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06665

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.218/1
19 September 1975

ENGLISH

Consultation Panel on International
Co-operation in the Instruments,
Electronics and Telecommunications
Industry

Budapest, Hungary

November - 5 December 1975

# THE IMPORTANCE OF MEASURING INSTRUMENTS IN THE DEVELOPING INDUSTRIAL AND COMMERCIAL LIFE 1/

by

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id.75-7346

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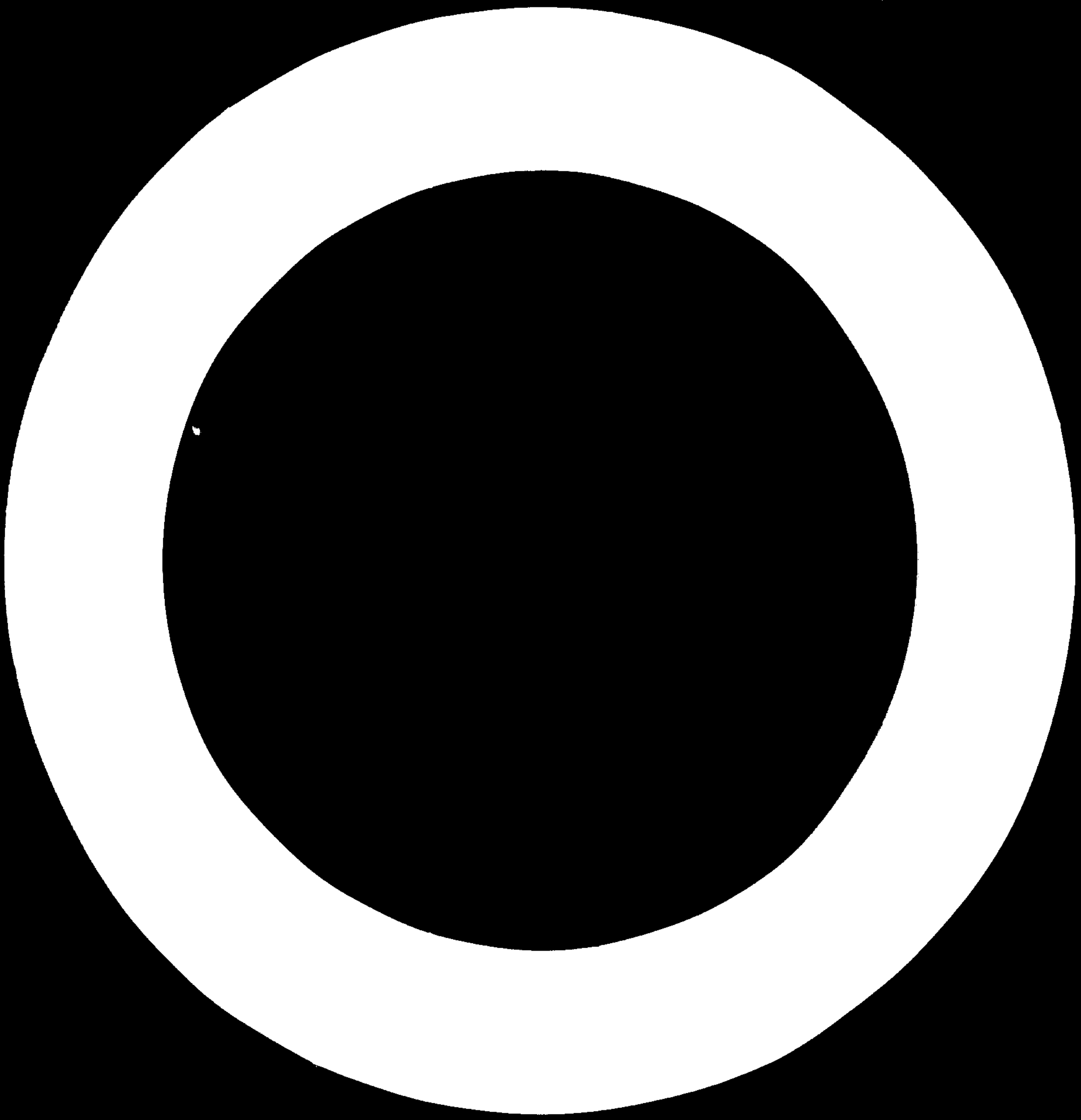

## INTRODUCTION

### The importance of measuring instruments in the developing industrial and commercial life

The duties of measurement engineering include the numerical determination of the quantity /length, weight, etc./ and characteristic properties e.g. dimensions of a commodity produced by industry, or marketed by trade. Commodity means in this sense either any industrial product /weight, length/, an area of land, or a building thereon /dimensions, location/. In order to determine numerically how much of something exists and where, and what characteristics it features, more or less precise and rather sophisticated measuring instruments are indispensable.

