be given to the adequate training of operators and specialized supporting staff.

TABLE 1. ESTIMATED WORLD PRODUCTION OF METALWORKING MACHINE TOOLS IN 1970

Country	Proportion of world production (per cent)	Value (million dollars)		
		All types	Cutting types	Forming types
United States .....	18.6	1,460	1,015	445
Federal Republic of Germany ...	18.3	1,434	984	451
USSR .....	15.0	1,185	1,000	185
Japan .....	14.0	1,099	861	238
United Kingdom .....	6.0	475	382	94
Italy .....	5.0	400	320	80
France .....	3.7	291	218	73
German Democratic Republic ...	3.5	275	180	95
Czechoslovakia .....	3.1	245	201	44
Switzerland .....	3.0	240	228	12
Poland .....	1.6	123	112	11
Spain .....	1.1	90	79	11
Sweden .....	0.8	66	46	20
Hungary .....	0.6	50	47	3
India .....	0.6	48	45	3
Canada .....	0.5	40	24	16
Austria .....	0.42	33	18	16
Belgium .....	0.41	33	16	17
Argentina .....	0.41	32	18	14
Australia .....	0.38	30	8	22
Bulgaria .....	0.29	23	21	2
Brazil .....	0.28	22	13	9
Yugoslavia .....	0.25	20	15	5
Romania .....	0.25	20	18	2
Netherlands .....	0.23	18	11	7
Denmark .....	0.18	15	9	6
Mexico .....	0.07	6	...	...
Portugal .....	0.04	3	1	2
Other countries .....	0.06	5	...	...
<b>Total .....</b>	<b>100</b>	<b>7,845</b>		

Source: *The American Machinist*, January 1971.

Note: Totals do not add up due to rounding.

#### UTILIZATION OF MACHINE TOOLS

The successful development of the engineering industry in a country depends not only on its stock of machine tools and other related industrial equipment, but also on the way in which these are used. Some countries have sufficient stocks of equipment, but they are not being properly utilized. This means unnecessary expenditure on buying, servicing, repairing and maintaining the equipment.

### MAINTENANCE

In order to keep equipment in permanent working order with minimum expenditure of time and resources, it is necessary to institute a maintenance system that will ensure that the equipment is properly lubricated and operated, and that minor troubles are corrected immediately.

Systematic maintenance and repair of all machinery is essential even in the early phases of industrialization. In large establishments, comprehensive schemes for preventive maintenance will be necessary, but even the smallest shops must organize simple procedures for maintaining their equipment if costly repairs and loss of production are to be avoided.

### MACHINE-BUILDING

Machine-building projects must be viewed as part of a general plan for industrialization. A Government may set up its own factories for machine-building, or it may encourage free enterprise to do so, or it may favour a combination of these arrangements. The newly established machine-tool industry will be in an economically precarious position which may justify some form of government protection. It is, however, important that the industry should become economically viable as rapidly as possible, as prolonged protection can lead to stagnation and inefficiency which will be damaging to the metalworking industry of the country as a whole.

### DESIGN AND DEVELOPMENT

In the initial stages, the types of machines to be manufactured should be simple or elementary. However, the developing country should not be content to continue indefinitely in this fashion and, once the intricacies of machine-tool production have been mastered, machines of a more sophisticated nature should be introduced into the manufacturing programme. If the developing countries are to contribute high-quality metalworking machines to the world market, they will have to adopt modern, practical and technically sound designs. Until the machine-tool industry reaches a very advanced stage of development it may be better for it to obtain designs from industrialized countries, either through licensing agreements or through partnership arrangements, keeping in mind, however, that changes in environment may necessitate modifications.

When development has reached the stage where design of machine tools can be undertaken locally it will usually be more practical for the design facility to be concentrated in one centre, regardless of whether or not more than one manufacturing unit is to be served.

The design unit will be most effective if it has full development facilities for manufacturing and testing prototypes.

### MARKET RESEARCH

Introducing a new model of machine tool is an extremely costly affair and it is therefore of great importance that it meet the market requirements in every respect and that the potential demand has been accurately assessed. As market research for capital goods is one of the most difficult operations to carry out successfully, staff with a wide experience of machine-tool marketing should be employed if reliable results are to be obtained.

### USE OF NUMERICAL CONTROLS

The introduction of numerically controlled machine tools in a developing country presents many peculiar problems. Two classes of specialist must be trained:

- (a) Programmers to prepare the programme and input tape that will provide the commands for the machine control unit; and
- (b) Service engineers capable of servicing the electronic control systems.

The advantages of these machines, however, are so great that every effort should be made to achieve their early introduction throughout the batch production industries and especially into machine-tool building where flexibility of manufacture is of paramount importance. The procurement of jigs and fixtures for the comparatively small batch production which is an inherent characteristic of the machine-tool industry is a time-consuming and costly exercise. Many of these jigs and fixtures can be eliminated or greatly simplified when a numerically controlled machine is used, which makes it possible to commence manufacture of a new model of machine much more rapidly than would otherwise be the case.

### RECOMMENDATIONS

The recommendations approved by the Seminar take into account the different levels in the development of the metalworking industries of the countries of the region. They are given below individually for the developing countries and collectively for the developed countries. A final group of recommendations is for action by UNIDO.

IT IS RECOMMENDED that:

**Bulgaria** request UNIDO assistance in the establishment of a numerically controlled (NC) machine-tool demonstration centre for training operators, programmers and other supporting staff.

**Egypt**<sup>1</sup>

- (a) Train local personnel for the machine-tool building and tool-making industries;
- (b) Establish a national research and development institute centre for machine tools which would service the whole industry in the selection, design, adaptation of design, production, utilization, maintenance, repair and rebuilding of machine tools; and
- (c) Establish training programmes for machine-tool maintenance.

**Hungary** request UNIDO fellowships for engineers to study the following subjects:

Modern preliminary metalforming technology, such as four-dry, forge and press work;

Technology of the production of up-to-date abrasive materials and grinding wheels;

Organizational problems related to the introduction and use of NC machines;

The organization of production and the mechanization of administrative work;

Computer-aided design and mechanization of the engineer's work; and

Industrial research.

**Iran**

- (a) Request UNIDO expert services in the following fields:

Market research

Production engineering

Quality control

Jig and fixture design and production

Marketing

Financial administration and control

- (b) Study the possibility of establishing a plant for the production of metal-cutting tools;

- (c) Give special attention to the proper utilization and repair of machine tools and their accessories; and

- (d) Give special attention to the establishment of standards for machine tools in the country.

**Iraq**

- (a) Request fellowships in machine-tool maintenance and repair and in design of dies, jigs and fixtures;

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<sup>1</sup> Delegates from this country did not attend the Seminar; the above recommendations are based on reports on this country that were available to the meeting.

- (b) Request UNIDO assistance in a feasibility study of local manufacture of simple types of machine tools;
- (c) Give special attention to the proper utilization and maintenance of machine tools and their accessories; and
- (d) Give special attention to the proper selection of machine tools used for production purposes.

### **Israel**

- (a) Request UNIDO expert advice on the possibility of expanding the machine-tool industry of Israel and in defining the direction in which expansion might take place;
- (b) Request expert advice on the establishment of an international marketing programme for machine tools;
- (c) Train local people in the use of NC machine tools;
- (d) Give special attention to the proper selection of machine tools used for production purposes; and
- (e) Investigate the possibility of subcontracting for machine-tool components in the international field.

### **Jordan**

- (a) Request UNIDO fellowships in industrial engineering, modern industrial management, and marketing;
- (b) Study its existing stock of machine tools—their number, quality, type and age—and consider if they are suitable for present purposes;
- (c) Give special attention to the full utilization of machine tools and their maintenance and repair; and
- (d) Establish more craft training schools to increase the supply of skilled workers.

### **Kuwait**

- (a) Request UNIDO assistance in the preparation of a study on the feasibility of introducing NC machine tools in Kuwait;
- (b) Request UNIDO assistance in preparing programmes of preventive maintenance and repair for machine tools and other engineering equipment;
- (c) Request UNIDO to provide fellowships in the field of preventive maintenance and repair of machine tools and other related industrial equipment;
- (d) Study the existing machine tools in the country—their number, quality, age and type—in order to determine the types of machine tools that should be imported for future expansion;
- (e) Pay special attention to the utilization, maintenance and repair of machine tools and their accessories; and
- (f) Expand craft and technical training facilities.

**The People's Democratic Republic of Yemen**

- (a) Request assistance—in the form of operational experts, fellowships, mobile workshops, demonstration and testing equipment for strengthening appreciably repair and maintenance services;
- (b) Give special attention to the proper utilization, maintenance and repair of machine tools; and
- (c) Study the possibility of establishing a centre for the production of hand tools.

**Saudi Arabia <sup>2</sup>**

- (a) Study the existing stock of machine tools—their number, quality and age—and prepare a plan for future machine-tool purchasing; and
- (b) Establish craft training schools to meet requirements for skilled workers.

**Syrian Arab Republic**

- (a) Request UNIDO assistance in the establishment of an engineering design centre;
- (b) Request UNIDO assistance in determining the feasibility of manufacturing machine tools;
- (c) Request UNIDO assistance in the repair of machine tools and advice on the establishment of a machine-tool rebuilding centre; and
- (d) Study the existing stock of machine tools with regard to quantity, quality, type and age.

**Turkey**

- (a) Request UNIDO expert advice on the establishment of a development centre in Turkey to service the machine-tool industry;
- (b) Pay more attention to the establishment of machine-tool standards in the country;
- (c) Study the country's requirements of tools, dies, jigs and fixtures with a view to establishing a centre for their development, research and design; and
- (d) Establish training programmes for machine-tool maintenance.

**Yemen**

- (a) Give special attention to the proper selection and utilization of machine tools, dies, jigs and fixtures;
- (b) Establish craft training programmes to increase the supply of skilled mechanics and machine operators and request fellowships in this field; and
- (c) Consider expansion of the assistance already requested by the Government for repair and maintenance services to include the metalworking industry.

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<sup>2</sup> See footnote 1.

IT IS ALSO RECOMMENDED that the **developed countries**

- (a) Provide technical assistance to the developing countries of the region in the selection, production, utilization, maintenance, repair and rebuilding of machine tools, by supplying experts to train local engineers and technicians;
- (b) Accept trainees from developing countries;
- (c) Supply information relevant to the development and application of machine tools in these countries; and
- (d) Co-operate with UNIDO in providing technical assistance in this field.

IT IS FURTHER RECOMMENDED that **UNIDO**

- (a) Organize seminars, in conjunction with the developed countries, on the introduction of numerically controlled machine tools and their operation;
- (b) Investigate the desirability and feasibility of establishing, in suitable countries of the region, centres for the demonstration of NC machine tools and for training operators, programmers, and other supporting staff;
- (c) Co-operate with the International Labour Organisation (ILO), in the organization of training programmes especially designed for:
  - NC machine programmers
  - NC machine tool maintenance
- (d) Provide, upon request, technical assistance in the establishment of metalworking industries development centres, machine-tool rebuilding centres, and tool-and-die development centres;
- (e) Make expert assistance available, upon request, to the countries of the region for comprehensive machine-tool surveys, market research, and the selection, application, maintenance and repair of machine tools;
- (f) Arrange fellowships in various technologies such as metal-forming, metal-cutting, abrasive machining and numerical control programming;
- (g) Co-operate with CECIMO and other machine-tool manufacturers' associations in order to provide all forms of technical assistance;
- (h) Determine whether books on machine-tool maintenance and repair are available for use by developing countries, and if not, to arrange for the publication of such books; and
- (i) Make information available on sources of supply and performance characteristics of metalworking machine tools.



## Appendix 1

### STATEMENTS TO THE SEMINAR

*Statement by Mr. I. H. Abdel-Rahman,  
Executive Director, UNIDO*

It gives me great pleasure to welcome you to this Seminar. The balance of the representation—delegates with specialized knowledge and experience from the industrialized countries, together with those from developing countries, the real pioneers in industrialization—augurs well for the success of your work, as it has come to be realized that the technological and managerial know-how of the advanced countries must be related to the experiences of the developing countries in order to succeed in establishing industries under difficult conditions.

The subject before you is how best to transfer modern technology, specifically in the field of metalworking, to the developing countries. The application of modern technology requires special examination of the economic and technological factors that determine the success of industrial enterprises under particular sets of conditions.

Science has made phenomenal advances in recent years, especially in the fields of space research, electronics and communications, and a great number of new techniques and processes have been developed, some of which may be suitable for application in developing countries.

Yet the question arises again and again: how many of these innovations—such as automation and computer control—can be usefully introduced in the industries of the developing countries against the prevailing background of shortage of capital and skilled manpower?

There are other practical problems to be resolved. One of these is the need of developing countries to increase their manufacturing capacity in terms of machinery in general and of machine tools in particular. Many important factors must be considered in studying this problem.

It is significant that the number of machine tools *per capita* in developing countries is decreasing in comparison to that in advanced countries. This is a serious indicator of the growing gap between the developed and the developing countries and seems to reflect a relative slowing down in the industrialization of the latter.

Productivity presents another problem. For instance, modern cutting tools with throwaway carbide tips, an innovation that has been applied in developed countries for more than 20 years, is hardly known in developing countries. There is also room for improvement in the installation of machinery, the organization of preventive maintenance and repair, and the utilization of existing machinery.

Quite apart from the technological problems, we hope that the question of regional co-operation will receive the required attention. We believe that the development of their metalworking industries offers countries a great opportunity to diversify manufacture to their mutual co-operation and advantage.

Needless to say, these are only a few of the problems that may be aired in the course of your meeting.

To facilitate your work, a number of papers on the technical aspects of the development of machine tools and on the status of the industry in each developing country participating in this Seminar have been prepared by recognized experts and UNIDO. In addition, visits to a number of industrial enterprises have been arranged to enable you to observe the production and utilization of machines and to discuss points of common interest with plant management and personnel.

These measures, we believe, will help you to reach important conclusions on the subject before you, and to make recommendations for practical action by developing countries, by developed countries and also by UNIDO. We are confident that the nature and form of these recommendations will make their successful implementation possible.

It is with great sincerity that I extend my good wishes to you for success in the work before you and for the fulfilment of the ultimate purpose of this Seminar.

*Welcoming address by Mr. N. Guzor,  
Ministry of Machine Building of the People's Republic of Bulgaria*

It gives me pleasure to welcome you on behalf of the Ministry of Machine Building of the People's Republic of Bulgaria.

We hope that the conditions created for the holding of this Regional Seminar on Machine Tools will contribute to its fruitful outcome and are confident that this unique undertaking will lead to further and closer co-operation between our country and UNIDO—co-operation to which we attach great importance.

Only two decades ago the engineering industry in Bulgaria was almost non-existent. Now, however, our machine-building industry satisfies most of our domestic requirements and in 1970 it accounted for 28 per cent of our total exports. During the period 1956 to 1970 production increased 13 times; over the next four years our machine building is expected to develop at an even higher rate. The total production of machine tools will double. Production of computing techniques will increase as much as 10 times; instruments, gauges and measuring apparatus 2.7 times; electronic equipment 3.5 times; and metalworking machines 2.7 times. About 40 per cent of the existing equipment in

the machine-building industry will be modernized, re-built, or adapted for heavy-duty work. The introduction of automatic or assembly-line production methods will make it necessary to adopt new know-how and to organize production, labour and management on a more rational basis. The whole structure of the machine-building industry will be greatly advanced, while the production of individual units will change with the introduction of machine grouping, new systems of manufacture, and apparatus for the automation and mechanization of the manufacturing processes. Research, technology and design organizations will play an active part in this development.

Contacts between States and mutual assistance on the international level are essential if rapid progress in the economic, cultural and political development of the world is to be realized, and the assistance which the highly developed countries can give to the developing countries is a significant factor in this respect. UNIDO plays an extremely useful role in this connexion. We are proud that the People's Republic of Bulgaria, a country with established socialistic policies and an advancing economy based on all-round technical progress, can also make a great contribution towards the realization of this highly humane and noble goal.

Gentlemen, we wish you every success in your work.

*Statement by Mr. N. Krainov,  
Industrial Development Officer,  
Engineering Industries Section, Industrial Technology Division, UNIDO*

I should like to thank the Government of the People's Republic of Bulgaria for giving us the opportunity to meet here and discuss the important problems of the future selection, development and utilization of machine tools in the developing countries of Europe and the Middle East.

