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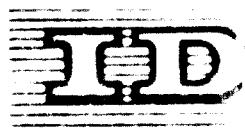
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United Nations Industrial Development Organization

Expert Group Meeting on the Development of
Design Capabilities in Developing Countries

Yemen, 14 - 17 May 1970

11-15

MANUFACTURE OF PROTOTYPES BY CENTRES 1/

by

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^{1/} The views and opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the secretariat of UNIDO.
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United Nations Industrial Development Organization

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Joint Meeting of the
Economic Commission for Europe
Development Planning
Vienna, 11-12 May 1961

SUMMARY

Joint Meeting of the
Economic Commission for Europe
Development Planning

by

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Swiss Federal Institute of Technology
Zürich, Switzerland

/ The views and opinions expressed in this paper are those of the authors
and do not necessarily reflect those of the Economic Commission for Europe.
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We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

The paper contains six chapters on various topics in relation with prototype production centres; the summary of the individual paragraphs is given below:

First chapter (Organization of prototype production centres)

The tasks and aims of the centre, its necessity and usefulness to the local industry in the developing country. Further it deals with the problems of production, selection of prototypes and cost calculation. The end of the first chapter contains a proposition for a step-wise development of the centres activity during the first years.

Second chapter (Staff organization and proposals)

The required staff for the centre, minimum qualifications and selection methods; salaries of technical staff in comparison with the wages paid by the private industry. Responsibility and competence of UN-experts. Professional training of the technical staff and possibilities of promotions within the organization.

Third chapter (Co-operation with industry)

The importance of co-operation and good relations with the local industry. Making available the centres technical equipment, the industry tasks, and accepting production jobs. Advices to the manufacturers regarding planning of factory layouts; Production-problems, assembly lines and inspection, licence manufacturing and financial assistance.

Fourth chapter (Quality control)

An additional useful activity of the centre would be the quality control of locally produced articles; especially items being developed at the Design centres and manufactured later on by the local industry. A proposal on quality indices and quality control amongst manufacturers and customers.

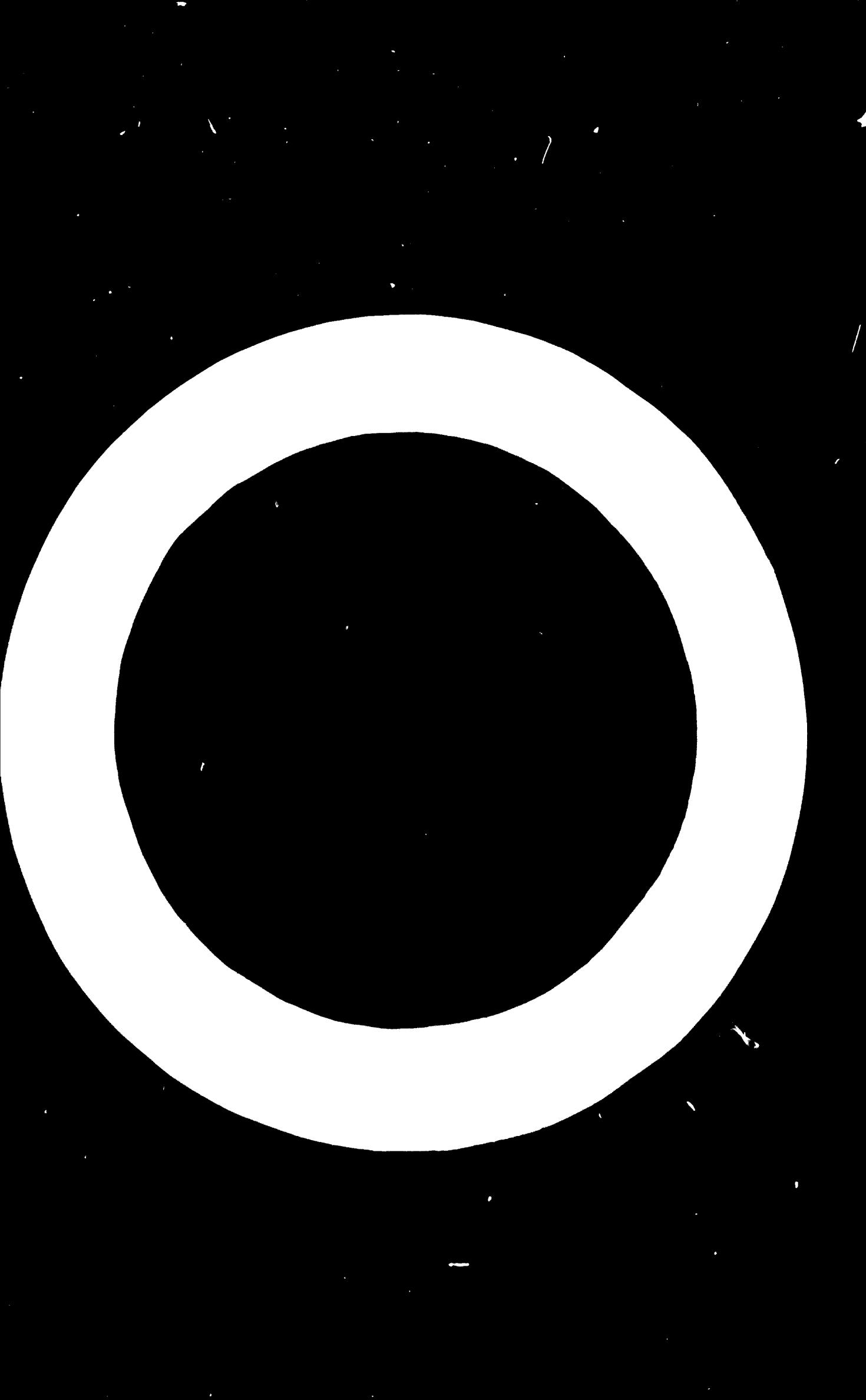
Fifth chapter (Design section)

The importance of practical workshop training and experience for the staff of the Design office; possibilities of such training at the prototype production centre.

Sixth chapter (Prototype production centre in the field of Precision Mechanics and Instrumentation.)

Possible collaboration of a Design centre with a Training centre in the field of precision mechanics and instrumentation; the centre could in addition to its educational activity be in charge of the development of prototypes.