It is, therefore, easily understood why certain measurements and the associated measuring instruments like scales, volume and linear measures have played for thousand of years a significant role in the everyday activities of mankind during each phase of development. It is similarly quite obvious that the commercial measuring devices defining quantities had been thrust much earlier into prominence than the measuring instruments of industrial activities which gained ground only through industrialization. Measurements and their means, however, have been still more important in learning about nature, or in medical and veterinarian therapeutics. Neither the ancient science of astronomy, nor medical diagnostics and therapeutics can be imagined without instruments and various means of precision mechanics. It is thus self-evident that no up-to-date educational and research institute, nor the hospitals and clinics can operate without instruments and research aids continuously available.

### The position of instrument production within the framework of industrial activities in general

According to their structure, measuring instruments are manufactured partly by precision mechanics and the mechanical instrument industry

/weight and length measuring instruments/, and partly pertain to the field of glasswares /thermometers, laboratory glass media/. The mechanical instruments include optical devices, /geodetic levels, microscopes, etc./ and various educational requisits as well.

The instruments for measuring voltage and electric power, without which the installation and operation of power facilities or electrification in general can hardly even be envisaged, are products of the electrical industry.

Finally, products of the electronic industry include the complex measuring instruments constructed by using semiconductors and vacuum tubes, indispensable in telephone, radio and TV engineering.

Even this, somewhat oversimplified summary reveals what a wide range is covered by the assortment of instruments, not only from the aspect of the various fields of application, but also according to the characteristics of the different manufacturing industries. When introducing an instrument industry in a developing country, the local degree and character of industrialization will obviously have to be taken into account. This problem will be discussed later.

The task and objective of the present paper is to render assistance in deciding on

- what products should be manufactured
- what are the technical preconditions of establishing such a plant in a developing country
- what materials, components, etc. must be ensured for the purpose
- what personal conditions are to be met for such an undertaking, and
- what are the preconditions of any possibility of industrialization.

The paper will deal furthermore with the methods, whereby the transfer of technology can be best provided for and specify the best course of starting as well as expanding production up to independent manufacture and marketing.

At the end six short "profiles" will be attached on various instrument factories characterized by the special feature that each of them has been based on an actually designed and realized plant constructed in a developing country.

## 1. Preconditions of the establishment of an instrument industry enterprise in a developing country

Decision on whether instrument industry should actually be established in an area to be industrialized, and on the product family of the rather wide assortment instrument industry that should actually be introduced in the new area, may be made on the basis of the following decision factors:

/1/ Local demand for the instruments to be manufactured
/2/ Industrial preparedness of the area selected
/3/ Possibilities to provide for the materials and components required
/4/ Provisions for appropriate labor
/5/ General industrialization environment.

Let us examine now, how these factors might influence our decision on what instruments should be produced, and where, in a developing area under industrialization.

### 1.1. Local demand for the instruments to be produced, as a primary factor of decision

As it is commonly known, measuring instruments are used in a wide range of human activities and, therefore, it is rather expedient to examine the individual fields of application, as factors exerting an influence on the relevant decision, in details.

In this context, the following fields of application deserve special attention:

1.1.1 Subsistence and health protection
1.1.2 Trade
1.1.3 Industrial activities
1.1.4 Transport and telecommunication
1.1.5 Power production, oil and gas prospecting, transport and processing

1.1.6 Agriculture and food industry
1.1.7 Educational requirements

We shall scan now the areas listed above and examine, how they might contribute to our decision.