The Interregional Symposium on the Development of Metalworking Industries in Developing Countries, held in Moscow in 1966, discussed general problems of the metalworking industries in Africa, Asia and Latin America, and drew attention to the different levels of development in these regions. The Symposium also emphasized the key role played by the machine-tool industry in the expansion of industrial production.

In accordance with the recommendations adopted by the Symposium, UNIDO is planning to organize regional seminars on machine tools for Latin American countries in 1972 and for the countries of Asia and the Far East in 1973.

The subjects before us for discussion now are:

The role of machine tools in metalworking industries in the countries of the region;

The selection, production, utilization, maintenance and repair of machine tools;

Prerequisites for the establishment of machine-tool building industries in the countries of the region; and

The possibility of introducing NC machine tools in the countries concerned.

It is expected that the participants from the developing countries will indicate what technical assistance they require and that the participating developed countries will be able to provide this assistance. We hope that you will establish contacts which will be of mutual benefit.

The industrial development of a country depends to a considerable degree on the number, age, quality and type of machine tools it possesses. However, the successful development of the engineering industries depends not only on the stock of machine tools and other related industrial equipment but also on the way in which they are used. Some countries have sufficient stocks of equipment, but their improper use leads to wasteful expenditure on buying, servicing, repair and maintenance.

The successful operation of machine tools and other related machinery and equipment is only possible if highly trained personnel is available that can understand and interpret blueprints, in order to make use of the most complicated means of dimensional and quality control, tolerances of which may be expressed in fractions of millimetres. They must also be qualified to adjust, at any given moment, a deviation from the required tolerances in the operation of machine tools serviced by them.

Today, developing countries of southern Europe and the Middle East can obtain the machine tools necessary for sophisticated manufacturing processes. They can also obtain the services of managerial personnel and skilled foremen, when such staff is not available locally. However, skilled labour cannot normally be hired from foreign countries - or at least not in sufficient numbers and, to a large extent, has to be trained locally.

It is not enough that the people of a country should wish for the creation of machine-tool building industries: the countries must have certain prerequisites for design and production capabilities, such as skilled labour, ancillary industries for castings, forgings, bearings, electrical equipment, components and tools. As a first step in this direction, they should develop their metalworking industries.

UNIDO is prepared to give technical assistance in the metalworking sector, if it is requested by the Governments of the countries of the region. The participants in the Seminar will find samples of job descriptions for experts provided by UNIDO in paper No. ID/WG.87/29 entitled "Role of UNIDO in the Machine Tool Industry".

I hope that all the items on the agenda will be discussed to your satisfaction and that you will leave the meeting with realistic recommendations on how to improve the situation in each country of the region. I hope that you will also find interesting the visits that have been arranged to a number of machine-tool manufacturing plants where you can see machine tools being produced and used under workshop conditions, and where you can study the experience gained in the creation and development of the machine-tool industry in Bulgaria.

Finally, I should like to make particular mention of the invaluable co-operation given during the preparation of this Seminar by CECIMO, the European Committee for Co-operation of Machine-Tool Industries, which represents 1,500 manufacturers from 13 European countries.

## Appendix 2

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### Appendix 3

#### LIST OF DOCUMENTS<sup>1</sup>

<i>Symbol</i>	<i>Title and Author</i>
ID/WG. 87/1/Add. 1/Rev. 1	Preliminary information sheet
ID/WG. 87/2/Rev. 2	Provisional agenda and work schedule
ID/WG. 87/3	Aide mémoire
ID/WG. 87/3/Corr. 1	Aide mémoire
ID/WG. 87/4	Preconditions for creating machine tool industry in developing countries by G. I. Susanov, Union of Soviet Socialist Republics
ID/WG. 87/5	Ways and means of co-operation between industrialized and developing countries in the selection, development, marketing and utilization of machine tools by K. C. Berger, Federal Republic of Germany
ID/WG. 87/6	Country study report on the machine tool industry in Hungary by A. Koltai, Hungary
ID/WG. 87/7	The possibility of introducing numerically controlled machine tools in developing countries by L. Champetier, France
ID/WG. 87/8	Report on machine tools in the People's Democratic Republic of Yemen by S. Ghanem, People's Democratic Republic of Yemen

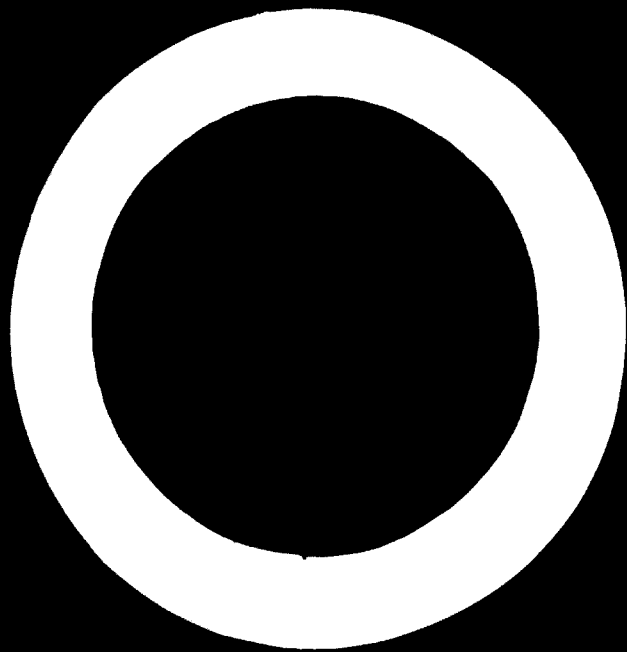
<sup>1</sup> A limited number of copies are available upon request.

<i>Symbol</i>	<i>Title and Author</i>
ID/WG. 87/9	Report on the machine tool industry in Iraq by Y. Robaie, Iraq
ID/WG. 87/10	Country study report on the machine tool industry in Iran by E. Ghassemloo, Iran
ID/WG. 87/11	Country study report on the machine tool industry in the Syrian Arab Republic by W. Rihawi, Syrian Arab Republic
ID/WG. 87/12/Add. 1	Country study report on the machine tool industry in Israel by Y. Bobrov, Israel
ID/WG. 87/13	General report on machine tools in Yemen Arab Republic by N. A. K. Al-Karbash, Yemen Arab Republic
ID/WG. 87/14	Tour programme
ID/WG. 87/15/Rev. II	List of participants
ID/WG. 87/16	Tool industry in Jordan by F. Hadidi, Jordan
ID/WG. 87/17	Rebuilding, maintenance and repair of machine tools by L. Champetier, France
ID/WG. 87/18	Mission report of the machine tool industry in Iran, Iraq, Lebanon, Syria and Turkey by R. Gabriel, United Kingdom
ID/WG. 87/19	Report on machine tools in Kuwait by A. M. Al-Khateeb, Kuwait
ID/WG. 87/20	Country study report of the machine tool industry in Turkey by R. Yilmaz, Turkey
ID/WG. 87/21	Country study report on the machine tool industry in United Arab Republic by I. H. Yasseen, Arab Republic of Egypt
ID/WG. 87/22	Report on machine tools in Turkey by R. Önen and R. Yilmaz, Turkey
ID/WG. 87/23/Add. 1/Add. 2	Provisional list of documents
ID/WG. 87/24	Metal working industries in Saudi Arabia by the secretariat of UNIDO

<i>Symbol</i>	<i>Title and Author</i>
ID/WG. 87/25	Effective use of machine tools and related aspects of management in developing countries by A. O. Schmidt, F. R. Bacon Jr., R. Kramer, in co-operation with the secretariat of UNIDO
ID/WG. 87/26	Maintenance and repair problems related to machine tools in Bulgaria by B. Belchev, Bulgaria
ID/WG. 87/27	A survey of the development of machine tool production in Bulgaria by S. Petrov, Bulgaria
ID/WG. 87/28	Modernization and reconstruction of machine tools in Bulgaria by P. Somlev, Bulgaria
ID/WG. 87/29	Role of UNIDO in the machine tool industry by the secretariat of UNIDO
ID/WG. 87/29/Corr. 1	Role of UNIDO in the promotion of machine tools in developing countries of Europe and the Middle East by the secretariat of UNIDO
ID/WG. 87/30	Notes on economics of the machine tool industry by UCIMU, Unione Costruttori Italiani Macchine Utensili, Italy
ID/WG. 87/31	Report on the machine tool industry in Romania by P. Balan, Romania
ID/WG. 87/32	Draft report
ID/WG. 87/33/Add. 1	The machine tool design process in a developing environment by G. M. Brown, United Kingdom
ID/WG. 87/34	Co-operation, industrialized countries—developing countries by A. Ryttel, Poland
ID/WG. 87/35	Training for numerical control by J. A. Moorhead, USA

*Part II*

**PROCEEDINGS BASED ON PAPERS PRESENTED  
AND DISCUSSIONS**





## PREREQUISITES FOR MACHINE-TOOL MANUFACTURE

### WHY THE MACHINE-TOOL INDUSTRY IS VITAL TO A DEVELOPING ECONOMY

The production of machine tools is one of the most interesting industries for any country to develop, especially for one just beginning industrial development, for these reasons:

It occupies a central place in the interrelations between the different branches of production and is of paramount importance for the development of the engineering and electrical industries.

Its range of products is so wide that no country can monopolize it or any large part of it.

Even so, it lends itself to intense specialization, and any country, according to its resources, can play a special role in world production.

In the initial and even in more advanced stages the machine-tool industry does not usually require very large investments.

Machine-tool production means active participation in world markets because import and export business forms an essential technical and financial part of its evolution.

At least within certain limits, this industry does not obey the laws of industrial concentration and does not need vertical integration with capital-intensive industries (iron and steel, primary metals etc.).

It enables producers to work in a market where quality counts more than price. The smaller users can benefit from the existence of a second-hand market, since the general-purpose machines do not go out of date quickly. Furthermore, the amortization characteristic of machine tools, including the automated models, is for depreciation to be spread over many years, which ensures that the initial selection will be made with care.

### ESSENTIAL PRELIMINARY CONDITIONS

The birth of a metalworking machine-tool industry, no matter how interesting, must await the previous development of a metalworking industry, on which it is dependent for raw materials, semi-finished products and diverse finished goods.

To be viable, the infant industry will need to obtain, preferably from established local manufacturers, all or most of the following items:

- Grey-iron castings
- Non-ferrous castings
- Forgings of high-grade alloy steel
- Anti-friction bearings of precision quality
- Oil seals
- Single- and multiple-plate clutches
- High-tensile screws and bolts
- Electric controls
- Electric motors including those with special characteristics
- Cutting tools, standard and special
- Jigs and fixtures

There will also be a need for laboratory and metrology facilities.

It is assumed that engineers, technicians, operators and fitters will be available from the engineering industry already established in the country.

The industry must have an adequate local market for each size and type of machine in the manufacturing programme and must be able to produce them at competitive prices. Even in a country with a huge export business like the Federal Republic of Germany, the machine-tool industry accounts for only 0.64 per cent of the gross national product (GNP). A developing country must therefore consider whether the same effort and resources in management, technicians, labour, plant, equipment and materials would yield greater benefits if directed into other industries.

#### PREPARATORY ACTION

After the essential preliminary conditions are fulfilled, one of the first questions to be answered is what types and sizes of metalworking machine tools should be produced and in what quantity. At first, it is advisable to produce "universal" machines, which are designed to perform a wide range of operations. The types usually in greatest demand in a developing country are centre lathes, drilling machines and shaping machines. These may be followed by milling, surface-grinding and cylindrical-grinding machines. But whatever types of machines are produced, they must be modern and incorporate the latest design features.

The development of metalworking machine-tool production should be effected in close co-operation with all other industries being developed in a country, for it is ultimately the user industry that determines the types, sizes and quantities of metalworking machine tools produced.

#### MODEL OF A SCIENTIFIC AND ENGINEERING CENTRE

When it is decided to establish a metalworking machine-tool industry in a country, a scientific and engineering centre should be set up to undertake

the tasks that should precede the establishment of the industry and continue throughout its development. The following description constitutes a general model for such a centre. There will, of course, be substantial differences in the specific requirements of each country.

#### *Planning department*

Studies the needs of industry for metalworking equipment and determines the types and sizes of machines required. Proposes the types and sizes of machines which should be produced in the country and recommends the number of machines of each type to be produced and the number to be imported.

#### *Familiarization department*

Studies the design, operation and maintenance of both imported and locally produced machines. Translates into the language of the country the specifications and service manuals for imported machines for the convenience of the customer. Assists customers in setting-up and proper servicing of machines, whether imported or domestic. To carry out this work, the centre should have a special location where specimen machines may be demonstrated. This demonstration hall may also be used for teaching the representatives of user companies to operate these machines and for demonstrating the manufacture of certain parts. On no account should the demonstration hall be turned into an ordinary production shop and thus be prevented from carrying out its primary function.

#### *Design and testing department*

Creates new models of machines for regular production and improves the design of machines already being produced. Before starting to design a machine, it is necessary to understand thoroughly machines of similar purpose. This department therefore studies similar machines produced in other countries and determines specifications suitable for the conditions under which the model under consideration will be used.

In the initial period of the development of the national metalworking machine-tool industry, when there is no experience in developing new machines, the reproduction of some foreign machines may be advisable. This may be done by purchasing licences that cover design and complete manufacturing techniques or simply by purchasing drawings from foreign Governments or firms.

The prototype of a new design will usually be built by the scientific and engineering centre itself, so that the designers can settle expeditiously any problems that arise. After the prototype has been built, it is subjected to a detailed laboratory test, and necessary design changes are made. Then a small batch of five or ten machines is produced and installed at various companies for field tests. These tests may reveal additional defects in the machine, which should be corrected before the design is approved for quantity production.

On the staff of the design section it is desirable to have groups specializing in the following types of machines:

Turning machines

Drilling and boring machines

Planing, slotting and milling machines

Grinding machines

Gear-cutting machines

Metal-forming machines

Woodworking machines, if they are included in the programme

This department should also include groups dealing with electrical, hydraulic and lubricating equipment for metalworking machine tools. These groups should have appropriately equipped laboratories at their disposal.

The availability of national standards is of extreme importance for the improvement of design work in this field of technology. In working out national standards of metal-working equipment and tools, it is desirable to use the recommendations of the International Organization for Standardization (ISO) as much as possible.

#### *Metallurgical and chemical department*

Deals with the problems of iron and non-ferrous casting, steel and its heat treatment, flame cutting, electric and gas welding, plastics and rubber technology, lubrication, paints and resins. This department should have foundry, metallurgical and chemical laboratories for carrying out investigations and tests.

#### *Metalworking techniques department*

Studies the achievements of world engineering in metalworking technology and takes measures to introduce into the national industry those which are of interest. The department is also responsible for research in the cutting and forming of metals.

#### *Maintenance department*

Prepares recommendations and manuals on all aspects of service and repair.

#### *Technical information department*

Collects and transmits scientific and technical information. Translates technical articles and manuals of interest to the country's manufacturing industry. Maintains a technical library.

### SCIENTIFIC AND TECHNICAL ASSISTANCE FROM INDUSTRIALLY DEVELOPED COUNTRIES

In the initial period of creating the metalworking machine-tool and equipment industry in a developing country that lacks both experience and specialists, it is important to invite specialists from industrially developed countries to

assist in all phases of the operation, not forgetting the establishment of the scientific and engineering centre described above. Such assistance is usually given under a "know-how" agreement or a manufacturing licence agreement. When it is necessary to construct a new enterprise or to reconstruct an existing one in a developing country, agreements are often made with government institutions or firms of a developed country to undertake the complete project, including the provision of buildings, machines and equipment, the organization of production and the training of staff at all levels.

In carrying out this work, specialists from the developed country share their experience in developing the new enterprise with the local staff; this is a good way to train specialists and workers in a developing country. Another way is for the local specialists and workers to go to industrially developed countries for training and study.

#### ORGANIZATION OF A TYPICAL PLANT

The organizational structure of a machine-tool manufacturing plant may take the following form:

##### *Procurement department*

Obtains raw materials and finished parts. In a developing country, the task of this department is likely to be much more exacting than in an industrialized country, where the principal suppliers are usually close at hand and fully conversant with the customers' requirements.