Recommendations for the required buildings, selection and training of personnel, fellowships for special training abroad and a list of the technical equipment of "Praktika" centre for precision mechanics normality classes.



**PRODUCTION OF PROTOTYPES BY CENTRES AND THEIR INTRODUCTION
IN VARIOUS BRANCHES OF INDUSTRY IN THE DEVELOPING COUNTRIES.**

1. ORGANIZATION OF PROTOTYPE PRODUCTION CENTRES.

- 1.1. Tasks assigned.
- 1.2. Selection of prototypes to be developed.
- 1.3. Production.
- 1.4. Cost calculations.
- 1.5. Progress reports.
- 1.6. Tentative programme for the development of the centre.

2. STAFF ORGANIZATION AND PROPOSALS.

- 2.1. Qualifications for employment.
- 2.2. Salaries.
- 2.3. Promotions.
- 2.4. Competence of experts.
- 2.5. Training of personnel.

3. CO-OPERATION WITH INDUSTRY.

- 3.1. Advice to industry for new production.
- 3.2. Contacts with big, medium and small-scale industry.
- 3.3. License manufacturing.
- 3.4. Financial assistance.

4. QUALITY CONTROL.

- 4.1. Quality testing at the centre.
- 4.2. Tertiary relations for quality control.

5. DESIGN SECTION.

- 5.1. Practical knowledge and training of design engineers and draughtsmen.

**6. PROTOTYPE PRODUCTION CENTRE IN THE FIELD OF:
PRECISION MECHANICS AND INSTRUMENTATION.**

- 6.1. Collaboration of prototype centres with established precision mechanics companies.
- 6.2. Design section.
- 6.3. Production.
- 6.4. Selection, training and specialization of personnel.
- 6.5. Fellowship, visit, training abroad.
- 6.6. Standardization.
- 6.7. Drawing.
- 6.8. Measurement and equipment.
- 6.9. Quality management.
- 6.10. Cost of manufacture.

1. ORGANIZATION OF PROTOTYPE PRODUCTION CENTRES.

1.1. Tasks and aims:

The necessity of fostering the design possibilities and prototype production in developing countries is self evident and will not be contested by persons concerned with the problem of technical development. This activity should even receive priority in industrial aid as many firms will not be able to progress sufficiently if they cannot be provided with the required designs. The output of these firms will remain small and uneconomical and their capacity in form of labour and equipment will not be used to its best advantage. They are condemned to remain copiers, or assemblers of imported components and will never be able to profit from the rapid development of new techniques and the application of new materials.

In most of the countries in question, manpower is available in abundance, but usually its training and proper utilization is inadequate. The local manufacturers should be encouraged to produce items involving a relatively large proportion of labour, instead of importing mainly prefabricated parts; this would at the same time help to save foreign exchange.

To determine the centre's activity, a thorough investigation of the local industry, meetings with industry associations and with the Ministry of Planning and Development are necessary to find out the most urgent and efficient contribution to the future industrial development of the country. Close collaboration between the centre and the industry is absolutely essential; a design and prototype production centre could never be successful acting alone.

In most of the developing countries the feeling for quality is badly lacking. Institutions for quality-control and standardization are either missing or ineffective. These two additional activities could be other useful tasks of engineering centres.

There are mainly two possibilities in running an engineering design centre, which should include the production of prototypes as well as certain gadgets, tools and gauges required for the manufacturing process.

- a) A complete independent centre, incorporating all necessary divisions and offices, such as design office, sections for market studies, documentation, patents, material, standardization, reproduction, laboratory and experiments, packing and transportation, and a workshop for the production of prototypes, with its various sections.

Such a centre would have the advantage of being run under one and the same management, with the attached production workshop entirely at its disposal. It would, however, mean the purchase of very expensive machinery, which could hardly be utilized fully. At the same time it would be difficult to find, or to train, the required operators and specialists for the prototype production.

b) The second possibility would be a centre working in close collaboration with a training centre, for instance for instrument mechanics. Such a centre would have the necessary facilities to produce prototypes in the mechanical, electrical, electronic and optical fields. (More details about the possibility of collaborating in the chapters 6.1. to 6.10).

1.2. Selection of prototypes:

In order to achieve a maximum contribution to the economic development of the industry and the production in the country, the selection of the prototypes to be produced is most important. The danger of developing "attractive" prototypes, without guarantee that the industry is really in a position to manufacture them, and perhaps even without a sufficient market and demand for them in the country, should by all means be avoided. The selection for the development of new engineering designs and the manufacturing of the corresponding prototypes depends mainly upon two factors:

- a) a very good knowledge of the existing industrial facilities, and
- b) the results of the latest market survey.

Very often, due to national or personal ambitions, the most advanced engineering items are being produced in developing countries, whereas simple yet very useful articles for day-to-day and domestic use are completely neglected. Articles used in households, offices, schools, etc., like electric switches, door locks, latches for steel-framed windows, handtools etc. are often of inferior quality, and no one cares to improve them. Therefore, we are of the opinion that the improvement of perhaps less attractive, but more useful articles should, at the beginning, be one of the centre's activities. It would be a better contribution and technical assistance than some sophisticated equipment which would benefit only a small minority.

The possibilities for exportation should not be a prime target for the selection of a prototype; in the first instance, there should be a reasonably promising market in the country itself.

A very useful field of the centre's activity would be the development of demonstration instruments and equipment for educational purposes; these items are often badly needed for the different teaching subjects such as: physics, mechanical and electrical engineering at various levels of education, up to engineering colleges and universities.

The proper way of selecting a new engineering design would be to get in touch with the enterprise which is interested in manufacturing a new article after careful study of the consumer market. The centre could then develop the design permitting the entire production in the country itself. At the same time, it would guarantee that one or various enterprises would be ready to take up its production. The development of a new engineering design, including the production of its prototype, without an immediate subsequent production by the local industry would not only be disappointing, but also very bad for the reputation of the centre's activity.

Especially at the beginning the designs selected and their prototypes should aim rather at improving existing articles already produced in the country.

There are tremendous possibilities in improving the designs, not only to facilitate the manufacturing process, but also to improve the functional, practical, and even in certain cases the aesthetic aspects of certain items.