1.1.1 Instrument requirements of subsistence and public health

When a baby is born, his firts two numerical data: weight and length are determined already by measurement. Without going into details, it is quite obvious that many measuring and other instruments are used in large quantities all over the field of subsistence and public health, and that their "market" is rapidly increasing with the development of this field proper. A number of devices, like scales for babies and adults are produced and can be marketed in almost every industrialized country. Similar "instruments" are the syringe, dental forceps and many other medical tools. In this field, with an improving life standard and medical service, a significant and steadily increasing market may be predicted.

1.1.2 Requirements related to the exchange of goods /trade/

It sounds almost trivial but still must be mentioned that, in connection with the exchange of goods, mass, volume and length measurements are of utmost importance. Consequently, the most diverse types of scales and balances find important commercial applications in vast quantities, and so do the volume measures, their calibration, as well as the various length gauges. Areometers are similarly important in trade, particularly in alcoholic beverage deliveries. Accordingly, these instruments might reckon with a considerable demand in the developing countries as well.

1.1.3 Demand expected in connection with industrial activities

In the developing countries, industrial activities manifest themselves mainly in the tertiary sector, in connection with the repair of machines, power and electronic installations. Production dependent manufacture and marketing.

At the end six short "profiles" will be attached on various instrument factories characterized by the special feature that each of them has been based on an actually designed and realized plant constructed in a developing country.

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1.1.3 Demand expected in connection with industrial activities

In the developing countries, industrial activities manifest themselves mainly in the tertiary sector, in connection with the repair of machines, power and electronic installations. Production often starts in the same fields, so a considerable demand may be encountered mainly for mechanical measuring devices /slide calipers, gauges, micrometers/, fundamental electric instruments and electronic radio engineering instruments, which, if the supply of large geographic areas is involved, may fully justify the establishment of such production bases.

The instrument requirements of the processing branches /textile, food, canning, and leather industries/, on the other hand, are usually so special, that the development of a production basis for such purposes does not seem to be justified at all. Mining and processing of oil and gas may be an exception to this.

1.1.4 The instrument demand of <u>the railway and navigation branches of the industrial and transport infrastructure</u>, as well as of the telegram, radio and TV services may be rather significant in the countries somewhat more developed industrially, in the field of both power and electronic measuring instruments. A similarly considerable associated demand is related to the water, gas and electricity services for metering and accounting instruments, due, according to experience, to urbanization. Thus, for example, the consumption of kilowatt-hour meters accounts to approx. 3ooooo pcs. per year in Algeria today.

### 1.1.5 Demand connected with energy carriers, power production and distribution

In most developing countries the national energy basis is strongly expanding, and in some of them considerable export capacities, too, exist in the field of energy carriers /oil and gas/. Both thermal and hydroelectric power stations, just like oil and gas production, transport and processing require great many instruments which, at least in the initial phase, are provided mostly by the contractor companies of the investments, of course. Subsequently, however, the instrument consumption requirements of these energy bases will have to be reckoned with from the aspects of repair, renewal and expansion. Chapter 2.2 will discuss this subject in detail.

### 1.1.6 The instrument demand of agriculture and food processing

One of the fundamental steps in the development of agriculture is the assessment or "mapping" of the areas concerned. This is why, according to experience, a considerable demand can be observed for surveying instruments like levels and theodolites. Another relevant demand is based on the establishment of meteorological and hydrological service stations. An extensive demand for such instruments may be expected particularly from the industrialization of agriculture.

As referred to above, except the industrial thermometers and manometers widely used in the canning industry, no large-scale instrument utilization may be thought of in connection with food processing. Thermometers and manometers, on the other hand, can only be manufactured profitably in mass production, which, in turn, might hardly be recommended on a local basis.

### 1.1.7 Instrument and the like requirements of educational institutions

At each of the three educational levels a significant demand is known to emerge for instruments and other training media. Through a selection according to the quantities involved, these requirements could be satisfied by the industries of the developing countries proper, if adequately organized, as the engineering complexity of these products and their manufacture is in many cases rather moderate. Here mainly the requisites and measuring instruments of the natural science classes of primary and secondary education are being considered, but the laboratory equipment of colleges and universities used in large quantities like Bunsen burners, glassware, etc. might also be added. The scope of the present study should, therefore, cover the production of educational aids as well, parallel with the manufacture of instruments.

## 1.2. The technical level of the developing countries as a secondary factor

When an industry is established, the following two questions should always be answered in advance:

/1/ What is the qualification of the labor available /professional skill, educational level, etc./?