##### *Receiving department*

Inspects materials and parts as they are received and checks to see that they comply with specifications.

##### *Stock control department*

Stocks the materials and parts that have passed through the receiving department. Arranges for storage and issuance of stock.

##### *Manufacturing department (excluding foundry)*

Produces individual components by machining and surface treatment of castings and by machining and heat treatment of steel parts.

##### *Assembly department*

Puts the manufactured and purchased parts together. The building of a machine usually takes place in two separate operations. First, all the sub-assemblies are built and wherever possible tested as independent units. Second, the sub-assemblies are brought together and joined with the main frame of the machine, and miscellaneous items are fitted. When alternative specifications are offered, the particular requirements of the customer are incorporated at this stage.

*Test department*

Subjects the completed machine to all the static and dynamic tests required to ensure that it meets the specifications. Ensures that the operational performance is satisfactory; this may necessitate the machine being run for a long time. When special tooling has been ordered, it is usually tested on the machine to see if it will actually do the job required by the customer.

*Painting department*

Cleans the tested machine and paints it to specifications.

*Shipping department*

Packs and ships the machine to the customer.

*Other departments*

Production is only one function of the machine-tool company, which must also have departments for market research, product planning, design and development, marketing, billing, sales, and customer service.

**MEASURES TO BE TAKEN FOR SAFEGUARDING MACHINE-TOOL INDUSTRY  
IN DEVELOPING COUNTRIES**

By the Government:

- (a) Ask for assistance of foreign experts, especially from UNIDO, when installing new machine-tool factories.
- (b) Limit or stop the importation of products similar to the products manufactured in its own factories for a limited period.
- (c) Facilitate the importation of raw material and components for manufacturers by decreasing customs duties and other costs.
- (d) Try to reach regional agreements with other developing countries, thereby creating wider markets.
- (e) Encourage and help the private sector in the installation of ancillary industry, thereby providing the machine-tool industry with locally manufactured parts and components.
- (f) Arrange the training of technical staff and management needed by industry in parallel with universities and institutes and also send trainees to developed countries to gain practical experience in respective fields and professions.
- (g) Establish a nation-wide system of wages and salaries to prevent the creation of special attractions in some places.
- (h) Establish industrial standardization as a guideline for systematic development of industries and for eventual co-operation between different industrial units.
- (i) Make long-term industrial development plans and take appropriate action for realization of these plans.

By the factories themselves:

- (a) Select suitable products to be manufactured, using modern technology and machinery, after a full study and technical assistance of foreign, and especially UNIDO, experts.
- (b) Employ experienced people and ensure their continuous training.
- (c) Make use of experienced experts of developed countries, at least during the first five years after starting a factory.
- (d) Organize production planning activities, particularly regarding human factors and capacity loading of production facilities.
- (e) Ensure optimum selection and consumption of material.
- (f) Create a suitable relation between the numbers of direct and indirect production workers in order to decrease indirect and overhead costs.
- (g) Organize planned preventive maintenance of machinery and equipment, thus avoiding unnecessary interruptions in production processes and increasing the life of the plant.
- (h) Pay special attention to the quality control of manufactured parts and final products.
- (i) Establish organizational rules and principles for smooth and proper running of the factory.

### SELECTION OF MACHINE TOOLS<sup>1</sup>

When new machine tools are being selected, care should be taken to ensure that they complement the machines already in operation. This is comparatively easy in a small plant, but as the size of the operation increases it becomes progressively more difficult, and at the national level it is impossible unless adequate statistical records are maintained. To be useful these records should show the numbers of machines, not only in broad categories, but also within closely defined limits; the age and condition of the machines should also be indicated. Such records are essential in replacement programmes, such as the common one in which 5 per cent of the oldest machines are scrapped every year. The criteria for selection of a replacement machine depend somewhat on whether it is bought to replace one that is worn out or to meet expansion requirements. In the first case, one merely purchases the current model of the same type; in the second, the expansion requirements may dictate that a different, more productive type of machine be obtained. For example, if production rates are low a centre lathe may still be suitable, but if production is increasing a turret lathe, or even a single- or multi-spindle automatic, may be the better choice.

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<sup>1</sup> See *The Selection and Acceptance Testing of Metal-Cutting Machine Tools*, United Nations (Sales No.: E.71.II.B.3), a practical guide for developing countries.

A machine tool should be selected with full knowledge of alternative methods of manufacturing a particular item. The choice of an unsuitable machine will result in inefficiency for its service lifetime, which may be many years. The cheapest machine may also prove to be a poor choice, since it may not stand up to its task. Finally, for full effectiveness, the chosen machine must afford an adequate range of tooling for the job it is to perform.

Every two years CECIMO organizes in Europe a World Machine Tool Exhibition where the latest developments in machine tools and production technology are demonstrated. Representatives of developing countries that wish to procure machines would undoubtedly benefit greatly by visiting these exhibitions.

A UNIDO information service relative to the sources and characteristics of machine tools would be extremely helpful to countries of this region.

## UTILIZATION OF MACHINE TOOLS

### EFFECTIVE UTILIZATION

The industrial development of a country depends to a considerable extent on the number, age, quality and type of machine tools it has. But the way in which these tools are used is also very important. Some countries have a sufficient number of tools but are not utilizing them properly and are therefore making unnecessary expenditures for buying and servicing them.

The effective use of machine tools is a very important factor in increasing productivity. In considering the utilization of machine tools, the industries of the country should answer the following questions:

- (a) Is the machine tool suitable for the job in question? What are the alternatives for its use?
- (b) Is the machine working at optimum capacity? What is the utilization (in percentage of the total machine time available) and how can it be improved?
- (c) Is it better to have special-purpose or general-purpose machine tools? (The latter are adaptable to a wider variety of jobs but have lower capacity.)
- (d) Should machines take over manual tasks? If so, which tasks?

The production control and planning departments play vital roles in the effective utilization of machines. However, it may be much more difficult for these departments to function effectively in a developing country than in an industrialized country, since procurement of raw material is often difficult, especially in the case of alloy steels. There may also be difficulties and delays in obtaining the required jigs and fixtures and even the correct cutting tools. Replaceable (throw-away)



carbide tips, for example, appear to be much less frequently used in countries which are only just beginning their industrialization compared with those where industrialization is more advanced, even though skilled toolgrinders, scarce in these countries, are not needed to make them.

Detailed machining instructions should be prepared in the planning department for every part that is to be manufactured. These instructions should give the cutting speeds and feed rates for each part of the operation rather than leave them to the discretion of the operator. Full efficiency will not be achieved unless the correct feeds and speeds are used, since too low a rate will prolong the operation unnecessarily whereas too high a rate will result in poor surface finish and premature tool failure.

Full utilization of the machines will not be achieved unless there is also an effective organization for routine servicing and maintenance.

In addition to these obvious and easily eliminated causes of underutilization, there are three others which are not so easy to deal with:

- (a) Too many companies producing the same type of product because demand was overestimated.
- (b) Reduction in demand due to a changing pattern of trade.
- (c) Lack of managerial competence.

The solutions to the problems facing companies in the first two situations may not be obvious, since the difficulties may have arisen from a complicated chain of events resulting from government actions, or normal market forces, or both. Before a remedy can be found, a detailed study of the problem must be made so that the causes can be isolated and understood. A detailed market research study might show that a different product would fully utilize the expertise and resources of the plant. Or, additional markets might be found outside national borders. The company may also find it necessary to ask the Government for reasonable protection against lower-priced imports or for tax concessions. Since the operation of these plants creates employment, the Government has a direct interest in ensuring that they be viable.

The effective application and utilization of machine tools should be the primary concern of management. Every aspect of the operation must be kept under scrutiny to prevent unnecessary loss of output due to machine breakdown, labour shortage, reduced sale volume or weakness in the production control system. Management should also consider whether capacity can be increased by subcontracting to other companies rather than by installing additional facilities that may not be fully utilized. On the other hand, if surplus capacity exists, it may pay to seek subcontract work to make full use of the plant.

#### LABOUR REQUIRED FOR THE OPERATION OF MACHINE TOOLS

Assuming that the machines selected have passed the acceptance tests and have been properly installed, they will be of little value unless skilled operators are available to run them. To realize the full value of the machines they should be worked intensively, i.e., there should be enough operators to work double shifts.

These operators should be able to read and understand complicated blueprints, if modern systems of dimensional and quality control, with tolerances expressed in fractions of millimetres, are to be employed. They must also know how to make immediate adjustment for any deviation from the required tolerances in the operation of their machines. Properly trained operators will get the best from their machines and not cause unnecessary breakdowns due to mishandling.

Today, the developing countries of southern Europe and the Middle East can obtain the tools that are necessary for the most complicated manufacturing processes. If there is a shortage in the local labour market they can hire from abroad the highly skilled managers and foremen they need. However, enough skilled operators cannot normally be hired from foreign countries, and many would have to be trained locally.

### SPECIAL ADAPTATIONS

The effectiveness of many machine tools can be greatly increased by adding such accessories as power-operated chucks, hydraulic copiers, pneumatic vices and other air-operated attachments, pre-set tooling, and in-process gauges (on grinding machines). The list could be greatly extended until one has added all the complicated attachments that convert a turret lathe, for example, into a fully automatic sequence-controlled machine.

The effectiveness of the basic machine itself may be improved by increasing the feeds and speeds. This may be done by changing the main-drive pulley ratio or increasing the size of the drive motor. If the feed rate is not related to main-spindle rotation, it may be desirable to make additional adjustments to the feed system itself.

Adding attachments and equipment or altering the basic machine itself should only be undertaken after a careful review of all the environmental factors affecting the operation and characteristics of the machine.

## MAINTENANCE AND REPAIR

### MAINTENANCE

The purpose of maintenance is to increase the lifetime of machines and to prevent breakdowns that slow or stop production. The greater the degree of mechanization of any enterprise, the greater the need for carefully-worked-out schedules for lubrication, performance checks, and parts replacement.

### *Lubrication*

The responsibility for lubrication should be assigned to specific persons and not left implicitly in the hands of the machine operator. If the enterprise is large enough, these persons may be the members of an organized maintenance team.

An effective lubrication plan should provide for:

- (a) A comprehensive lubrication calendar that specifies the lubrication tasks to be performed daily, together with a system for checking that the tasks are done.
- (b) A chart for each machine showing its lubrication points, the amount and type of lubricant to be applied to each point and the frequency of application.
- (c) A list of recommended lubricants and a system for keeping them in stock.
- (d) Standardization of lubricating systems, e.g., different lubricators for oil and for grease, lubricators colour-coded according to viscosity.
- (e) Facilities for storing and dispensing lubricants.
- (f) Specialized equipment for application of the lubricants.

### *Performance checks*

When a machine is first put into operation, it should perform in accordance with the manufacturer's specifications. As the machine wears, the quality of the items made on it deteriorates. This process of wear has three stages:

1. Initial run-in. The rate of wear depends strongly on surface finish of the mating parts.
2. Normal operation. A prolonged period in which little wear takes place.
3. Deterioration. The rate of wear increases, the play between mating parts increases rapidly, further accelerating wear, and the noise level increases appreciably.

The operating time of the machine can therefore be taken as a rough indication of the wear; the actual load carried, i.e., the electrical energy consumed, is a much more reliable criterion and can be measured with a watt-hour meter connected in series with the machine.

Every machine tool should also be equipped with a time recorder, which makes it possible not only to schedule maintenance activities more precisely but also to study the law governing the wear of the machine as a function of operating time.

The following items should be checked regularly:

Power input to the machine while it is running idle at various speeds

Mechanical efficiency curve

Abnormal noise or vibration

Machining accuracy

Loss of geometrical precision due to play in the spindle or guides

### *Parts replacement*

These checks may disclose that a number of adjustments are required and certain parts should be replaced in addition to those that are replaced routinely such as drive belts, filters, clutches and electronic components. For effective preventive maintenance, spare parts must always be on hand for both regular and emergency replacements. However, the stock of spares should be held at the minimum level that will meet this purpose, for the stock represents a non-productive use of capital.

### REPAIR

Every machine tool, regardless of how well it is maintained, will eventually require more extensive repairs than can be accomplished by routine maintenance. For such repairs it may be necessary to remove the machine to a special section of the plant where better facilities are available for the work. During the repair many parts that have not actually failed will be replaced in order to give the machine a longer period of use before repairs are again required. Detailed records of the time and material used in these repairs should be kept for comparison with the records of similar machines and also for determining after further service whether the machine should be replaced or rebuilt.

### *Rebuilding*

A machine may be rebuilt at its normal location, but more usually it is taken to a plant specializing in this kind of work. The machine is completely taken apart, and each part is cleaned and inspected. All the worn parts, such as gears and bearings, are replaced and, if necessary, the main slideways are re-machined or (in the case of bolted-on slideways) replaced. The machine is then reassembled and tested against the specifications for a new machine. A machine rebuilt by an experienced shop should be just as good as new and should in fact retain its alignments better than a new machine because the main-frame castings have now been fully aged.

In deciding whether to rebuild a machine it is advisable to take account of its replacement cost. Generally speaking, the cost of rebuilding a heavy machine tool is 25 - 30 per cent of the cost of a new machine, while for a medium-sized machine tool it is 50 - 60 per cent.

With proper maintenance, machine tools will probably give service for 10 to 20 years before rebuilding is necessary. There is a hazard, therefore, that the machine may become obsolete in that time. In the case of general-purpose machines, this is unlikely, since the design of this type of machine does not change rapidly. Some production machines, however, may become obsolete because of advances in manufacturing techniques. It is a waste of time and money to rebuild such machines.

The principal cost of rebuilding is for labour; the cost of materials is quite low. Rebuilding is therefore particularly advantageous for developing countries, since labour is usually available and can be trained for this work and the purchase of material requires a negligible amount of foreign currency.

## EDUCATION AND TRAINING

The shortage of technical manpower in the developing countries that have little or no manufacturing tradition is often acute. In most of these countries, therefore, technical education and vocational training are organized by the Government, and persons receive their education locally or abroad at public expense. Unfortunately, the metalworking industry is often very low on the priority list and only a small part of its trained manpower needs is satisfied.

One of the main difficulties encountered by managerial and technical personnel who have been trained in the industrially advanced countries is that the skills and points of view acquired are too sophisticated for application in a setting which includes obsolescent machinery, short supplies of material, indiscriminating customers, inexperienced technicians and inexpert workers. Such circumstances can be frustrating to the newly trained engineers or scientists and, along with the lure of higher salaries elsewhere, account for the reluctance of some of them to return to their own countries when their studies abroad are complete. There also seems to be a tendency in the metalworking industries to make managers of local people who have a background in marketing. Such managers find it difficult to adjust to the technical and manufacturing responsibilities they must assume in addition to sales promotion.

An alternative method of developing skills is to encourage foreign manufacturers to set up plants which are designed to fit the capabilities of the local labour force. The foreign manufacturer at first provides designs, techniques and supervisory manpower, enabling production to commence rapidly and expand steadily. The foreign specialists and techniques can then be replaced gradually by local ones.

Young workers in some developing countries, after receiving their basic practical training, often take up employment in one of the industrialized countries, a practice that is sometimes looked on with disfavour. In truth, the results are highly favourable to the developing country, since the young man usually returns to his own country after a period of three to five years, having greatly improved his skill. While abroad he probably sent an appreciable part of his wages home regularly, either for use by his family or for his own use on his return. His improved skill is of considerable benefit to his employer, since not only is he capable of doing better work himself but through example he improves the work of his colleagues.

Because of the rapidly increasing use of highly sophisticated equipment there is a growing need for specialized technical personnel. Included in this category are programmers who prepare the command tapes for numerically controlled machine tools, technicians who maintain electronic controls, planning engineers who are conversant with every aspect of modern production techniques and production controllers, who must be familiar with production control computer techniques to enable the larger factories to operate efficiently with minimum stock levels. Finally there is the market research staff, who need to be conversant with the latest techniques of capital goods market research, if costly mistakes in tooling up are to be avoided.

Much of the training in these highly specialized areas can be accomplished by having experts work with the local staff to meet existing problems rather than by undertaking a theoretical training programme. However, it is still necessary to send selected personnel to the industrialized countries for training.