Since the decision for the selection of new designs and development of prototypes is really of great importance, it is suggested to appoint an expert, especially for industrial public relations and market survey, to supply the centre with the necessary information about the most useful and essential projects. This public relations expert should be a personage well familiar with the industrial conditions of the country and able to hold meetings on government level whenever required. This expert could at the same time be the assistant of the project manager and replace him in case of his absence.

1.3. Production.

a) Production of prototypes:

The prototype production workshop should in all aspects be a model and a good example to the developing industry of the country. The equipment should be so selected that practically all jobs of the centre's various activities could be carried out in the production workshop itself.

The raw materials supply should include moderate quantities of all required locally available and imported items for the production of prototypes and the manufacturing of engineering items for the industry or other customers. As a rule, the development of prototypes in the production workshop should include the total manufacturing process for industrial production, including all the required jigs and fixtures, press tools and control gauges for production, assembly and inspection.

c). Production of other items

During official meetings on government and management levels, details of production problems and difficulties on workshop levels are usually not discussed - for lack of knowledge, national pride or personal prestige. In order to become familiar with the actual industrial problems of the country, the only way is to collaborate with the manufacturers.

The well-equipped production centre may not be fully occupied all the time with the manufacturing and development of its own prototypes. The centre is likely to possess certain costly production and testing equipment which the local industry badly lacks. In brief, spare capacity in development projects must be offered to industry. This can create some of the much needed "good-will" and help to lay a basis of confidence between industry of the private sector and the sometimes isolated projects. This activity furthermore gives the staff of the centre an excellent opportunity to become experts in the various machine tools and in workshop equipment.

A survey of the production industry will in most of the developing countries reveal that there is no adequate tool-making industry that could serve as a basis of profitable high-class production. Trained personnel to man such workshops are rare and the precision machinery required very expensive.

Improving the production potential therefore begins with the creation of facilities for tool-making. One possible way could be the introduction of common facilities centres, or co-operatives, where the producers, who at the same time and at prices much below those of imported ones. A few such centres in industrialized cities of the country could improve the situation to a great extent.

These common facilities centres could also form part of the proposed prototype production centres, and at the same time train personnel required by the industries for their own tool-making sections. These common facilities could be expanded by the addition of auxiliary services for heat and surface treatment, etc. A modest start of such a centre has been made in Argentina (Buenos Aires) with the assistance of the Ford Foundation. The manufacturing country had interest, and the demand target was very low.

In order to make possible the manufacture of items in the most economic way, for reasons of prices and acceptable quality, a chain of such auxiliary facilities, in the form of feeder plants, should be developed. In most of the developing countries local industry does not yet manufacture and supply "standard-parts" of good quality, such as screws, nuts and washers, rivets, pins, springs, handles, hand-wheels, plugs, etc. The producer of this industry, for instance, is forced to manufacture these standard elements and other parts himself in small quantities, resulting in high costs of the finished article. Without developing such a supporting industry, with various specialised activities in limited fields, the producers will never be able to compete with goods coming from highly industrialized countries.

The plastics industry also forms a very important part of the feeder industry; the reason why the plastic industry for precision parts is lagging in many of the developing countries is again related to the lack of tool-making possibilities and trained manpower.

One experiences similar difficulties with the supply of packing material and packing in general for finished goods. Without going into further details, it has to be mentioned that the problems of packing and transportation should get more attention in developing countries.

c). Service for repairs and maintenance

For the above mentioned reasons the centre should also offer service and repair facilities to private and government industries and institutions like hospitals, universities and research centres. In addition to a very great help to all these organisations such repairs, when properly handled, can have an excellent training value for the workshop staff and for designers too. Comparing the advantages and disadvantages of various products and finding out their defects, they should be able to avoid certain mistakes others have made earlier.

Local Calculations

Afterwards, the local calculations should be made and presented to the concerned organization for examination. It is important to have the local calculations made by the local experts, as they will be more familiar with the local conditions and the local market. The cost of labor, for instance, as it is locally constantly changing, is important. One cannot be too particular about a new project, particularly the local industry, with successful experience, and will be encouraged, whereas a bad calculation could lead to a big loss and frustration to the entrepreneur.

International Project

A well-planned and well-staffed agency should be able to work as efficiently as a private concern. The programme for the next 12 months should be known and the work distributed among various experts in the particular fields. There is a tendency to set up unrealistic targets for the following year for projects, and any experts will not be able to reach them in spite of the fact that they have established the schedules themselves. It is clear that an adviser cannot be expected to follow up progress as he would wish, but this is no good excuse for which it is strongly recommended that experts on such projects have full executive powers, at least during the initial stage. This would allow the agencies to question the progress of a project and the experts could be held responsible to meet the schedules. The progress reports will then be automatically realistic, and not merely a self-feeding excuse full of explanations why the work could not be accomplished as scheduled within a certain period.

International organizations should adopt a harder line in this respect.

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1. Application of physical sciences to the solution of practical problems, particularly those of engineering, technology, management, planning, production, design, construction, and maintenance of equipment.
 2. Research in basic, applied, experimental, and developmental areas of mechanical engineering.
 3. Precision engineering, automation, mechatronics.
 4. Electrical engineering, and optics.
 5. Electronics.

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2.2. Salaries:

One of the major problems for the development of the centre and its success after handing-over to the partner organisation is the stability of its staff. Frequent changes of well-trained personnel may rule continuous progressive activity tremendously. Especially in a centre with a good reputation employees often get attractive offers from industries that will try without facilitation to lure away poorly paid but qualified staff. In order to reduce this "exodus", the salaries of well-qualified and very useful employees of the centre, even perhaps even with special training abroad, should be above the scale of their equivalents working private industry. The fixed salary system of most of the government organizations is absolutely unacceptable, and makes it almost impossible to create a dynamic atmosphere in a design and prototype development centre. This institution should not only be able to compete with the private sector, but give guidance and provide know-how to manufacturers.

2.3. Promotions:

The local personnel should have possibilities of promotion within the organization of the centre, as is the practice in private industry in industrialized countries.

Promotion should be based on performance.

The centre should arrange courses to improve the professional knowledge of its staff. Based on the results of tests and periodical qualification reports, employees with exceptionally good performance should be given a chance of promotion. Under good leadership work at the centre can be extremely interesting and beneficial to the professional knowledge of its staff.