## MARKET RESEARCH AND MARKETING

Even before the preliminary stages of design can be undertaken for a new machine, an intensive market research programme should be completed. Such a programme is a sophisticated operation and cannot be based solely on statistics about machine-tool demand in earlier years. Rapidly changing technological requirements make it important that the right decisions be made if a company is not to be committed to the heavy expenditures of tooling-up for a new model that no one wants by the time production begins.

Market research may also lead to the modification of existing products. To investigate the need for a product change the first necessity is to establish company objectives, particularly with regard to the volume of sales desired. The strengths and weaknesses of a company's products should be compared with those of competitors' products. Then an analysis should be made of sales according to industry, location, volume, end-use, channels for distribution and expansion potential, as well as a review of the production costs and profit margin for each product. When this information has been obtained a product strategy can be devised that will meet the competitive situation and contribute towards attaining the company's growth objectives. Furthermore, a specific characteristic can be defined that new products must satisfy in order to fall within the company's range of manufacture and match the market needs. This will narrow the search for new or improved products.

A number of measures can be adopted that will enable smaller firms in developing countries to undertake these market research activities:

- (a) Seek information from government and quasi-government organizations that keep abreast of environmental and technical changes in the relevant markets.
- (b) Use a panel of part-time consultants to augment the company's technical managerial resources.
- (c) Set up a committee within the company to consider potential threats to the growth of its business.
- (d) Make a thorough evaluation of the technical methods used on existing products and proposed for new products.
- (e) Communicate with local universities regarding technological advances with which they are conversant.

## TRADE CYCLES

An important need in the machine-tool industry is for accurate forecasts of economic trends, since the user will delay his order for a machine tool if

the economic outlook is unfavourable. To counterbalance the negative effects of domestic trade cycles, manufacturers try to reach out beyond the home market and export their goods abroad. The machine tool is acceptable in all markets—the machine-tool industry may be described as a supra-national service. In fact statistics show that one out of four machines is exported, and that the countries exporting the most are at the same time those with the highest level of imports.

### MARKETING

Before a new product is actually in production an intensive marketing campaign will be required if sufficient demand is to be generated to prevent an imbalance between production and orders once the outstanding initial market requirements have been met. It must be emphasized that marketing is neither market research, which should have been undertaken at a much earlier period of the cycle, nor is it selling, although the latter is an important element in the total marketing operation.

Since no country can hope to be self-sufficient in all its machine-tool requirements, there will be considerable benefit if agreements can be reached with other countries for the manufacture of a series of compatible machines, i.e., machines which are complementary and not competitive. Thus the total market for the machines being manufactured by each country will be greatly increased.

A typical machine-tool company in an industrialized country not only supplies machines to its customers but also provides them with extensive technical information about the latest manufacturing methods. In this way, the company benefits itself by creating sufficient demand for the particular type of machine it has in its manufacturing programme and also benefits the customers by introducing them to efficient methods of manufacture that they might otherwise miss.

While it may not be necessary to indulge in such sophisticated marketing techniques in the developing countries, there will be a definite need there for effective marketing to be undertaken before any new machine-tool industry can become economically viable.

### NUMERICAL CONTROL OF MACHINE TOOLS

Numerical control (NC) is a kind of automation in which the sequence of operations needed to machine a given workpiece is set up in advance by means of numerical data recorded in some way on tape or cards. When the tape or cards are run through the control unit, the working parts of the machine, such as tool holders, workpiece holders and slides, go through the sequence automatically.

### ADVANTAGES OF NC

An important advantage of NC is that there are no cams or stops that have to be adjusted with every change in the size of the workpiece. By electronic feedback the control unit senses the extent of the movements as they are performed and stops them as soon as the desired amount of travel is accomplished. Once the tape carrying the control instructions (the programme) has been prepared, no further adjustment of machine travel is required.

Without NC, 80 per cent to 95 per cent of the time it takes to produce a finished item is waiting time—time spent in handling workpieces, in changing from one machine to another, or in changing over from one process to another on the same machine. But with NC it is possible to make changeovers simply by changing the tape. Numerical control can therefore eliminate most of the waiting time and greatly increase both production and efficiency.

There are other advantages of NC that make it attractive to the developing countries:

- Reduction of setting-up time
- Elimination of jigs and fixtures
- Uniformity of product—fewer rejections, lower scrap loss
- Fewer inspection requirements
- Reduction of human error
- Smaller inventories
- Less need for highly-skilled machinists

Inventories are smaller partly because economic production is possible on a smaller scale with NC, which indeed was originally developed for small- and medium-scale production. Mass-production processes had already been automated with transfer machines and special machines designed to make just one part.

The last advantage on the list above is tempered by the new requirement for electronic technicians to maintain the control units and for programmers to prepare the tapes.

### THE PROGRAMMING PROBLEM

Programming is the means by which a person can talk to a machine and tell it what to do. In simple machining operations, the "language" in which these instructions are given is a code based on patterns of holes punched in cards or tape, and the programme is merely a sequence of these patterns produced by the programmer himself on a machine furnished with a typewriter-like keyboard.

In more complicated cases this manual method becomes too difficult and time-consuming, and a computer is used to transform a language intelligible to the programmer into the hole patterns that the NC unit "understands". But this introduces other difficulties, for the computer, which is itself a machine, functions in yet another language.



A step-by-step description of the process will help make this clear:

1. The programmer describes, on paper, the different phases of the machining operation using a symbolic language such as APT (an acronym for Automatically Programmed Tools, a programming system developed for contour milling with several axes).
2. The APT programme is encoded on cards or tape and fed into the computer, where it is translated by a **processor** into machine language.
3. The result is a general machine programme which must be further translated by a **post-processor** into the language understood by the particular machine tool on which the operations are to be performed.
4. The instructions for the machine tool are punched on paper tape or recorded on magnetic tape.

Since APT was designed to accommodate the most complex programmes possible, a large, expensive computer is required. Moreover, the system is too complicated to use for programming the simpler operations. New languages are therefore being developed in most of the principal industrialized countries to meet the needs of the average user. This has led, unfortunately, to a veritable Babel of programming languages. Developing countries would be well-advised to wait for the development of an internationally standardized language and use only manual programming for the time being.

## TWO TYPES OF NC

A clear distinction should be drawn between contouring control and the point-to-point system.

Continuous-path, or contouring control, is a costly and complex system, which presently concerns only a small sector of industry; indeed, it is designed for industries that are in the forefront of development, such as the aerospace industry.

The point-to-point system, much simpler and considerably lower in cost, meets 80 per cent of the needs of industry. In the initial stage of development, all effort should be concentrated on this type of control. Furthermore, the use of the point-to-point system of NC does not necessarily require the use of electronic computers; manual programming is quite sufficient for parts that require simple machining operations such as drilling, tapping, straight-line milling and plain turning, so long as the number of instruction blocks on the punched tape is not unreasonable.

## INTRODUCING NC

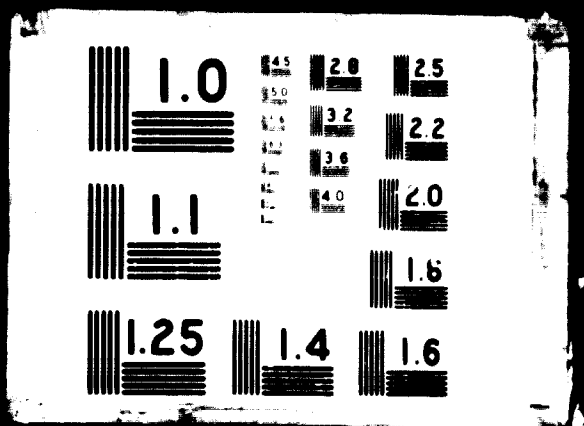
There are many difficulties involved in the introduction of NC into any company, but with determination these can be overcome and the rich rewards that come with this system of control can be realized.



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2 OF 2

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To determine whether numerical control will benefit any particular factory, a detailed review of its production requirements must be made. The review must cover component design, methods of manufacture, batch sizes and frequency of design changes. In the case of established parts the value of the existing jigs and fixtures will also have to be considered. When this information has been collected it will be possible to decide on the types of numerically controlled machines that will be suitable and finally to work out the economics of the operation. The design flexibility that results from shorter manufacturing cycles, the increase in accuracy and reliability and the reduction of inventories—these are advantages of NC that should not be neglected in the analysis.

#### DEMONSTRATION CENTRES

There is no substitute for first-hand experience with NC. To gain such experience, the Governments in some countries have acquired numerically controlled machines and loaned them to users. Other countries have set up demonstration centres where the machines can be used to produce items from the production programmes of many potential customers. A demonstration centre has the advantage that the machines can be operated under carefully controlled conditions and the information obtained from the manufacture of many items readily circulated throughout the industry. Programmers and service staff can be trained at the centre, and the production engineer from a company considering numerically controlled machines can learn about potential problems with them.

#### CO-OPERATION BETWEEN THE INDUSTRIALIZED AND THE DEVELOPING COUNTRIES

Opportunities for co-operation between the industrialized countries and the developing countries exist, particularly in the area of selection and utilization of machine tools. For example, CECIMO has offered special assistance to the developing countries of Europe and the Middle East. Since CECIMO represents the machine-tool industry of 13 Western European countries, it is in a unique position to help generally, by providing literature covering all the commonly used types of machine tools, or specifically, by requesting advice on particular tools from member companies.

One of the most effective ways in which a production engineer can broaden his knowledge of manufacturing methods and bring himself up to date with the latest techniques is to attend a major machine-tool exhibition. In Europe these are held every two years under the auspices of CECIMO, which is prepared to arrange special programmes for visitors from the developing countries to ensure that they gain the maximum benefit from the time available.

Numerical control can offer many advantages, but mistakes in utilizing it are extremely costly. Companies considering numerical control usually benefit from taking part in a discussion group led by an experienced numerical control engineer, studying cases where numerical control can be successfully applied and where it is unlikely to be economically justifiable. Before numerical control can be used successfully programmers and other specialists must be trained. The industrialized countries are in the best position to supply the expert instructors for this work, since they have had many years of experience with this equipment.

CECIMO has assured UNIDO that it will co-operate in every possible way in UNIDO's programmes of assistance to the developing countries by providing machine-tool experts, training engineers from developing countries under scholarship schemes, giving advice on selection, application and utilization of machine tools and assisting with UNIDO seminars or other training programmes.

#### A PROGRAMME FOR ACTION

The following suggested programme of action for the developing countries of this region is based on the practical experience of one of the countries reporting to the Seminar.

1. **Initial action**      Contact the organization in the industrialized country with whom co-operation is desired.  
Sign an *outline agreement*.
2. **Market research**    Obtain specialists from the industrialized country to make detailed market studies in the developing country, with a special stress on:
  - Stage of industrialization
  - Demand for machine tools by types and number
  - Payment capability of the home market and of permanent machine-tool imports
  - Labour availability, qualifications, wages
  - Availability of raw materials and semi-finished products
  - Analysis of expected production costs
3. **Forecast**            Work out a detailed *forecast* for the future including effects of trends that may influence the machine-tool industry in the next 10 to 20 years.
4. **Programming**      Review production or assembly of machine tools, with special consideration of:
  - Types and sizes demanded by the market in greatest volume

- Degree of technological difficulty  
Alternative methods  
Specialization of factories
5. Subsequent action      Sign the *co-operation agreement* and associated contracts.
- Depending on whether the production will be in a new plant or in an existing one, each of the following actions would differ substantially in scope.
6. Production planning      Establish technological processes, make jigs and fixtures and put the workshop into operation, with considerable assistance from the industrialized partner.
7. Start of production      Commence production under supervision of the industrialized partner. Gradually include local components, depending on the rate of product development.
8. Initial training of personnel      Training of technicians in the industrialized country, as well as at home, by instructors from the industrialized country.
9. Subsequent training      Organize a *training system* to provide new engineers and technicians.  
Establish *training centres* in the principal factories, controlled initially by specialists from the industrialized country, covering:
- Training workshops
  - Laboratories
  - Production planning
  - Design of jigs and fixtures
  - Design of machine tools
- Provide for *scholarships* in the industrialized country; these should stipulate that the student return and take a job at home.
10. Sales      Organize a *joint sales organization* for the markets in which the developing country will be active.  
Gradually replace machine tools from the industrialized country by those manufactured in the developing country.
11. After-sales service      Organize a joint *after-sales service* for machine tools delivered.  
Train servicing staff  
Organize spare parts supply  
Organize a consulting service to advise users as to proper utilization of the machine tools

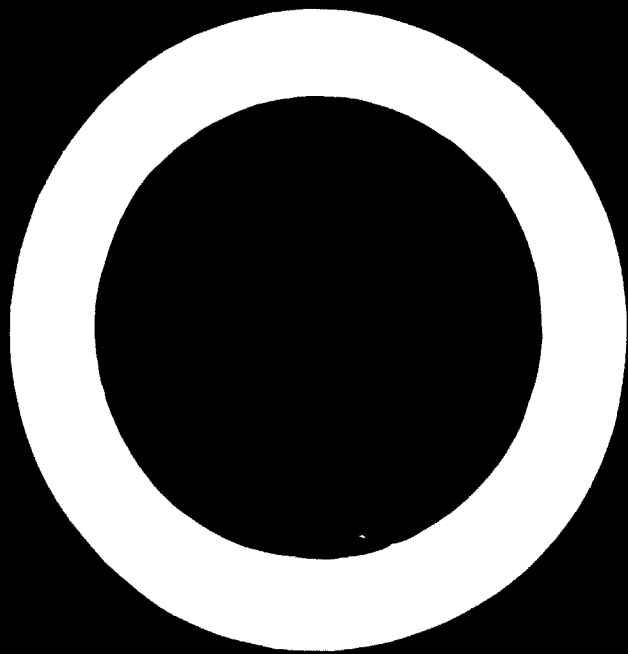
*Part III*

**SUMMARIES OF COUNTRY REPORTS**









## BULGARIA

### ENGINEERING INDUSTRY

Before 1944 the Bulgarian economy was primarily agricultural. In that year, signs of industrial development could be seen, but it was not until 1949 that the metalworking machine-tool industry burgeoned. In 1970 total industrial output reached \$7,176 million, 36 times greater than it was in 1939. The production of all types of machines in Bulgaria is increasing exceptionally fast. The total value of the machines produced in 1965 was \$594 million; in 1970 the figure rose to \$1,314 million and is expected to be \$2,812 million in 1975. There are 440 plants employing 250,000 engaged in machine production. The share of machines in the total trade turnover of the country jumped from 2.6 per cent in 1965 to 29.1 per cent in 1970 and should reach 45 per cent by 1975.

Radio electronics, telecommunication apparatus, material handling equipment and shipbuilding showed a particularly rapid rate of progress. Other sections of the machine-building industry that showed good progress were: computers, cars, trucks, tractors, electric hoists and engines.

### MACHINE-TOOL INDUSTRY

When Bulgarian industry was nationalized in 1949, the State Engineering Plant, with a machine-tool factory in Sofia, was established. A cutting-tool factory was established in Gabrovo, a press and forging-machine plant in Pleven and a woodworking-machine plant in Troyn. The initial production of these plants covered a range of simple general-purpose machines, including lathes, milling machines, drilling machines and shapers; the designs for these machines were obtained from other countries.

In 1954 the first machines of Bulgarian design were introduced. These had the usual advantages of indigenous design—they made the best use of local production technology. Against the background of greatly increased demand for machine tools, the industry expanded rapidly and the quality of its products improved greatly. Today there are 26 factories producing metalworking and woodworking machine tools, two research institutes and two technical institutes, with a total employment of 15,000. The industry manufactures boring machines, grinding machines, thread-cutting machines, programmed automatic turning machines, special-purpose machines and transfer lines, as well as a range of

general-purpose machine tools. The woodworking section also makes general-purpose and specialized machines for the building and the furniture trades.

To ensure that all the important castings are of top quality, a licence has been obtained from the Meehanite Corporation so that the castings can be manufactured according to the Meehanite formula and quality-control procedures.

To enable batch sizes to be increased, the latest designs employ the unit construction principle. Many of the machine tools in use within the industry have been supplied with special tooling and equipment such as hydraulic or electric chucks, hydraulic copying attachments, air-operated tailstocks, auxiliary turrets and other labour-saving devices. The use of these devices has resulted in an increase in productivity of 40 per cent on the average and in certain cases, 100 per cent.

The total industrial production is scheduled to increase 3.4 times between 1970 and 1975. Such a high rate of expansion can only be achieved if separate plants specialize in the production of particular components such as shafts, axles and gear wheels, using the latest methods of manufacture. The metal-working machine-tool industry will play a key role in this programme of expansion, since 60 per cent of the Bulgarian machine-tool consumption goes to the machine-building industry while the remaining 40 per cent meets the needs of all other sectors of industry, principally transport, agriculture and building.

Bulgaria currently exports 40 per cent of its total machine output to 60 other countries. The volume of exports is expected to double by 1975. A special state organization, Machinexport, in Sofia, is responsible for all the export business.

#### EDUCATION AND TRAINING

To meet the need for engineers and technicians to design and produce these increasingly sophisticated machine tools, the Machine Tool Corporation operates seven schools where qualified men undergo three years of training. The six or seven hundred graduates who leave these schools every year are assigned to plants where they are obligated to work for three more years. In addition to this programme, workers may also improve their skills by taking special courses, three or six months long, during which they receive their normal pay.

#### NUMERICAL CONTROL

Since 70 per cent of the total machine output consists of job and small-batch production, it is particularly appropriate that numerical control should be introduced as widely and quickly as possible; it is in just these areas that the greatest benefits can be reaped from numerical control. Most of the machines using numerical control will be equipped with a straight-line (point-to-point) system while some lathes and milling machines will be equipped with continuous-path systems to handle more complex operations.

## FUTURE DEVELOPMENT

Steady progress is being made in developing special machines, numerically controlled machines and computer control of production. Even more lies ahead, since the Tenth Congress of the Bulgarian Communist Party has instructed the industry to change from the production of single machines to the production of complete systems of machines, systems of appliances and automated equipment.

## EGYPT

## STATUS OF MACHINE TOOLS

Statistics show that in Egypt the demand for machine tools is increasing rapidly, especially for heavy general-purpose machine tools, various kinds and sizes of grinding machines, special-purpose machines and precision machines for the manufacture of cutting tools, jigs and fixtures. Although the volume of machine-tool imports does not correspond exactly to the volume of domestic demand, it reflects the general trend—imports have increased steadily from \$1.6 million in 1962 to \$3.5 million in 1970. The expected demand in 1975 is \$12.3 million; in 1980, \$15.7 million.

Production of machine tools began in 1964 and has increased rapidly, as shown in table 2.

TABLE 2. MACHINE-TOOL PRODUCTION IN EGYPT<sup>a</sup>  
(Thousand dollars)

Type	1964	1965	1966	1967	1968	1969	1970
Centre lathes .....	234	298	439	539	814	880	1,232
Bench drills .....	87	11	43	53	53	81	113
Pillar drills .....	—	82	60	118	147	118	143
Milling machines .....	—	—	—	—	33	—	98
Grinding machines .....	—	—	—	—	—	9	43
Shapers .....	—	—	—	—	31	130	112
Total .....	321	391	542	710	1,078	1,218	1,741

<sup>a</sup> Expected production in 1975, \$4.6 million; in 1970, \$7.0 million.

All the machines produced are being used locally in various industries. Part of the future production, however, will be exported starting from 1973. The plan calls for an export volume of about \$1.2 million after 1975.

### GOVERNMENT POLICY

The general policy of the Egyptian Government is that the machine-tool industry be included in the group of industries which receive first priority and that expansion should be carried out in parallel with the ancillary industries such as foundries and forges. The goal is to supply the machine-tool industry with more than 90 per cent of its requirements. Domestic production of machine tools should meet 60—70 per cent of the demand for general-purpose machine tools. Priorities in the production programmes should be based on domestic demand and on the production cost in comparison with world prices. It will be necessary also to take financial measures to favour the industry, especially in the first year of production.

### ANCILLARY INDUSTRIES

There exist ancillary industries in Egypt which supply all the requirements of the machine-tool industry for malleable iron, steel, sand and precision castings, forgings, non-ferrous parts, paints, plastic parts and various consumable materials. There are also industries that supply part of the requirements for ball-bearings, fasteners, standard and special cutting tools, jigs, fixtures, electric motors and components, and commercial sheet- and bar-stock. Eighty per cent of the items needed are now produced locally, and the remaining 20 per cent are imported.

### EDUCATION AND TRAINING

There is a special need to establish schools where large numbers of skilled workers, technicians and technologists can be trained to the required standards. Owing to the rapidly changing technology, there is also a need for retraining skilled workers and technicians who received their original training in earlier years.

### NUMERICAL CONTROL

It is expected that numerically controlled machines will be used in Egypt in increasing quantities. The problems that should be studied are: the high initial cost of NC machine tools; their application to batch rather than mass production; the training of personnel for operating them; the availability of adequate maintenance and repair facilities.

### CO-OPERATION WITH DEVELOPED COUNTRIES

When the plan for industrial development was being elaborated, it was decided that Egypt should ask a developed country to assist with the establishment of a machine-tool industry on a scientific basis; an agreement was subsequently reached with the USSR. The following points had to be considered:

## Economic aspects

Submitting technical and technological documents for the machine tools

Technical assistance by training Egyptian personnel abroad or by deputing experts

Delivery of machines and equipment to meet the annual production programme

## HUNGARY

## STATUS OF MACHINE TOOLS

Data on production, imports, exports and holdings of machine tools in Hungary are given in table 3. Most of the 115,000 machines presently in the country are of the general-purpose type, but the proportion of specialized types is increasing. Some 60 per cent of the machines were manufactured in Hungary and their average age corresponds to the international average except in the case of finishing machines, which have an average age of little more than six years.

TABLE 3. STATUS OF MACHINE TOOLS IN HUNGARY

Type	Year	Number of units			
		Produced	Imported	Exported	Available
Lathes .....	1960	2,729	989	1,453	20,411
	1970	3,395	390	1,720	24,237
	1980	3,000	500	1,600	25,000
Drilling machines .....	1960	3,054	303	1,001	15,790
	1970	4,128	145	1,095	23,631
	1980	3,900	150	1,000	30,000
Milling machines .....	1960	1,176	498	990	7,990
	1970	1,042	162	603	10,199
	1980	800	200	500	10,500
Grinding machines .....	1960	2,422	576	225	15,699
	1970	3,010	303	347	21,977
	1980	3,000	500	400	26,000
Presses .....	1960	1,059	391	207	11,381
	1970	981	155	11	12,439
	1980	900	100	60	12,500
Others .....	1960	1,798	341	594	13,817
	1970	6,914	152	783	22,349
	1980	10,100	300	1,300	30,000
Total .....	1960	12,238	3,098	4,470	85,088
	1970	19,470	1,307	4,559	114,832
	1980	21,700	1,750	4,860	134,000

## GOVERNMENT POLICY

In the interest of technological development, the State provides monetary incentives to the companies that install machine tools and equipment of advanced types and penalizes those that install or retain old machine tools that preserve outdated technology.

## MACHINE-TOOL INDUSTRY

Started in 1872 and well established by the end of the century, the Hungarian machine-tool industry now produces 20,000 units annually, an output that places Hungary 15th on the world list of countries that produce machine tools. Some 95 per cent of this total is produced by 11 factories, which are supported by seven more factories that produce ancillary equipment such as hydraulic units, tools and machine components.

An institute that provides centralized facilities for research, development and testing and for investigating technological problems of the machine-tool industry is attached to one of the largest of these organizations. A second institute is concerned with developing automatic electronic units and numerical control systems. In addition, the two technical universities and two of the technical high schools assist the machine-tool industry by undertaking specific research projects.

Seventy-five per cent of the machine tools produced are standard light- and medium-weight metal-cutting machines, and 10 per cent are metal-forming machines. The industry produces 145 types of machines, including lathes, milling machines, drilling machines, grinding machines and other cutting machines including midget modular units, spark-erosion machines, special-purpose machines, complete production lines and a wide range of metal-forming machines. In recent years, programmed and NC machines have also been added to the range, including programmed milling and turning machines, automatic universal cylindrical and internal grinding machines and numerically controlled turret lathes, high-precision boring lathes, chucking lathes, milling machines, jig borers and NC machining centres.

Fully automated production lines that can machine the bodies and end-covers of three million electric motors a year have been built, and there are plans to introduce NC systems for machining even more complex parts in quantity.

The proportion of high-accuracy and special-purpose machine tools is steadily increasing, especially in the export field. In addition, there is a steadily increasing international demand for machine tools intended for the production of specific parts. For these reasons, the number of machine tools produced in 1980 will not be greatly above the present level.

The varied requirements of their customers encourage the machine-tool manufacturers to widen the selection of machine tools, whereas economic factors dictate that the range of machines offered should be narrowed. To



facilitate production, considerable attention is given to the development of "families" of machine tools of similar types.

The industry is studying the most advanced methods for centralized and specialized production of groups of parts. The industry is also improving its electronic data-processing systems to ensure the optimum utilization of machine tools. Quality control in the factories ensures that the accuracy of the machines meets specification. The acceptance tests are carried out both statically and dynamically. In addition, machines are selected from the production line and subjected to endurance runs. The mounting and final inspection of the high-precision tools are done in air-conditioned shops. There are also air-conditioned rooms for high-precision measurements of parts.

The machine-tool industry helps its customers to get the best from their machines by offering technical advice, a wide range of accessories and, if necessary, machines already tooled-up for specific manufacturing operations.

#### MAINTENANCE AND REPAIR

Considerable importance is attached to adequate maintenance. In addition, the machine-tool industry rebuilds 6 per cent to 8 per cent of its machine tools annually according to a programme which pays particular attention to the most critical tools used at the plant. The manufacturers also rebuild for their customers. Since the demand for this work is increasing, a company has been established which rebuilds not only Hungarian but also foreign-made machines.

#### EDUCATION AND TRAINING

The machine-tool factories have regular apprentice programmes. In addition, vocational education is given in special secondary schools. Depending on their inclination and ability, young people from these schools become skilled workers or technicians. Classes are organized for adult unskilled and semi-skilled workers as well.

#### NUMERICAL CONTROL

In 1967 a model plant of NC machine tools was established in the Csepel Machine Tool Works, comprising five NC lathes, two NC mills, two NC boring machines and one NC drill. The aim of this model plant was to supply the Hungarian metalworking industry with workshop experience in NC techniques, to establish the methods of workshop and labour organization best fitted for NC and to provide a basis for the practical training of the specialists for complex automation.

Hungarian-built NC machines will be available shortly with either Hungarian or imported control systems. The production costs during the introduction of NC machines are higher than for conventional machines. The State therefore provides support to those enterprises establishing NC machine groups. This

support is available to those companies whose production range offers reasonable possibilities for the economic use of NC and who undertake continuous and planned operation of the NC machines requiring at least 5,000 hours' production time from each machine every year.

#### CO-OPERATION WITH DEVELOPED COUNTRIES

The Hungarian machine-tool industry recognizes that it is not practical for one country to develop all types of machine tools and has therefore bought licences to produce such machines as the Matrix thread-grinder, the Ratier-Forest numerically controlled milling machines and machining centres and the Zschokke edge-bending machine. It is intended to speed product development by buying more licences, and several machine-tool companies are co-operating successfully with important Western European companies. This traffic is not entirely one-way; Hungarian companies have sold licences to build some of their machines in Switzerland and Turkey and are negotiating with several companies in Latin America and Asia to sell them licences. Hungary is also ready to help other developing countries develop their machine-tool industries. There is successful co-operation between Hungary and other countries in the Council for Mutual Economic Assistance (CMEA) in many research and product development areas, some of the most important being the development of NC systems and their operating units, production systems and associated conveyor systems, computer-aided programming and design, tooling systems for NC machines, high accuracy grinders and turret lathes.

### IRAN

#### STATUS OF MACHINE TOOLS

The results of a recent census of machine tools are not available at this time. There are some data on imports, and these are presented in table 4.

TABLE 4. IMPORTS OF MACHINE TOOLS IN IRAN

<i>Type of machine</i>	<i>Number of units</i>				
	1965	1966	1967	1968	1969
Lathes .....	993	882	1,157	1,272	999
Drilling machines .....	279	444	752	604	230
Milling machines .....	13	10	21	35	44
Grinding machines .....	444	311	1,038	632	692
Presses (except hydraulic) .....	165	248	264	317	267
Total .....	1,894	1,895	3,232	2,860	2,232

On the basis of these figures it may be assumed that the total stock of machine tools in the country is about 30,000.

## THE ENGINEERING INDUSTRY

The Iranian engineering industry can be divided into three main groups:

- (a) Government-owned industry controlled through the Industrial Development and Renovation Organization of Iran (IDRO), which was established by an act of Parliament in 1967.
- (b) Large enterprises, most of which have been established in collaboration with a major foreign company specializing in the field concerned.
- (c) Small-scale shops employing relatively few operators, usually located in primitive areas—the so-called “bazaar industry”.

In the first group, IDRO controls four companies, each of which is about to start production. When these companies are fully operational, they will have a tremendous effect on the industrial life of Iran. They are:

*Tabriz Metallurgical and Engineering Plant, Inc. (Machine SAZI)*

This plant will manufacture machine tools, electric motors, pumps and small diesel engines.

*Iran Tractor Company, Tabriz*

Initially, this plant is scheduled to manufacture 5,000 tractors of 65 hp yearly. Ultimately, this will increase to 10,000 tractors per year.

*Arak Machine Building Plant, Inc.*

Constructed under Russian technical guidance, this plant is entirely equipped with Russian machinery and equipment. The company is scheduled to manufacture pressure vessels, conveyors, mine cars, bridges, package boilers, heat exchangers, equipment for the food and sugar industries, construction, earth-moving and road-making machinery and technological structures for petrochemical industries.

*Iran John Deere Company, Arak*

This company will manufacture the agricultural and industrial equipment designed by the John Deere Company of the United States. The operation will be principally one of assembly in the early stages but will ultimately take on a considerable volume of fabrications from the Arak Machine Building Plant.

The second group, the sector of private industry associated with foreign partners, includes such recently established companies as Mercedes Benz, Leyland, Dorman and S.K.F. There are also major assembly operations with limited local manufacture by companies such as Chrysler (Hillman) and American Motors (Rambler). Production of consumer durables, such as refrigerators and air conditioners, is also undertaken using imported compressors and electric motors but locally manufactured housings and other components.

A representative company of the third group, the bazaar industry, normally employs fewer than 10 people and may use only two or three machine tools. There are no reliable figures as to how many companies exist but there are

certainly several hundred, and the total number of machines in use is greater than in the very large new companies.

The development of the large companies will undoubtedly assist the development of the companies in this group, since the large companies will need to purchase items from local suppliers and will demand high quality.

### MACHINE-TOOL INDUSTRY

Since Machine SAZI is the only company scheduled to manufacture machine tools in Iran it is given special attention here. Brief details about it are given in table 5.

TABLE 5. INFORMATION ABOUT MACHINE SAZI IN IRAN

Grade	Divisions						Total
	Management	Financial	Commercial	Technical	Production	Personnel	
Technician . . . . .	53	16	42	103	124	35	373
Administrative worker . . . . .	11	50	41	19	16	17	154
Direct worker . .	—	—	—	—	948	—	948
Indirect worker.	84	—	115	338	245	69	851
Apprentice . . . .	—	—	—	—	—	238	238
<b>Total . . . . .</b>	<b>148</b>	<b>66</b>	<b>198</b>	<b>460</b>	<b>1,333</b>	<b>359</b>	<b>2,564</b>

Foundry capacity: 10,000 ton/yr

Total investment: \$23 million

Total number of machine tools installed: 600—includes 70 in Training School

Annual production:

Electric motors . . . . .	50,000 (1.1 to 10 kW)
Small pumps . . . . .	8,000
Small diesel engines . . . . .	(future product)
<b>Machine tools:</b>	
Lathes . . . . .	550
Drilling machines:	
Bench . . . . .	325
Column and radial . . . . .	175
Milling machines . . . . .	100
Grinding machines, double-ended floor-mounted . . . . .	1,000
Presses, eccentric . . . . .	350
Shaping machines . . . . .	160

The machine tools will be built by the company to proved designs of TOS of Czechoslovakia.