The possibility of promotion to a higher salary class within the centre's organization would certainly help to reduce frequent changes of the local staff to a great extent.

2.4. Competence of experts:

Though it is against the general practice of the United Nations, it is strongly recommended that UNIDO experts working in design and prototype development centres should have, at least during the initial stage, full responsibility and competence to organise the centre.

To set up a new training centre, a powerful, experienced director (project manager) should be chosen for the planning and the executive function to control various activities. Under his guidance, other experts, specialists in their fields, should also be fully responsible for their activities. Responsibility is the true meaning of a job; one can only be given to someone who will have necessary authority, competence and experience to fulfil it. The supervisory organization should, therefore, from time to time have the opportunity to control the experts much better. Inefficient and rigid, local staff cannot be too cover-happy in supervising them. Another problem is the prolongation of contracts for experts. Not infrequently they depend on the good will of the local head of the institution or even the counterpart. This pattern is often times so powerful that for all practical purposes they can veto extensions of individual contracts. Any expert carrying out his duty properly will have to come up with ideas and suggestions which will sometimes not please his partner; the easiest way not to accept these proposals is to get rid of the expert. He knows that his contract is at stake, and keeps quiet, even when it would be imperative to speak. In brief, the expert cannot contribute to the development of the centre as he is supposed to. The engagement of experts as "advisors" needs first of all a tremendous amount of diplomacy and usually hampers the progress of a centre.

On the other hand, the training of the local staff should be expedited, if not carried out in advance. Only when the local staff is well trained and in a position to take over certain charges should responsibility gradually be transferred from the UNIDC experts to the local employees.

2.5. Training of personnel

The training of counterparts and other local staff members of the centre has to be planned accomplished in a systematic way on different working levels. This activity requires an additional quality on the part of all experts who should be not only specialists with excellent professional qualifications, but at the same time good teachers with pedagogic aptitudes. During this initial stage of systematic training it is again most essential that the competence and responsibility be with the UNIDC experts.

Since experience of personnel is usually not easily available in developing countries, their training has to be provided at the centre itself, and in order to be successful, not only by advice, but by clear orders and instructions.

This can also be explained by the fact that
the cost of the product is not necessarily the
same for all companies. Some companies may
have lower costs than others due to various
factors such as economies of scale, better
management, or more efficient production
processes. This can result in a company being
able to offer a lower price while still making
a profit.

2. CO-OPEARTION AND COLLABORATION

3.1. Alliances and Strategic Partnerships

Alliances and strategic partnerships are another factor.
The cost of a product can be reduced if it can be shared.
In fact, if two companies work together to produce
a product, they can often reduce their costs by sharing
overhead expenses and by combining resources.
Companies can also benefit from working together
in order to increase their market share, develop
new products, or enter new markets. By working
as a team, companies can often achieve greater
efficiency and innovation. This can lead to a
better quality product and a higher profit margin.

Many companies have formed alliances and strategic partnerships in order to gain a competitive advantage.
The goal of these alliances is often to share costs,
facilitate access to new markets, or develop new
products. By working together, companies can often
achieve greater efficiency and innovation.
At the end of the day, the goal is to increase profits, never
to increase costs.

Another factor that can contribute to lower prices
is competition. When there are many companies
offering similar products, it can lead to a
price war. In order to stay competitive, companies
may offer lower prices to attract customers.

1. The Case of the Dying Man

The man was dying. He had been ill for a long time. His wife was beside him, weeping. She told the doctor that her husband had been very sick for months. He had lost weight and strength. He could not eat or sleep well. He was in pain and could not move his legs. The doctor examined him and found that he had a serious illness. He told the wife that her husband would not live much longer. The wife was very sad and asked what she could do. The doctor said that there was nothing more he could do. The man died peacefully a few days later.

2. The Dying Man's Story

The man was dying. He had been ill for a long time. He told his wife that he was very tired and weak. He could not eat or sleep well. He was in pain and could not move his legs. He told his wife that he was afraid of death. He asked her to pray for him. He said that he wanted to die in peace. He died peacefully a few days later.

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4. QUALITY CONTROL.

4.1. Quality Control System.

The quality control system is designed to ensure that the quality of the products is maintained at a high level throughout the production process. It consists of several interconnected components:

- Product Specification:** A detailed description of the product's characteristics, performance requirements, and quality standards.
- Design Review:** A process where the design is evaluated to ensure it meets the specified requirements and is free from potential defects.
- Process Control:** Monitoring and controlling the manufacturing processes to maintain consistency and prevent deviations from the specification.
- Quality Inspection:** A systematic examination of the product to verify its quality against the specification.
- Corrective Action:** Implementing measures to address any identified quality issues and prevent their recurrence.

4.2. Quality Control Policy.

Relating to the policy of quality control, the company aims to maintain a high level of quality in all its products, ensuring customer satisfaction and competitive advantage. The policy is based on the following principles:

- Customer satisfaction is the ultimate goal.
- Quality is built into the product through careful design and process control.
- Continuous improvement is encouraged to maintain and enhance quality levels.

The quality control policy is implemented through various means, often involving participation from low-level workers. For instance, the company has established quality circles, which involve employees at all levels in identifying and addressing quality issues. This approach promotes a sense of ownership and responsibility for quality. Additionally, the company has established a quality management system, such as ISO 9001, which provides a structured framework for managing quality. The quality management system is designed to ensure consistency and reliability across all operations.

4.3. Quality Control System.

4.3.1. Inspection and Testing Techniques.

For inspection and testing, the company uses various techniques depending on the nature of the product and the required quality. For example, visual inspection is often used for physical products, while statistical process control is typically used for process control. The company also employs non-destructive testing methods to evaluate the quality of materials without causing damage.

with all practical staff and aspects, including selection of the most suitable right and determination of the appropriate technique.

The practical work of training should include a good introduction to all the aspects of design and training on the various methods of design, and supervision of workshops and practice.

Designers should be given a good education, the design of simple parts of great importance, in particular industry, which can be made of wood, metal, or very good plastic materials. They should be able to design with the best standards of quality, strength, economy, before they proceed to more complicated designs with increased work with more advanced training.

• PROTOTYPES FREQUENTLY USED IN THE FIELD OF EDUCATION MECHANICS AND INDUSTRIALISATION.