Procurement of materials and cutting tools is proving to be particularly difficult, especially if special steels are needed. Many small parts of the type that a manufacturer in an industrialized country can easily purchase from many local sources are also difficult to obtain.

## INDUSTRY PROTECTION

At present the following charges apply to imported machine tools:

	<i>Per cent</i>
Customs duty .....	10
Commercial profits .....	5
Bonus on export .....	1
Insurance .....	1
Bank charges .....	5
Transport to Djulfa .....	3
Other charges .....	2
Total .....	27

However, on purchases by government establishments, the first two items are omitted.

These rates may not provide the protection necessary to support the company until it has reached full productivity and efficiency and has become able to withstand a reasonable amount of foreign competition.

## MAINTENANCE AND REPAIR

As all the machinery in the recently established plants at Arak and Tabriz is new, the equipment should remain in excellent condition for many years provided the instructions from the suppliers are strictly followed. The other large engineering companies, because of their foreign connexions, are likely to be pursuing adequate maintenance programmes.

The difficulty exists with the small companies, where maintenance is likely to be of the most rudimentary kind and the condition of most machines is doubtful. In time, the educational programmes and development of the new large companies should be highly beneficial to the small ones. Thus, it is vitally important that the new organizations should tackle the requirements of machine and equipment maintenance on a fully scientific basis.

## EDUCATION AND TRAINING

At both Machine SAZI (Tabriz) and the Arak Machine Building Plant superb craft and technical training schools have been set up. There are places for 240 students at Tabriz and 400 at Arak. There are sections for training on each class of machine tool, on fitting and maintenance and on foundry and forging practice. The lecture rooms are equipped with all the appropriate models for the subject covered. Spending alternate days in workshops and on theoretical studies, a student will remain one or two years, depending on the class of work he will be expected to undertake.

University graduate students are considered to lack practical training and to have an excessively theoretical approach to problems. A suitable training programme that will integrate them into industry before they are allowed to undertake management responsibilities is therefore desirable.

The establishment of these training centres in the state-owned industries will ultimately benefit the private industries as well.

### *Market research*

Machine SAZI has a market research section that assessed the market before the types and models of machines to be manufactured were decided upon.

## IRAQ

### STATUS OF MACHINE TOOLS

Iraq is one of the developing countries that is not starting any machine-tool industry, in either the government or the private sector.

The principal metalworking industries and training centres in Iraq are:

	<i>Number of machine tools</i>
State Mechanical Industries Co., Iskandryia .....	697
State Electrical Industries Co. ....	169
Railway Workshops, Baghdad .....	204
Transport Administration Workshops .....	38
Training centre of National Oil Co. ....	52
Recently established technical and vocational schools—total of 11 schools .....	280
<b>Total .....</b>	<b>1,440</b>

The industrial statistical survey of 1968 showed that there were 1,435 industrial establishments, of which 226 are in the metalworking industry. On the assumption that each of these metalworking shops has three machine tools on the average, the total is 678 machines. If it is further assumed that the other industries have one machine tool each, the total is 1,209 machine tools. To this must be added estimates for machine tools in other training establishments, which brings the grand total to 3,367. A breakdown of this total and data on imports are given in table 6.

TABLE 6. STATUS OF MACHINE TOOLS IN IRAQ

Type	Year	Number of units	
		Imported	Available
Lathes .....	1960	111	1,871
	1970	233	
	1980	366	
Drilling machines .....	1960	21	352
	1970	44	
	1980	69	
Milling machines .....	1960	8	133
	1970	19	
	1980	27	
Grinding machines .....	1960	11	193
	1970	24	
	1980	38	
Presses .....	1960	24	405
	1970	50	
	1980	80	
Others .....	1960	25	413
	1970	50	
	1980	80	
Total .....	1960	200	3,367
	1970	420	
	1980	660	

#### ENGINEERING INDUSTRY

A major engineering plant employing 1,800 has been set up by the Government at Iskandryia. The machines were manufactured in 1961 but have been in use for only a short time; breakdowns occur frequently. A programme of preventive maintenance is now being introduced, and a supply of spare parts is being manufactured to meet anticipated requirements.

#### *The Electric Manufacturing Company*

This company, which has been operating for five years, is producing a considerable volume of small motors. There is, however, serious underutilization of plant because (a) the plant was designed to produce not only fractional horsepower motors but electric motors up to 50 hp, and (b) outdated methods of manufacture and unsuitable machines are being used in many operations.

### *Railway Workshops, Baghdad*

These workshops were established when the railway was first built, and with the exception of new shops for servicing diesel locomotives and carriages the premises and equipment are extremely antiquated. The newest machine tool at the present time is approximately 15 years old, whereas the majority range from 20 to 50 years old. However, a new installation for wheel turning is due to be introduced shortly that will be five times as productive as the present set-up.

In spite of these primitive conditions of work, the operators and supervisors are competent and take great pride in keeping their machines in the best possible condition. There is, however, no programme of preventive maintenance, and repair work is undertaken only when a machine actually fails.

### *Transport Administration Workshops*

The machine shop is comparatively small, since the majority of the work is carried out in the fitting shops, where vehicles are stripped down and rebuilt primarily using replacement parts from the original manufacturer. However, the shop does undertake the metal spraying and regrinding of crankshafts and reboring of engines, as well as the limited manufacture of parts which are not readily available from the equipment makers.

### *Small companies*

Driving down the main street of the engineering district of Baghdad, one can see several hundred machine tools in the open-fronted workshops. Most of these shops have only two, three or perhaps four machines, which are operated by the owner and his friends or family. Most of these machines are very old, but occasionally machines of less than ten years of age are to be seen. The craftsmanship in these shops is often of high order.

## MAINTENANCE AND REPAIR

Because of their age many of the machines at the railway workshops have become inefficient. In general, the class of work being undertaken would not justify the cost of new, modern machines—the need for a major rebuilding programme is indicated. Advice on the most suitable method of conducting a rebuilding programme to cover such a wide range of machines would be extremely helpful. Skilled operators for these machines, as well as skilled fitters for a rebuilding programme, are available, although undoubtedly guidance would be needed.

At both Iskandryia and the Electric Manufacturing Company, there is an urgent need to set up an effective preventive maintenance programme to avoid serious damage to the machines.



### EDUCATION AND TRAINING

There is one established training centre and two to be opened soon. The first is the Railway Institute, which has been in operation for five years and is equipped with about 40 modern machine tools. The emphasis at this centre is on practical work rather than theoretical studies, which occupy only a small part of the curriculum.

The oil company at Baghdad has established a modern training centre equipped with first-class machine shops and excellent lecture rooms with all necessary models provided. The centre is due to become operational in autumn 1971, and a number of Russian instructors will be attached to it.

The third centre is at Iskandryia, but the buildings for this centre are still under construction. The machine tools have been delivered already and are being stored at the main factory.

Eleven technical and vocational schools are being established, each of which will have 25 machine tools on the average. The International Labour Organisation is helping establish the training methods and curriculum.

### NUMERICAL CONTROL

The benefits which can be derived from the simpler types of numerically controlled machines, such as vertical drilling machines, are not yet fully appreciated in Iraq. Many components which could be cheaply and quickly machined on a numerically controlled drill are being produced laboriously and at enormous cost on jig-boring machines.

### FUTURE DEVELOPMENT

The problems at the two major state-owned industries are principally organizational and administrative. Since these plants represent the nucleus of Iraq's future engineering industry, every effort should be made to bring them into effective production. For this, the help of a small team of experts is urgently needed.

## ISRAEL

### STATUS OF MACHINE TOOLS

Table 7 shows that in spite of large increases in locally produced machine tools imports are also increasing rapidly.

TABLE 7. STATUS OF MACHINE TOOLS IN ISRAEL

Type	Year	Number of units				
		Produced	Imported	Exported	Available	Demand
Lathes .....	1960	...	150	...	6,000	150
	1970	150	700	...	12,000	850
	1980	1,000	2,500	500	35,000	3,000
Drilling machines .....	1960	10	550	...	1,800	560
	1970	150	1,450	...	3,000	1,600
	1980	3,000	7,000	1,500	15,000	8,500
Milling machines .....	1960	...	30	...	400	30
	1970	...	150	...	1,500	150
	1980	200	800	100	5,000	900
Grinding machines .....	1960	...	800	...	1,000	800
	1970	500	2,500	...	8,000	3,000
	1980	3,000	6,000	2,000	15,000	7,000
Presses .....	1960	40	200	...	1,000	240
	1970	300	200	...	2,500	400
	1980	1,500	800	800	15,000	1,500
Others .....	1960	300	2,000	...	2,000	2,300
	1970	1,000	5,000	600	18,000	5,400
	1980	7,000	10,000	3,000	100,000	14,000
Total .....	1960	350	3,730	...	12,200	4,080
	1970	2,100	10,000	600	45,000	11,400
	1980	15,700	27,100	7,900	185,000	34,900

TABLE 8. INDUSTRIAL CAPACITY AND EMPLOYMENT IN ISRAEL

Branches	Output Based on 1969 fixed prices (million dollars)				Average annual growth rate (per cent)		
	1955	1965	1970	1975	1955-65	1965-70	1970-75
	Total industry .....	280	855	1,438	2,410	12.1	10.8
Metal industries and electronics .....	43	209	420	856	16.9	15.1	15.4
Machine-tool industry ..	0.04	0.21	0.7	2.1	20.2	23.8	23.6
	Number of employees (thousand)						
Total industry .....	127	220	280	352	5.6	4.9	4.7
Metal industries and electronics .....	32.2	69.0	95.5	135.3	8.0	6.7	7.2
Machine-tool industry ..	0.03	0.07	0.150	0.360	8.5	15.3	20.0
	Output per employee (thousand dollars)						
Total industry .....	2.1	3.9	5.1	6.8	6.1	5.7	5.6
Metal industries and electronics .....	1.3	3.0	4.4	6.3	8.4	8.0	7.5
Machine-tool industry ..	1.2	3.1	4.8	6.0	9.2	9.1	5.5

## MACHINE-TOOL INDUSTRY

Table 8 indicates the extremely rapid rise in output and employment in the machine-tool industry compared with metal industries and industry as a whole.

To assist industry in maintaining and improving its efficiency during this rapid expansion, the Israel Institute of Productivity incorporates a body known as the Automation Institute of Israel. This body assists industry in the application of automatic control systems, developing "tailor-made" systems using standard components; in the introduction of numerical control; in the application of automatic process-control systems; and in the implementation of new concepts of advanced management techniques.

At present the machine-tool industry is manufacturing bench- and pillar-type drilling machines, two sizes of lathes under a know-how agreement with T. S. Harrison and Son Ltd. of England, bench- and pedestal-type grinding machines and tool-sharpening machines, eccentric presses from 4 to 40 tons and hydraulic presses, as well as presses to the design of the Bliss Company of America of up to 400 tons. Sheet-metalworking machines, in the form of guillotines, power-brake presses and plate-bending rolls are also manufactured. Recently, manufacture of a small electro-discharge machine (EDM) began.

Although production is organized on a modern technological basis, the small production runs tend to reduce efficiency. On the other hand, utilization and factory layout have been improved recently. Quality control is stringent, and maintenance is undertaken on a routine basis.

Following the government plan for the industry's development for 1970 to 1975, Israel will continue the present line of machine production. At the same time, new types with specifications carefully selected to fit the prevailing technological, social and educational situation will be introduced gradually.

Obviously, Israel will for a long time still import specialized and recently-developed machines, especially the heavy-duty types. Among these will be: turret lathes; single- and multi-automatics; universal, plain and vertical milling machines; ultrasonic, multispindle and radial-arm drilling machines; universal, cylindrical, surface and centreless grinding machines; numerically controlled machining centres; EDM and electro-chemical machines (ECM).

*Ancillary industries*

Notwithstanding the smallness of the machine-tool industry, Israel has made dynamic progress in the same short period in a number of ancillary industries:

*Foundries*

There are approximately 10 large and medium size grey-iron, steel and stainless-steel foundries and many small shops that supply all cast iron now needed for machine building. There is also a very important plant that specializes in malleable cast iron, steel castings and Meehanite castings.

*Forgings*

A large plant specializes in hot forging of all kinds.

*Electrical equipment and components*

There are several important producers of electric motors to supply all machine tool needs up to 750 hp and electromechanical and electronic devices for machine control.

*Tool industries*

There are 10 plants producing all kinds of tools. Turning and boring tools, milling cutters, end mills, twist drills, saw blades, grinding stones and a complete range of diamond tools. The cutting tools are produced from high-speed steel (HSS) or are carbide-tipped.

*Industry protection*

Since the early 1960s the period of protectionism that allowed the new industry to develop has gradually come to an end. The present policy of liberalization of imports is compelling manufacturers to find ways to improve quality and reduce prices.

## NUMERICAL CONTROL

First introduced in 1966, there are now about 45 NC machines in operation. A yearly growth of 10 to 15 units is anticipated. There is already a good team of qualified technicians to run and service this expensive equipment, and more teams are being trained.

## CO-OPERATION WITH DEVELOPED COUNTRIES

A number of technical "know-how" and manufacturing licensing agreements have been entered into with organizations in the developed countries. Israel is seeking more bilateral assistance agreements for the development of new lines of machine tools with agreed market rights.

## JORDAN

## STATUS OF MACHINE TOOLS

Since no statistics are available on the use of or demand for machine tools in Jordan, only a rough idea of the situation there can be given.

During the last few years, certain types of machines have been manufactured to meet the local demand. Efforts are now being made to improve the quality of these machines in order to compete effectively with similar imports in the local market.

## GOVERNMENT POLICY

In order to assist local industry to compete with foreign industries, the Government issued the laws entitled, "The Encouragement and Guidance of Industry" and "The Encouragement of Foreign Capital Investment".

In 1966 an industrial development bank was established in Jordan, the main task of which is to make loans to all new industries that undertake projects shown to be feasible.

Capital investments by the public and private sector, which were \$53 million in 1963, are expected to rise to \$118 million in 1970. As an inducement to invest, the Government guarantees to foreign capital all the privileges and exemptions granted under the law and promises not to diminish these privileges by subsequent legislation.

## ENGINEERING INDUSTRY

As in other small countries where local consumption is limited and road vehicles are the only means of transport for export, the concentration is on small-scale industry both for local consumption and for export to neighbouring countries.

The last 10 years have seen a rapid growth in economic development. The economic policy of the Government and the Seven-Year Plan have contributed to this rapid growth, which manifests itself in the increase and diversity of manufactured and semi-manufactured goods and in the gradual expansion of exports.

The promotion and diversification of manufactured goods have been enhanced in several ways, depending on the needs and requirements of the local market; for example:

- (a) Since Jordan is developing its tourist industry, much attention is being given to the traditional handicraft industry.
- (b) The increasing demand for houses was the main reason machine fabrication was begun in Jordan. Foundries were established to cast parts for stone crushers and tile-making machines.
- (c) Olive-oil presses and many kinds of pumps were manufactured to Italian design and modified later to suit local requirements.

The industry flourished very quickly, some firms, like Messrs. Khalifen Bros., soon being able to export their machinery to Iraq and Kuwait. Because of the wide demand for this type of machinery, the foundries were expanded; they are now able to make castings weighing up to five tons for the tile industry and for agriculture. Machinery is manufactured in Jordan for olive-oil presses which can work at 350 kg/cm<sup>2</sup>. Stone crushers and earth-moving dumpers are also produced in Jordan on a large scale. Centrifugal pumps coupled to electric motors or diesel engines are produced in more than one factory.

A firm called United Industries produces automobile batteries and sells them throughout the Middle East. This plant is equipped to produce all the parts required. Dry batteries are also completely produced in Jordan.

A complete range of sanitary fittings and pipes are produced for the local building industry and for export markets. Cast-iron manholes are produced to all specifications to meet the increasing demand for sewage works and treatment plants. The Industrial Company for Castings and Sanitary Fittings, the leading firm in this field, uses modern moulding machines and complete production lines for this purpose.

The progressive expansion of industrialization continues to be the Government's principal target. Statistics indicate that there were 5,867 industrial establishments operating in 1966, but since there is no indication of the size of these establishments, it should be assumed that they are principally small-scale operations with one to five employees.