• 1. Collaboration between the State with established, or planned, educational institutions.

In the field of education there is the use of prototypes based on the requirements of the State, and with a view to the needs of industrial activity. In this sphere such prototypes as those of basic parts, and to connect with existing educational institutions, with cooperative and other industrial units, are of great assistance to their educational work, and in the production of prototypes. Such a relationship will help to increase the quality of modern equipment, and to make it available for initial production experiments.

Prototypes may be developed and used especially on an experimental basis, in the development programme and tests of new educational equipment in the centres of technological progress, and in the development of products developed at the Central Research Institute of Mechanical and Technical Education.

The task of developing prototypes is a difficult one, and tasks connected with the preparation of prototypes and training workers in the use of prototypes, is likely to call additional attention. It is necessary to have sufficient experience in the use of prototypes, and to have a large number of prototypes for practical purposes.

The design centre and the training unit would run under two separate managements; the good collaboration and co-operation between the project manager and the head of the training centre would be a condition for the smooth working of the two institutions.

6.2. Selection of site:

Selection of the most suitable site for a new centre has a great influence on its success and future development. An agricultural centre may be well located in one part of the country and an institute for industry in another; changing the two would almost certainly be a disaster. The conditions for a successful activity in the field of precision mechanics are proximity to the industry which this particular activity, the climatic conditions (coastal areas usually require costly air-conditioned workshops and large offices, and to maintain many provisions for materials and equipment). A third aspect is the question of transport facilities, by rail, road and air; and finally, also the living conditions for experts and the local staff and their families, including possibilities for children's education. It is sometimes difficult to convince highly qualified personnel to move from a city with all the social and cultural facilities to an isolated rural provincial town.

6.3. Buildings:

In exceptional cases existing buildings are made available by the parent organization. When this is possible, new buildings, built for the particular purpose, are certainly preferable. The building of the centre, offices and workshops should be well-planned and in all respects and details a contribution example to the developing industry of the country. It is not necessary, and in fact not recommended to build a massive industrial palace. Everything should be practical, functional and of good quality. Consideration natural and artificial light, electrical installations and sewage connections, ventilation arrangements and distribution of the various rooms and the possibility for a further extension should be considered by experienced persons.

6.4. Selection, training and specialization of personnel:

The selection of the local staff for the centre should be independently planned.

Good professional practical and theoretical knowledge are the minimum qualifications for all candidates appearing for tests and interviews. The final selection should however be made entirely on the basis of the results of practical aptitude tests, held at the centre under the guidance of experts.

Specifying during the initial stage is will be unavoidable to organize systematic training courses for all technical personnel required together with all the workshop equipment. Theoretical staff should be enabled to work at complete independence according to the orders and specifications of technical drawings.

6.5. Fellowships, and training abroad

Fellowships should only be granted to exceptional qualified persons of the centre for a specialised training abroad or various enterprises abroad. The training programme must be very well prepared in detail and discussed in advance with the sponsoring firms. The training should mainly be of a practical nature, and on no account should it happen that trainees are spending several months abroad more or less as observers.

6.6. Standard equipment

The selection of all workshop equipment should be done by the project manager, in consultation with the expert in charge of the workshop. The activity of the centre must be known for at least the first period of one year. Accordingly the recommendations for purchase of the required machinery, tools and machine tools, measuring tools and additional equipment can be worked out. It is preferable not to equip such a centre with the most modern automatic production machinery with electrical control. Such equipment needs highly skilled specialists for its maintenance alone. Conventional machine tools of good quality with all necessary additional equipment, to make possible a maximum utilization, are much more useful. Along with the various racing tools, the corresponding cutting tools have also to be selected. In order to be independent from other industries, the necessary tool-grinding machines have also to be provided for the maintenance of all sorts of cutting tools.

For all general tools, measuring tools, special cutting tools, gauges, etc., a suitable tool cribs has to be planned. The proper way of storing costly tools is usually not known, or at least neglected, in developing countries with the result of big losses due to unavoidable damage to expensive tools and equipment.

To avoid the purchase of expensive equipment, only the absolute minimum should be ordered at the initial stage. But for this reason, it is necessary to provide within the first budget already an additional amount which enables the project manager at any later date to order additional equipment, required for new activities taken up by the centre.

6.7. Layout

As soon as the list of machineries and equipment has been completed, the planning of the workshop layout can be done in details, preferably with the help of a layout-modell on a reduced scale (1 : 50).

The various departments such as machine sections, assembly, repairs, inspection and measuring room, tool grinding, heat treatment, smithy, welding, soldering and brazing, electroplating, painting, carpentry, raw material store, oil and fuel store, spare parts, but also foremen's offices and canteen have to be well separated from each other to assure good working conditions everywhere.

Sufficient space should be provided in all departments for additional activities of the centre at a later date. The layout for each section should be perfectly planned in all details so that it may serve at the same time as incentive example to the local industry.

(See Appendix: Layout Training Centre for Precision Mechanics) (Swiss Foundation - SONATI, Lima - Peru).

6.8. Measuring tools and equipment

It is hardly necessary to emphasize that the measuring tools and control gauges for such a centre have to be of top quality. The measuring equipment should include a profile projector, hardness tester, surface quality tester, microscope and all the necessary electrical and optical control instruments, according to the activity of the centre.

5.9. Additional equipment:

This block contains information on the additional equipment which is required for the production of aircraft, additional equipment is required for the assembly independent of aircraft work. For this reason, it is necessary to have separate tables for each type of aircraft assembly. This additional equipment includes: fixture attachment, tool and gauge, welding fixtures, assembly fixtures, and different types of entry fixtures.

5.10. LIST OF EQUIPMENT:

A. Machine fixtures:

6. Lathes
Schaefflin 102 VM

Accessories:
coolant equipment
jet air filter
trill chuck
driving plate
3-jaw chuck
4-jaw chuck
grinding attachment
face plate
steady rest
movable steady rest

5 Toolmakers Lathes
Schaefflin 102-10

cutting tools
arbor shank
driving plate
3-jaw chuck
three jaw chuck attachment
milling attachment
grinding attachment
turret attachment
cylindrical turning attachment
spherical turning attachment

5 Toolmaker lathes Haberger - ?	set of collets drill chuck face plate 3-jaw chuck 4-jaw chuck
2 Toolmaker lathes Schaublin 70	coolant equipment parallel vise steady rest driving plate 3-jaw chuck
2 Lathes Simonet 450	coolant equipment set of collets face plate driving plate steady rest drill chuck 3-jaw chuck
2 Lathes Menziken 135	coolant equipment 3-jaw chuck face plate steady rest movable steady rest driving plate
1 Lathe Gallic 14	coolant equipment face plate steady rest movable steady rest conical turning attachment drill chuck 3-jaw chuck 4-jaw chuck driving plate
7 Universal Milling Machines - Schaublin 13	coolant equipment universal table vertical milling head set of collets parallel vice 3-jaw chuck rotary table dividing equipment

1 Universal Milling machine Schmitz 65	coolant equipment swivel parallel vice set of collets face plate vertical milling head rotary table
2 Universal Milling machine Sivis 100	coolant equipment vertical milling head parallel vice set of collets slotting head
1 Multi purpose machine Meyer & Burger	coolant equipment slide chuck face plate steady rest dividing equipment set of collets
4 Sharpeners Gack	machine vice
1 Sharpener von Roll SH 500	machine vice
1 Gear Hobbing machine Mikron 102	coolant equipment center support set of collets set of cutters set of exchange gears
1 Surface Grinding machine Maegerle F-7	coolant equipment magnetic chuck universal vice
1 Surface Grinding machine Tripet MHP 500	coolant equipment magnetic chuck dial indicator wheel balancing device
1 Cylindrical Grinding machine Studer - 1 /universal	coolant equipment dial indicator wheel balancing device internal grinding attachment steady rest set of collets face plate grinding vice

1 Cylindrical Grinding machine Tschudin HTG 400/universal	coolant equipment dial indicator wheel balancing device internal grinding attachment magnetic chuck 3-jaw chuck face plate set of collets grinding vice
1 Engraving machine Kuhlmann GMI/1	dividing head vice set of templates
1 Engraving machine Grafograph IT	dividing head vice set of templates
1 Band saw Moessner Record SM 320-B	
1 Screw press Lutny Ø 60	
5 Surface plates	400 x 500 mm
1 Radial Boring machine Cerlikon	
2 Drilling machines Aciera 22 S-1 VR	coolant equipment drill chuck 0-13 mm drills 0-22 mm
2 Drilling machines Fehlmann P-18	coolant equipment drill chuck 1-13 mm drills 1 - 1 ^{1/2} mm
2 Drilling machines Fehlmann TB-8	drill chuck 1 - 8 mm
1 Drilling machine Aciera 10 K-2	coolant equipment double spindle drilling and tapping 0-10 mm
1 Drilling machine Aciera 10 K-1	coolant equipment drill chuck 0-10 mm

- 1 Drilling machine drill chuck 0-6 mm
Aciera 6 K-1
- 1 Tapping machine
Aciera TP-3
- 1 Drilling machine drill chuck
Aciera E-3 capacity 0-3 mm
- 1 Hand Shearing
machine - von Arx
- 1 Hand Bending machine
Gossel
- 1 Pipe Bending machine
Bykart AG
- 1 Slitting saw
Adige P-60
- 1 Power Hack-saw LWR
- 2 Arbor Presses
- 2 Marking tables

B. Tool grinding section:

- 1 Tool Grinding machine coolant equipment
Kellenberger 57 - W dividing equipment
internal grinding attachment
machine vice
- 1 Universal Tool Grinding
machine/Dubied - 564 coolant equipment
dividing head
vice
inclinable table
- 1 Cutter Grinding machine
Kuhlmann SU-2
- 1 Tool Grinding machine coolant equipment
Ufanger Senior twist drill grinding attachment

4 Tool Boxes, p = 170000

1 Polishing Paste, p = 10000

C. Inspection Tools

1 Vernier caliper, 250 mm, MT 500

1 Slip gauge, 100 mm, with dial indicator TESA
1-1000000

1 Thread pitch Micrometer set, TESA

1 Profile Projector, 300 mm

1 Tap wrench, quality TESA

1 Gear tooth dial

Gear tooth thickness micrometers 0-50 mm

Thread Micrometers 0-50 mm

Slip Gauge, quality DIN 1 0,5-100 mm

Slip Gauge, quality DIN C 0,5-50 mm

1 Measuring Cylinder

1 Sine bar

1 Height Gauge 100 mm

1 Surface plate, scraped 400 x 500 mm

2 Control Ruler, with illuminated magnifiers

D. Measuring Tools (1 tool only, for general utilization)

4 Precision Calipers TESA 200 mm

2 Depth Gauges TESA 150 mm

4 Precision Micrometers, TESA/AS/DF 0 - 25 mm

2 Precision Micrometers, TESA/AS/DF 25 - 50 mm

2 Precision Micrometers, TESA/AS/DF 50 - 75 mm

2 Precision Micrometers, TESA/AS/DF 75 - 100 mm

1 Set Inside Micrometers 6 - 100 mm

1 Set Depth Micrometers

0 - 25 mm

6 Dial Indicators ± 10° mm

1 Dial Indicator 1/1000 mm

2 Lower limitors in oil line

4 Pressure limiters

New type of the lower limiters

1 Barn door type of safety

General Tools

1 Jet Flame Burner - Max 104 - 16 mm

1 Jet Flame Burner, small 100 - 100 mm M2 - M 20

1 Set T-Head Bolts, 1/2" & 3/4" N 3 - N 20

1 Jet Lamp - Max 100, Mores 0 - 4

1 Precision T-Head Burner

2 Star Burners

1 Control Burner

1 Spirit Level, square

1 Spirit Level, straight

3 Set Fitter Tools

4 Sets of tools for concave - convex 1 - 25 mm

4 Sets of tools for concave - convex - English

1 Set Thread Gauge, external rough to grind
exterior threads

2 Sliding caliper, standard 150 mm

4 Measuring tape 2 m

1 Measuring tape 20 m

10 Foot rule 200 mm

1 Rule 1 m

5 Precision straight edges

1 Set Fitter tools square 100 x 100 / 100 x 100 / 100 x 100

5 Precision T-Head square

5 Precision T-Head square 100 x 100 mm

5 Try squares 100 x 100 mm

2 Precision T-Head square 750 x 750 mm

2 Universal square setting device

1 Centering device

4 Precision T-Head straight edges

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100. *Electrode*

4. External Database Integration and Tools

- 24 Universal Caliper 4½" w/pins
48 Tools each with 4 answers etc., fixed under the workbench, not in tool box