## KUWAIT

### MACHINE-TOOL INDUSTRY

Five Kuwaiti Ministries are using machine tools on a fairly large scale:

- (a) The Ministry of Public Works started using machine tools in 1952, when a transport section was founded and a fleet of road machinery was imported, creating a need for machine tools for maintenance purposes. Now this ministry has many centre lathes of various sizes, milling machines, shaping machines, crankshaft grinders, cylinder boring machines and machines for overhauling diesel engines.
- (b) The Ministry of Education controls the technical college, which was founded in 1953 and has a substantial number of machine tools for training purposes. The graduates of this school are employed by various technical ministries.
- (c) The Ministry of Social Affairs manages an institute for training skilled labour in various trades, which offers an eighteen-month machine-tool course. The graduates are employed mostly by technical Ministries. This institute was founded by the Government of Kuwait and the International Labour Organisation. International experts teach the various trades with the aid of Kuwaiti instructors who have graduated from the same training institute.
- (d) The machine tools in the Department of Customs and Ports of the Ministry of Finance are particularly suited to marine maintenance. Their workshops have large-capacity lathes, shaping machines and large drilling machines, grinders, welding machines, etc. They also machine parts for cranes, trailers and transport engines.

- (e) The Ministry of Electricity and Water has the largest workshops in Kuwait and the Middle East. The main workshop at Shuwaikh was founded in 1953, mainly for the maintenance of the Ministry's first distillation plant and power station. More distillation plants and power stations are being constructed; accordingly, the main workshops will have to expand. There are now approximately 12,000 employees.

In the private sector, each local company is equipped with the machine tools it needs for its business, e.g. engine overhaul, aluminium industry, iron-mongery, marine workshops, sheet-metal workshops, steel furniture and wood-working machinery. Each company may also request the use of the machine tools at the main workshop of the Ministry of Electricity and Water.

Demand for die casting is increasing because it uses various scrap materials, expedites production of parts and saves at least 70 per cent of the labour costs and 50 per cent of the material wasted by turning processes.

A problem in Kuwait is that expensive shafts and crankshafts need rebuilding. These cannot be scrapped due to the high cost of replacement. If Kuwait had the know-how, it could purchase the machinery and rebuild these shafts.

For curing vibration troubles such as occur in electrical motors of 500 hp and over, there is a Hoffman balancing machine with a capacity of 10 tons, a length of 20 ft and a swing of 6 ft, purchased in 1958. False weights are used and corrections worked out through long calculations. Information is needed on an easier method, particularly one that will permit vibration analyses on location.

More knowledge and training is required in the field of precision internal and external grinding finishes.

#### MAINTENANCE AND REPAIR

Most of the machine tools were imported in the early 1950s and are due for rebuilding or replacement. The majority of these are of the general-purpose type and it would be logical to rebuild rather than replace them. It is therefore suggested that a rebuilding centre supervised by experienced foreign staff be established.

#### EDUCATION AND TRAINING

At first, most of the machine tools were operated by foreign technicians. Now, skilled workers, and technical assistants graduating from the technical college and the training centres are taking their place in industry, and more than half of the machine-tool operators and supervisors are local personnel. This training programme should be expanded and accelerated in order to meet the demand for skilled employees and to release the foreign artisans.

## PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

## BACKGROUND

Very little industry exists in the country other than a medium-sized oil refinery, and this alone accounts for more than 80 per cent of all industry. However, the recent Three-Year Plan lays great stress on industrial development. Nearly \$25 million, almost a quarter of the Government's capital investment in the plan, is to be allocated to the development of light industries. The plan includes the construction of 30 new factories, of which 25 are to be completed within three years from the date of commencement of the plan. These include factories for the manufacture of shoes, matches, cigarettes, plastic goods and cotton cloth, as well as a leather tannery, a tomato puree canning factory and a fish-meal factory.

## METALWORKING INDUSTRY

Workshops are operated by the Public Works Department, the Ministry of Agriculture and Agrarian Reform, the Ministry of Defence, the Port Trust, the refinery, the National Shipping Company Dockyards and several small private jobbing companies. There are no fully automatic, and only a few semi-automatic, machine tools in these shops.

*The Public Works workshops*

The Public Works garages and workshops look after the maintenance of more than 1,000 government vehicles and road-construction machines. The problems are formidable because funds, mechanics and parts are scarce. The arduous climatic conditions—high temperatures, high humidity, high salinity and frequent sandstorms—shorten the life of equipment. In addition, the terrain is very rough and the roads—or rather tracks—are very poor, putting considerable strain on the vehicles that use them.

The machine tools in these workshops are old manual types that are in many cases no longer sufficiently accurate and reliable. The largest lathe is an ordinary 16-in. × 72-in. centre lathe more than 10 years old. There are also a few smaller lathes, drilling machines, power saws, shapers etc., but no capstan lathes, crankshaft grinders, gear-cutting machines, planing machines or even a satisfactory milling machine.

The machine shop has no foundry attached to it. In fact, little casting is done anywhere in the country. There is one shop, however, that can handle castings of up to three tons for the benefit of ships stopping in Aden harbour that are in need of repair.

If the workshops could be improved it would be possible to produce the simpler spare parts locally. As a first step the Ministry has decided to expand the two main workshops at Khormakear and Mukalla. The facilities here are very limited at the moment, but it is expected that many additional machines



will have been acquired by the end of 1971. Khormakear will get a universal milling machine, a radial drilling machine, an upright fine-boring machine, a grinder, a heavy-duty bar-sawing machine and an open-front hydraulic press, with accessories. Though modest, this list actually signifies a considerable expansion of the workshops. At the same time, UNIDO has sent two experts to help improve the organization of the shops and the standard of maintenance in them. The Government has also arranged to obtain from the United Nations two mobile workshops and, through bilateral agreements, has contracted for more.

Further assistance is coming from the International Bank for Reconstruction and Development, which has agreed to allocate \$300,000 for the procurement of spares and equipment. The cost of training one machine-shop supervisor is also included.

The arrival of the machines mentioned should alleviate the problems faced at the moment. However, it will not solve them altogether—the Public Works Department will still be lacking experienced machinists and mechanics for the operation and maintenance of the machines.

## POLAND

### MACHINE-TOOL INDUSTRY

The Polish machine-tool industry is based on a tradition going back to the end of the 18th century, when the POREBA Factory was starting its production. This tradition and the dynamic development of the last 25 years has brought the industry to the 11th place in the world, as high as some industrialized countries.

The present yearly production is about 40,000 machine tools, and exports are made to over 50 countries in all geographical zones. Nearly 30 factories, the largest employing 3,000—4,000 workers, are manufacturing a wide range of general-purpose machine tools, as well as a number of special and specialized machine tools working in fully automatic cycles under programme and numerical control.

The machines produced include all sizes and types of lathes—including numerically controlled lathes, special heavy-duty lathes for railway wheel sets, boring and turning mills up to 10,000-mm turning diameter, all sizes of plano-millers, grinding machines of various types, horizontal boring and milling machines, pneumatic and steam-air die hammers, presses and spark-erosion machines.

In some lines, for instance in railway machine tools, or in heavy-duty plano-millers, Poland has reached the highest world standards and competes effectively with the best machine-tool firms in the United States and Japan.

The dynamic expansion of industry in recent years has compelled an increase in imports of specialized machine tools not being made in Poland. The idea is to equip the machine-tool factories with the most advanced machines made anywhere in order to improve the precision and quality of machine tools manufactured in Poland.

Ten Research and Technology Development Institutes and Design Bureaux have been established to work on problems connected with factory planning, machine-tool design, metal machining and production engineering.

#### CO-OPERATION WITH DEVELOPED COUNTRIES

Poland has found that co-operation with machine-tool manufacturers in other countries is an excellent way to speed up industrialization while indigenous designs are developed and to reduce foreign currency expenditures.

Many machines that would ordinarily be imported from particular suppliers are now being built locally to the suppliers' designs. At the same time, the necessity of increasing exports in specific markets has led to permanent collaboration with buyers and distributors of Polish machine tools. The machine tools are adapted to the local market needs, and sold through these companies as a joint product under a special trade mark. This sort of agreement is regarded as superior to the usual licensing agreement, which sometimes does not bring the expected benefits to the buyer of the licence, since the seller's interest ceases with payment of the royalty.

A suggested programme of action for use by developing countries, based on the Polish experience in this area, can be found in Part II.

## ROMANIA

### MACHINE-TOOL INDUSTRY

The range of machines now in production includes—vertical turning and boring mills, boring and milling machines, longitudinal portal milling machines, external and universal cylindrical grinding machines, centreless grinding machines, broaching machines, gear-cutting machines, turret lathes and vertical turret lathes, drilling machines, internal threading machines, planing machines, tool-room milling machines, pneumatic hammers, power presses, hydraulic presses up to 160 tons, sheet-metalworking machines, beading and rolling machines, steel forming machines and pipe-bending machines.

Licences have been obtained to manufacture boring and milling machines from Cerutti, Italy, vertical boring and turning mills from Morando, Italy, longitudinal portal milling machines from Köllman, Federal Republic of Ger-

many, internal grinding machines from Nova, Italy, ball grinding and filling machines from Giustina, Italy, and universal and external grinding machines from Fortuna, Federal Republic of Germany.

The production level was two times greater in 1970 than in 1965. There has been not only a quantitative growth due to the production diversification and the assimilation of new types of machine tools but also a qualitative growth in accuracy and quality.

#### NUMERICAL CONTROL

Numerical linear positioning and contour programme control will be introduced for some types of machines, e.g. centre lathes, turret lathes, vertical turning and boring lathes, milling machines and drilling machines.

#### CO-OPERATION WITH DEVELOPED COUNTRIES

Romania is interested in extending international co-operation activities for turret lathes, facing lathes, multi-spindle auto-lathes, production milling machines, jig-boring machines and machine-tool programme control.

#### FUTURE DEVELOPMENT

The first aim for the long term is to meet the internal requirements by a threefold expansion of the industry by 1975. This increase will be achieved by extending the specialization and organization of the factories, increasing the number of single-purpose machines derived from the same basic family and delivering some machine tools with special accessories and control equipment to meet special requirements of the customer.

This expansion will make more products available for the export market. Of the 130 types of machine tools produced in Romania, almost half are sent to more than 40 other countries in all regions of the world. The value of the exports is currently about 20 per cent of the total value of machine-tool production and is expected to reach 32-35 per cent within the next few years.

#### RESEARCH

The Machine Tool and Accessory Research and Design Institute was established in Bucharest to develop new types of machine tools and improve previously introduced machine tools. The Institute operates in close co-operation with the design offices of the machine-building factories, as well as with other specialized institutes.

In the research and design field Romania is also interested in co-operating with other countries in seeking standard methodologies for, and exchanging results and interpretations of, measurements in the following categories:

Dynamic stability and vibrations  
 Static rigidity  
 Thermal deformation  
 Noise  
 Positioning accuracy (for NC machine tools)  
 Kinematic accuracy (for gear-cutting machines)

There are also possibilities for an effective exchange of detailed information on problems in the design of NC machines, machining centres, machine systems and the control system itself.

## SAUDI ARABIA

### METALWORKING INDUSTRY

Reliable statistics for industrial activity in Saudi Arabia are not available. There are no laws compelling industrial establishments to inform the Government of their existence or to submit production and other data. And unless foreign capital is involved or the company wants exemption from customs duties on imports of equipment and raw materials, no licence is necessary for setting up any industrial enterprise. Hence the meagre statistics which are available have to be supplemented by assumptions based on personal experience.

In 1967, the Central Department of Statistics conducted a survey of all industrial establishments in 25 cities. The survey revealed a total of 9,173 manufacturing establishments, of which 45 per cent are in the metalworking industry. A breakdown of the metalworking industry figures shows that there were 3,308 establishments with fewer than 5 employees each, 216 with 5 to 9, and 98 with 10 or more. Total employment in the first category was 3,926.

The metalworking industries in Saudi Arabia started primarily as service industries, and now there are many small shops specializing in servicing automobiles, motor scooters and bicycles. On the manufacturing side, the products of the metalworking industries are primarily:

- Steel furniture, both sheet-metal and tubular
- Aluminium doors and windows made out of imported extrusions
- Venetian blinds and window awnings made from imported aluminium and steel strips
- Aluminium utensils, spun and pressed (but not cast)
- Rolling shutters
- Wrought-iron grilles for railings and fencing
- Desert coolers
- Non-ferrous and ferrous castings (limited number)

In some of the industries the quality of products is good. Designs are mostly copies of current European products. The shop-floor managers, the skilled workers and, to a certain extent, the non-skilled workers, are mostly expatriates who are paid high wages to induce them to come to work in Saudi Arabia. There is a tendency to use more labour-saving devices, and the degree of mechanization in almost all factories is fairly high relative to that of other developing countries. Automation, however, has not yet appeared. There is virtually no local supply of tools, jigs and fixtures. Heat-treatment facilities do not exist in the country. Mechanical, metallurgical and metallographic testing facilities are not available; neither are design facilities.

#### INDUSTRY PROTECTION

Imports are practically unrestricted; with no price protection, the local industries are hard-pressed by foreign competition, even though they are allowed to import their industrial plant, equipment and raw materials duty-free. It appears that for some time development will be restricted to maintenance and repair and to production of bulky items such as steel furniture, refrigerators and desert coolers, i.e., items on which foreign manufacturers cannot compete because of excess freight costs.

#### MAINTENANCE AND REPAIR

Almost all the metalworking industries are beset with problems of maintenance and repair. There are no commercial maintenance and repair shops to look after machine tools and other industrial machinery.

#### EDUCATION AND TRAINING

There is an acute shortage of skilled manpower and entrepreneurship. Most of the technicians and skilled workers are expatriates; unless local skill can develop quickly, labour costs will remain excessively high.

Training centres should be established in certain of the industrial areas. These centres should include courses in machine-tool servicing, maintenance and utilization.

#### FUTURE DEVELOPMENT

Table 9 shows the plan for expansion of what are thought to be the most viable present and future industries in Saudi Arabia.

TABLE 9. SUGGESTED FIVE-YEAR INDUSTRIAL EXPANSION PROGRAMME IN SAUDI ARABIA

Industry	Present number of companies	Employment	Planned capacity (tons)	Additional employment	Additional number of machine tools required
Metal doors and windows .....	4	56	400	125	31
Steel furniture .....	14	405	800	240	55
Aluminium utensils .....	4	123	500	50	26
Foundry .....	...	...	6,000	110	2
Trunks, safes and barrels .....	8	148	150	130	37
Maintenance and repair .....	29	470	—	125	100
Aluminium extrusion .....	0	0	1,500	90	5
Gas stoves .....	0	0	200	35	6
Enamelled ware .....	...	...	500	35	18
Wire netting .....	0	0	1,500	25	10
Air conditioners and refrigerators ...	0	0	6,000	75	38
Electric cable .....	0	0	120	10	7
			(units)		
Electric fans .....	0	0	10,000	12	9
Bicycles .....	0	0	12,000	23	31

## SYRIAN ARAB REPUBLIC

## ENGINEERING INDUSTRY

Statistics relating to the engineering industry are given in table 10. At present the most important users of machine tools are the Railway (60 machine tools), the Oil Field (20) and the Fertilizer (20) Maintenance Workshops.

TABLE 10. ENGINEERING INDUSTRY IN THE SYRIAN ARAB REPUBLIC  
Statistics of 1968–1969

Industry	Employment
Food and tobacco .....	32,000
Textiles, leather and clothing .....	42,000
Metalworking and equipment manufacture .....	8,000
Chemical, excluding petroleum .....	5,000
Transport workers .....	35,000
Manufacture and repair of electrical machinery .....	1,500
Manufacture and repair of transport equipment .....	4,200
<i>Motor vehicles registered in 1969: 54,087</i>	
<i>Number of firms in engineering industry:</i>	
50 firms employing 10–50 workers each and with 10–20 machine tools each. 3,000 firms employing 1–5 workers each. Only 10 per cent of these firms use machine tools.	

A large factory that has been built at Aleppo will be used initially for assembly of French-built Someca tractors. Ultimately, it will also manufacture certain of the components used in the tractor assembly and produce ironmongery for the building industry.