 - 1 Universal Caliper TESA 250 mm
 - 1 Micrometer TESA 0-25 mm
 - 1 Bevel Edge straight edge
 - 1 Try square with rev. edges
 - 1 Measuring Tape 2 m
 - 1 Foot Rule 200 mm
 - 1 Centre Punch
 - 4 Screw Drivers
 - 1 Marking Awl
 - 6 Chasers
 - 1 Bench Brush
 - 1 File Brush
 - 1 Brush round
 - 1 Brush flat
 - 1 Dividers
 - 4 Precision Pliers
 - 2 Chisels
 - 1 Hammer 200 gr.
 - 1 Hammer 100 gr.
 - 1 Hand Cutting tool
 - 1 Parallel Clamps
 - 1 Hacksaw

- 1 Oil Filter
- 1 Pair of safety glasses
- 1 Battery tester
- 1 Set of jumper cables - 10 mm²
- 1 Oil can

General Tools

- 5 Griplock Clamps
- 1 Set of standard wrenches 60 - 125 mm
- 1 Set of Cam lock wrenches 100 - 400 mm
- 2 Sets Double ended spanners 6 - 16 mm
- 1 Set Double ended spanners 5/16" - 1"
- 2 Sets Spanners 4 - 7,5 mm
- 1 Set Box end wrenches 5 - 32 mm
- 2 Sets Socket wrenches with plastic handles 2 - 10 mm
- 4 Sets Allen keys 1,5 - 12 mm
- 2 Spanner Head type 180 and 250 mm
- 2 Sets Phillips Screw Drivers Nr. 01 - 4
- 4 Sets screw drivers
- 4 Sets Watchmak. Screw Drivers
- 4 Sets Offset Screw Drivers
- 2 Sets Dynamometric Screw Drivers
- 2 Universal Pliers
- 4 Side Cutting Pliers
- 4 Flat Nose Pliers 120 mm
- 4 Round Nose Pliers 120 mm
- 4 Long Lever Round Nose Pliers
- 2 Long Grip Pliers 200 cm
- 4 Adjusting Pliers, straight
- 4 Adjusting Pliers, bent
- 1 Set Circlip Pliers - inside and outside
- 1 Multi Grip Plier

- 1 Pipe Tongues 7"
- 1 Vice Grip Plier 175 mm
- 2 Caul Stripper
- 4 Tweezers - pointed and straight
- 4 Two End - bent
- 4 Two End - with small points
- 1 Universal Sprue Wrench
- 2 Sheet Metal Cutters - for Alas
- 2 Delrinite Scissors
- 2 Layout Cutters
- 1 Set Paper Scissors
- 1 Set Carpenter Tools
- 3 Sets Various Hammers - Steel, Plastic, Rubber, Wool, Lead.
- Flat Chisels
- Cross Chisels
- Groove Chisels
- 2 Sets Chasers
- 1 Set Pulley and Bearing Pullers
- 1 Set 3-Legged Puller for Ø up to 200 mm
- 2 Sets Screw Removers
- 2 Sets Tap Removers
- 4 Sets Hard Sizing Tools
- 4 Sets Numbering Punches 2 - 5 mm
- 4 Sets Lettering Punches 2 - 5 mm
- 1 Set Typewriter - Letters and Numbers 60 mm
- 100 Sets Tool Boxes
- 1 Electric Scriber for Metals
- 10 Sets Taps and Dies M 1 - M 16
- 2 Sets Taps and Dies/lips Threads 1/8" - 1"
- 1 Set Broaches for Key Ways
- Various sizes and shapes of Hack- and Fret-saws
- 10 Sets Hand Reamers 0 - 20 mm

- 10 Sets Tapered Reamers, 1 - 50 2 - 9 mm
10 Sets Adjustable Reamers 6 - 20 mm
Various bushings of different shapes
Various Oil- and Arkansas Stones - square,
round and triangular.
10 Triangular scrapers
6 Flat Scrapers
6 Hand Engravers, burrs
6 Soldering Irons - various sizes
Various Safety Devices for: Soldering,
drilling and grinding.
Various files of special shapes and sizes.
20 Sets Watchmakers - Files
2 Electric Hand Drilling machine PERLES
1 Electric Hand Grinder
1 Electric Plastic welding device

G. Machine Cutting Tools

- 5 Sets Small End Mills Ø 30 - 80 mm
5 Sets Small End Mills for roughing Ø 50 - 63 mm
6 Sets Cylindrical Cutters Ø 50 - 63 mm
10 Sets End Mill Cutters with cylindrical shank, 2 flutes
10 Sets End Mill Cutters with cylindrical shank, 4 and more
flutes
4 Sets Side and Face Cutters, plain and staggered
teeth, 0,4 - 15 mm
2 Sets Gear Cutters, Modul 0,5 - 3
2 Sets Gear Cutters (generating) M 0,3 - 2
6 Sets T-Slot Cutters \angle - 12 mm
5 Sets Counterbores with guides Ø 5,9 - 30,5 mm
5 Sets Counterbores with guides Ø 5,9 - 14,5 mm
Various Double and Single Angle Cutters
Various Radius Cutters - concave and convex
4 Sets Slitting Saws

Drills:

- 10 Sets Twist Drills for Steel $\varnothing 0.3$ - 20 mm/Steps
0.1 mm up to 10 mm
- 5 Sets Twist Drills for Brass $\varnothing \dots$ - 10 mm/Steps 0.1 mm
- 3 Sets Twist Drills for Aluminum $\varnothing 2$ - 10 mm
- 4 Sets Job Drill, Centered Carbide Tipped $\varnothing 6$ - 20 mm
- 4 Sets Twist Drills for Steel $\varnothing 1/16"$ - 1"
- 10 Sets Machine Tap $M 3 - M 14$
- 10 Sets Machine Reamers $\varnothing 1.4$ - 20 mm for
various materials and tolerances

Turning Tools:

- 10 Sets Tool-Rite HJ2 $1/4" \times 2$, 10 x 16, 16 x 16, 20 x 20
- 5 Sets Thread Cutting Tool "FANGR" 60° and 55°
- 15 Sets Facing Tools - left and right
- 10 Sets Parting Off Tools - various sizes
- Various Counterbored Cartridge Cutting Tools for
roughing, finishing, outside and inside turning.