An electric motor factory just completed at Lattakia will produce 25,000 motors a year ranging from  $\frac{1}{4}$  hp to  $7\frac{1}{2}$  hp. Adjacent to this factory will be a foundry with a capacity of about 30,000 tons of ferrous and non-ferrous castings and a forge with a capacity of about 10,000 tons.

The Metal Construction Company (Katsrailia) located north of Damascus manufactures a wide range of stationary and mobile storage tanks.

The textile industry will establish factories at Damascus and Aleppo for the manufacture of spare parts for its textile machines.

### MACHINE-TOOL INDUSTRY

The Government is considering the establishment of a small machine-tool industry to produce a range of machines at the production levels shown in table 11. Because of the low demand, there is a question whether this would be economical now, although co-operation with a suitable foreign company may enable the economical manufacture of certain simple machines. It is important that this project should be self-contained and not combined with any other machinery manufacturing programme in which the standards may be

TABLE 11. PROPOSED MACHINE-TOOL MANUFACTURE IN  
THE SYRIAN ARAB REPUBLIC

<i>Annual production (No.)</i>	<i>Item</i>
<i>Phase 1</i>	
100	Sliding, surfacing and screw-cutting lathes
180	Bench drilling machines
120	Pillar drilling machines
80	Horizontal milling machines
120	Two-wheel grinding machines
80	Hacksaw machines
60	Woodworking bandsaws
<i>Phase 2</i>	
60	Dividing heads for milling machines
40	Universal grinding machines
50	Surface grinding machines
50	Shapers
80	Sharpening machines for tools and cutters
60	Universal woodworking machines
60	Woodplaners, bilateral

drastically different. The Craft Training Centre at Damascus may manufacture the drilling machines in order to provide its students with some useful production work.

#### MAINTENANCE AND REPAIR

Most of the machine tools in use are quite old and are located in extremely small workshops; hence the only maintenance they get is routine lubrication. Repairs are carried out when the machine actually breaks down and these are the minimum necessary to restore operation. The effectiveness of many of the machine tools could be greatly increased by rebuilding.

#### EDUCATION AND TRAINING

Technical education is extremely limited; but because of the nature of Syrian industry, so is the demand.

The need for improving the training of engineers has already been appreciated—a proposed in-plant training centre will help newly graduated engineers obtain practical experience and acquaint working engineers with modern industrial methods.

So that the importance of adequate machine-tool maintenance should become accepted in the larger engineering firms, it is recommended that this subject should also be included in the curriculum.

Craft training centres have been established at Damascus and Aleppo. Each has room for 300 students when operated on a single-shift basis. The well-equipped machine shop has engine lathes, electrical workshops and a small pattern shop and foundry.

#### RESEARCH

An Industrial Testing and Research Centre is being established in Damascus with UNIDO assistance. One of its tasks will be to adapt international acceptance standards for machine tools to local requirements.

## TURKEY

#### STATUS OF MACHINE TOOLS

Table 12 shows the machine-tool production and demand targets for future years.



TABLE 12. FUTURE SUPPLY AND DEMAND OF MACHINE TOOLS IN TURKEY

Type	Year	Number of units	
		Supply	Demand
Lathes .....	1970	380	800
	1972	1,100	1,100
	1975	1,500	1,500
	1980	1,800	1,800
Drilling machines .....	1970	350	1,800
	1972	750	2,200
	1975	1,800	2,500
	1980	3,500	3,500
Milling machines .....	1970	60	200
	1972	180	280
	1975	400	450
	1980	500	500
Planers .....	1970	30	250
	1972	120	310
	1975	400	400
	1980	550	550

It can be seen that the machine-tool manufacturers have enough capacity to meet Turkey's needs in a short time. Since these plants, which are situated in or around Ankara and Istanbul, are equipped with universal machine types, they can be directed to the production of other machine tools at short notice when the need arises.

Table 13 indicates the target for machine-tool production in terms of money.

TABLE 13. MACHINE-TOOL PRODUCTION TARGETS FOR TURKEY  
(Million dollars)

Type	1970	1971	1972	1977	1982
Lathes .....	1.65	1.83	2.33	3.83	5.0
Drilling machines .....	1.32	1.4	2.0	3.0	3.33
Milling machines .....	1.24	1.53	2.0	3.07	3.73
Grinding machines .....	0.37	0.5	0.67	1.53	2.27
Planers .....	0.33	0.47	0.6	1.27	2.17
Total .....	4.91	5.73	7.60	12.70	16.50

There are four companies specializing in machine-tool manufacture, three of which manufacture lathes only. Production from 1965 to 1970 was:

Universal lathes .....	1,000
Upright and portable drills .....	740
Milling machines .....	110
Planers .....	70

In addition to the machine tools currently being produced, the following types will be introduced in the next five years: turret lathes, radial drilling machines, multi-spindle drilling machines, knee- and bed-type milling machines and presses.

Approximately 65 per cent of the demand for machine tools is met through imports. In spite of the increase in domestic production no significant change in this ratio is yet noticeable.

In January 1970, when domestic production of centre lathes coincided with demand, importation of all sizes of centre lathes was prohibited in order to protect the domestic production. At present only automatic lathes and semi-automatic copying lathes may be imported under the investment quotas for lathes. Generally, duty is levied at a rate of 50 per cent to 70 per cent of the cost of the imported machine, except for those imported under investment quota licence.

Information on imports, from the annual bulletin of the Statistical Institute, is given in table 14.

TABLE 14. IMPORTS OF MACHINE TOOLS IN TURKEY

Type	Number of units			
	1960	1963	1966	1970
Lathes .....	230	960	1,654	1,161
Drilling machines .....	975	2,803	4,736	1,263
Milling machines .....	50	144	172	211
Grinding machines .....	930	1,774	2,798	1,945
Planers .....	33	137	398	337
Total .....	2,218	5,818	9,758	4,917

Until now, a regional trade agreement between Iran, Pakistan and Turkey has not affected the machine-tool trade; although a joint machine-tool project has been prepared it is not yet operative. Exports into other countries have been restricted under licensing agreements and because of heavy home demand; machine tools are not yet available for general export.

#### MACHINE-TOOL INDUSTRY

Some difficulties in production are being experienced, the principal reasons for which are deficiency of technical documentation, failure to apply the techniques of production and inspection and failure to make use of ancillary industries. The shortage of qualified workers leads to single-shift working, and labour turnover results in loss of workers just when they have acquired the necessary skills. Raw materials and semi-finished materials are not on hand at the right time, especially if these materials have to be imported.

The state industries report an acute shortage of design and manufacturing capacity for jigs, fixtures and dies. In a country that is rapidly developing its industrial capacity, it is essential that this field be adequately developed if product design is not to stagnate. There is considerable talent available among the younger artisans who have returned to Turkey after working for a few years in the Federal Republic of Germany. Since the jig, fixture and die manufacturing companies in most of the industrialized countries of the world are relatively small specialist firms, the problem should be capable of rapid solution if the existing talent and adequate capital for the specialized machinery can be brought together. The establishment of a UNIDO subcontracting exchange at Istanbul could play an important part in the development of this part of Turkey's machine-tool industry.

#### EDUCATION AND TRAINING

The Government considers that there is a serious shortage of technicians in industry and has prepared a plan under which secondary education will be provided in technical schools. Most of the students will be expected to go directly into industry on completion of their schooling.

Some concern has been felt about the introduction of graduates directly into industry from the universities. A pilot scheme is being organized at the MKE government factories with the assistance of UNIDO whereby the graduate will obtain experience in a wide range of production disciplines within the various factories.

The number of graduate engineers in the machine-tool industry is extremely small, apparently only five in the private sector. Obviously, more are needed if the industry is to continue expanding, even if it does not undertake design on its own account but continues to buy designs from abroad. It is imperative that the best modern technology be used, but this is likely only where the responsibility rests on a graduate engineer.

#### MARKET RESEARCH

The main effort of machine-tool manufacture in Turkey has been in building engine lathes. This policy has had the advantage that the current needs of the engineering industry for this type of machine could be fully met from local production. As the engineering industry of the country develops it will be necessary to increase the range of machines that are manufactured. If the national resources are not to be wasted through the manufacture of machines that are unlikely to be required at the present level in years ahead, a painstaking review of the anticipated requirements of the engineering industry is urgently needed.

Since the state and private industries are both supplying machines to be used throughout Turkish industry, it is most desirable that a liaison committee of representatives from every machine-tool manufacturing company be formed.

### RESEARCH AND DEVELOPMENT

The Government is of the opinion that at this time it is preferable to undertake manufacture of machine tools to the design of a foreign manufacturer under a licensing agreement. This arrangement certainly offers considerable advantages during the initial establishment of a machine-tool industry; however, there is no reason why some of the simpler machine tools cannot be designed locally. The Government is establishing a research organization that could form the nucleus for a machine-tool design team and will provide the necessary test facilities. Alternatively, the private machine-tool companies may consider setting up a communal design office, which would look to the government research department to undertake specific research or test projects on their behalf.

### NUMERICAL CONTROL

One of the major obstacles to the introduction of NC machines is the lack of personnel who can do the programming either manually or by computer. A centre where programme tapes can be prepared and training in programming can be given would be highly desirable.

### CO-OPERATION WITH DEVELOPED COUNTRIES

For foreign technical assistance, Turkey relies mainly on licensing agreements, such as those that have been made with Fritz-Werner of the Federal Republic of Germany, Strojimport of Czechoslovakia, Technoimpex of Hungary and Elliott of England.

## YEMEN

Since there are no studies on the availability of machine tools in Yemen, only a general idea of the machinery used in the country can be given.

The major users of machines are a textile factory built in Sana'a, a privately-owned biscuit and sweet factory located in Taiz and cement and tobacco factories still under construction near Hodeidah. There are also a privately-owned aluminium factory in Taiz, three soft-drink factories in Hodeidah, some small-scale factories for oil extraction and flour mills.

Various machine shops were established during the building of the network of roads connecting the major cities, Hodeidah, Sana'a and Taiz. These shops contain practically all the necessary machinery for road construction, vehicle repair and welding. There are also about 200 garages for the repair of motor

cars and trucks, and about 250 carpentry shops equipped with modern wood-working machines.

The National Currency Board has started statistical studies on the import of all machinery and tools, which has increased greatly since 1962. Unfortunately, many of the people presently using the available machines are self-trained, and the life-span of many of these machines is consequently short.

It will be a long time before Yemen becomes self-dependent enough for the production of even the smallest machine tool. The reasons for this are:

- (a) There is no capital to invest in such industries.
- (b) Yemen cannot supply enough qualified and trained engineers.
- (c) Yemen is still primarily an agricultural country, whose food production does not meet its own needs; it would be unwise to shift to industrial development before the agricultural sectors are more fully developed.

Technical assistance has been given mainly in the road projects mentioned above and by FAO in the field of agriculture. The building of the International Airport at Sana'a is being assisted by the Federal Republic of Germany.

## YUGOSLAVIA

### MACHINE-TOOL INDUSTRY

Manufacture of machine tools in Yugoslavia began in 1939, at a time when 75 per cent of the active population was engaged in agriculture. That year a number of small workshops produced 84 tons of simple machine tools.

After the end of the Second World War, the first Yugoslav Five-Year Plan provided for accelerated industrialization and particularly for the development of basic industry and machine building. The completion of this plan saw the construction of a machine-tool factory in Zagreb and a factory for building heavy machine tools near Belgrade. These factories started building machines of their own design, which in most cases were modified copies of existing machines. The rapid expansion of this industry led to a certain degree of duplication; the disadvantages of this situation were soon recognized and arrangements were made for the harmonization of production programmes.

Further development was limited by the design capability of the industry, but this limitation was overcome by obtaining licences from well-known machine-tool builders in the industrialized countries. The industry could then embark on the manufacture of a range of advanced designs to meet the requirements of the expanding engineering industry while continuing production of the well-established indigenous designs.

## PRODUCTION

A wide range of general-purpose machine tools are included in the production programmes, as well as various metal-forming and production-type machines.

Licences have been granted by Manurhin, Pittler, Niles, Morando, Batingolles, Wema, Fortuna-Werke, Fritz-Werner, Berco and some Czechoslovak manufacturers. Long-term co-operation agreements have been made with Renault for transfer machines, Waintarten for eccentric presses and Wotan for horizontal boring machines.

The machine-tool industry now employs more than 9,000 persons, production having trebled in the last decade (table 15).

TABLE 15. PRODUCTION OF MACHINE TOOLS IN YUGOSLAVIA  
(tons)

Year	Cutting tools	Forming tools	All tools
1960 .....	2,700	1,200	3,920
1961 .....	3,749	851	4,600
1962 .....	3,930	503	4,433
1963 .....	5,622	2,064	7,686
1964 .....	7,429	1,766	9,295
1965 .....	7,500	2,180	9,680
1966 .....	7,300	2,300	9,600
1967 .....	9,000	3,200	12,200

The first five years of the next decade will see annual production rising to 24,000 tons. The present consumption of machine tools in Yugoslavia is about 30,000 tons/year, so that even with this increase it will be necessary to continue importing a significant volume of machines.

## IMPORTS AND EXPORTS

Some 60 per cent of the machine-tool requirements are currently met by imports. Table 16 shows that the volume increased substantially during the first six months of 1971 compared with the same period in 1970. However, the increasing level of domestic production will permit a reduction in imports and an increase in exports.

The import duty on machine tools ranges between 31 per cent and 36 per cent, considerably higher than the average of  $7\frac{1}{2}$  per cent in Western Europe. This high level of duty has enabled the local industry to compete with the large, highly organized machine-tool builders in the industrialized countries.

TABLE 16. IMPORTS AND EXPORTS OF MACHINE TOOLS IN YUGOSLAVIA  
*First halves of 1970 and 1971*

	Year	Imports		Exports	
		(tons)	(thousand dollars)	(tons)	(thousand dollars)
Lathes .....	1970	344	1,180	938	1,510
	1971	913	4,140	804	1,530
Drilling machines .....	1970	349	1,090	35	57
	1971	339	1,030	53	76
Milling and planing machines ..	1970	449	1,410	409	830
	1971	1,160	1,910	470	1,400
Grinding machines .....	1970	275	1,095	132	324
	1971	599	3,150	171	378
Presses .....	1970	797	1,490	53	46
	1971	1,481	3,700	400	335
Others .....	1970	815	2,480	132	1,205
	1971	1,445	5,450	82	134
Total .....	1970	3,029	8,745	1,699	3,972
	1971	5,937	19,380	1,980	3,853

#### CO-OPERATION

Further development of co-operation arrangements in both domestic and foreign markets can be expected, since the Yugoslav law on co-operation provides ample possibilities for sale and export of machine-tool products. Foreign firms having co-operation arrangements with domestic firms may sell their products in western markets under the preferential tariffs of the European Economic Community. Collaboration with CMEA countries also provides many opportunities to increase co-operation and sales.

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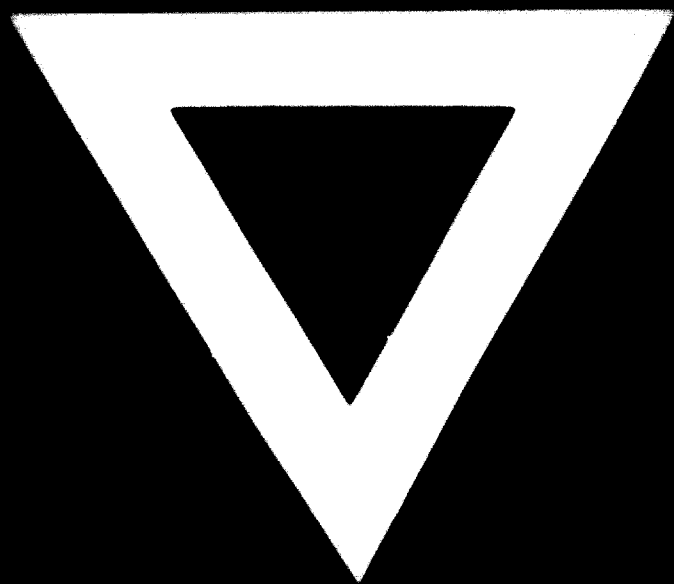
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