Miscellaneous Turning Tools:

- 1 Set Reamer, Oil Hard, Steel and Plastic - RG 1 - 4
- 3 Sets Milling Tools - different systems
- 3 Sets Disc Cutting Tools for \varnothing up to 200 mm
- 4 Sets Turning Arrows $\varnothing 1" - 40$ mm
- 2 Sets Milling Arrows $\varnothing 1" - 40$ mm
- 1 Sets Arbor (Carriage) for \varnothing up to 40 mm

II. HEAT TREATMENT

- 1 Electrical Furnace, with timer
SAFEC - type 103-42
- 1 Electrical Furnace, with salt bath
SAFEC - type 103-42
- 1 Electrical Furnace with air circulation
SAFEC - type 4-31-30
- 1 Container with oil cooling coil
- 1 Container with insulation material
- 1 Potassium Bath 1 Blanket Pan

I. Welding-section

2 Mobile Gas Welding Sets CONTINENTAL
1 Arc Welding Generator BROWN-BOWERT

J. Painting and Zinc Plating Section

1 Spray painting booth - APP. ZURICH
1 El. circ. fan
1 Gas & Paint spray gun - KLEICK NO. 40

K. Electroplating Facility

El. circulation plant LAMBEIN & PFANHAUSER
Water Purification Plant
Refrigerator
Exhaust system

L. Smithy

Furnace with x-must system
Anvil - Blacksmith-Vice - Various Hammers and Tongues

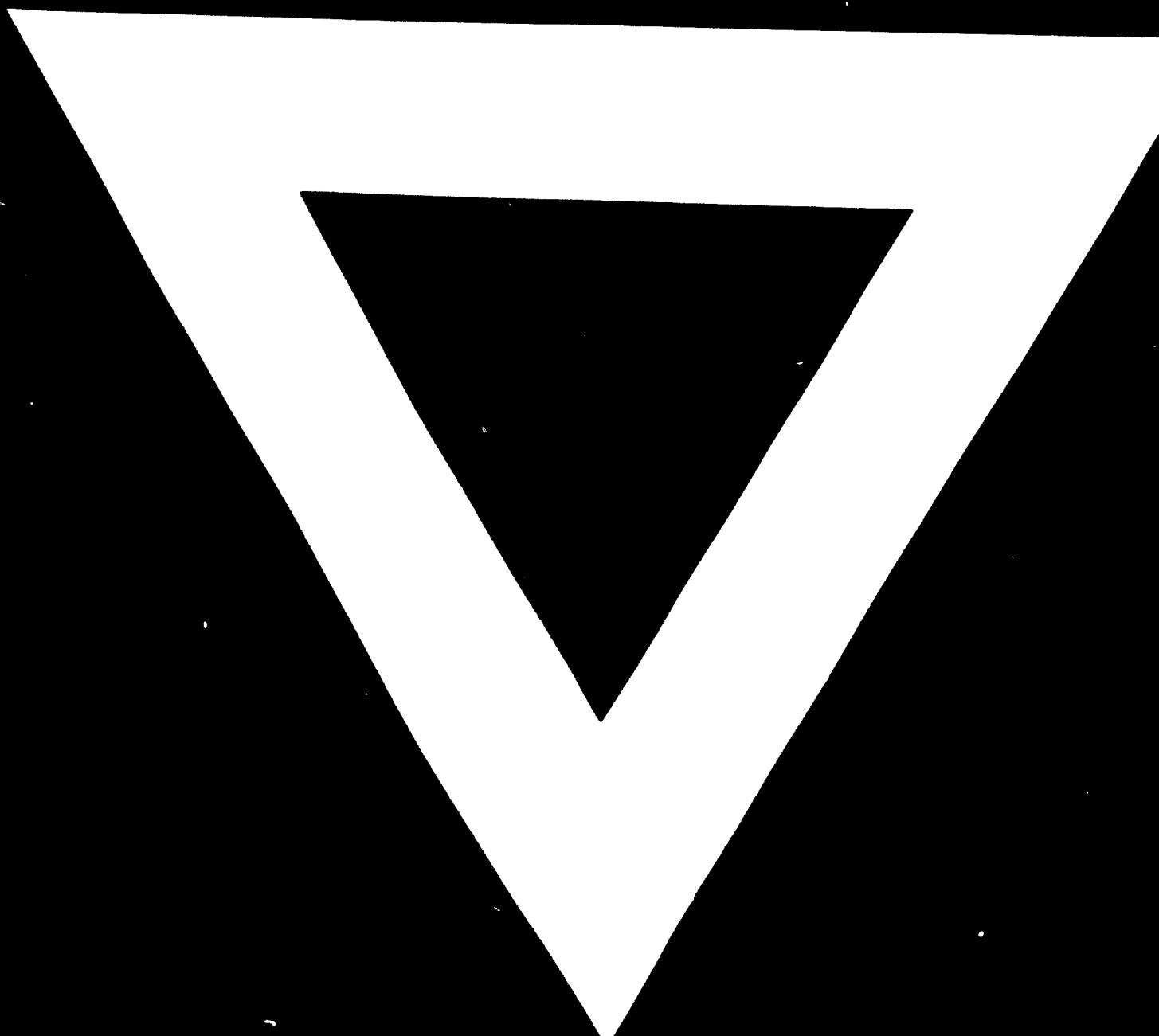
M. Sheet Metal, Soldering

1 Sheet metal Machine
1 Trim. & Shear
1 Nibbler & Sheet metal Machine
1 Creasing Machine
2 Anvils & 2 Vise
Various hammers, Soldering Irons etc.

Carving Tools

1 Circular Saw	1 Planer/Thicknesser
1 Band Saw	1 Molding machine with dove-tail/line attachment
1 Mortise Machine	1 Dust Collector
1 Built-in dry grader	1 Circular Hand Saw
1 Fret saw, 100mm	1 Hand Chain Mortising machine
2 Sets of Gauge Tools Hand Wire Saw Tools	2 Wire Saw
1 Jig saw	





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