/2/ What are the technological preconditions, how high is the level of mechanization?

These must be thoroughly examined in details, as only thereafter can we decide what starting possibilities the existing technological preparedness could offer.

Technological preparedness means the average level of factories, plants, labor and machine pool in the economic area in question. In the following paragraphs the conditions of setting up an instrument industry basis will be dealt with by the different technological branches.

1.2.1 <u>The technological level of metal processing</u>

Here only those of the metal working industries will be mentioned which ought to be considered as important from an instrument industry viewpoint:

- Forging /medical instrument industry/
- Cutting /in each of the instrument industries/
- Cold pressing /in each of the instrument industries/
- Surface treatment /in each of the instrument industries/
- Hardening and tempering /mainly in the production of medical instruments/
- Assembly work /in all branches of the instrument industry/

The existing conditions will greatly affect the character of the instrument industry to be established. Thus the existing manufacturing know-how means the existence of a professional staff, too, required even at the initial phase for the given technology, so no special training is needed at the very beginning, while later only an increase of the number of employees available, and their further porfessional training will be necessary.

In the advanced instrument industries a rather wide range of mechanical elements must be provided which, however, can be readily ensured by means of the existing skills, since the dimensions, quality, etc. of the processed materials do not differ considerably.

1.2.2 Power facilities, production of electric machines

In the above product category the most general technologies include

- production of laminated iron cores
- coil winding
- circuit measurements /e.g. resistance/ and
- safety measurements.

These technologies may be adopted almost "verbatim" in many areas of electrical instrument production. They can be used in the manufacture of the following instruments:

- Moving coil, moving vane and electrodynamic instruments
- Measuring converters, transformers
- Switches.

The above proves that power equipment production will render an excellent basis for the introduction of electrical measuring instrument production. European experiences confirm that most of the major European companies producing electrical machinery /AEG, Siemens, etc./ started instrument manufacture on their own. These workshops have grown later into independent plants and supply now a greater part of the world with electrical measuring instruments.

1.2.3 Production and maintenance of weak current and electronic instruments and equipment

The first question should be whether in the area concerned there is any such industry where weak current technology is dominating, like the production of civil or military radio transmitters and receivers, telephone and transmission engineering, etc.

Valuable assistance may be rendered here by the service shops engaged in the repair of electronic instruments, radio, TV and tape recorders, etc. The radio and TV amateurs represent a similarly valuable reserve of professionals. These two fields of professionals, plus the existing staff of the electronic industry might develop a framework of experts on which weak current instrument engineering could then be based.

1.2.4 <u>Plastic and cold pressing and the associated tool production</u>

The examination of where any sheet metal fabrication might be found seems to be similarly indispensable. This may include the production of

- household utensils, building ironwork,
- laminated cores of electrical rotors, transformer sheet packages,
- household and industrial plastic goods.

These experiences may be made excellent use of in the manufacture of the following instrument parts:

- cases, chassis, front plates, printed circuit boards,
- transformers, choke coils,
- various plastic components for the instrument industry in general.

Both fields are characterized by very high tooling requirements since even the production ofasingle component might need several dies which most likely will have to be imported for quite some time as the collection of sufficient experiences for their local production is a rather slow process.

Although the problem is quite complicated and its solution may be expected only after a longer period, the realization of a relevant local industry must not depend thereon. Both the necessary tools and components can be readily provided for through international trade.

Skilled labor may be supplied initially by the wood carver, bone cutter, gold, silver, copper and gun-smith professions.

It must be remembered, however, that up-to-date plastic constructions can only be obtained from suitable basic materials /e.g. Rilsan, Macrolon, etc./, since nothing but these ensure acceptable dimensional stability, heat and pressure resistance. These, too, can be acquired commercially without difficulty.

1.2.5 <u>The level of surface treatment, paint coating, electroplating and other finishing technologies</u>

Surface finishing is one of the fundamental technologies of instrument manufacture. It is aimed not only at corrosion protection but also at providing for satisfactory electrical interconnections and contacts.

Part of the motor vehicle repair shops have appropriate surface treatment plants available for the nickel or chromium planting of small, and painting or stoving of larger components.

Skilled labor reserve is represented here by those employed in these plants as they are familiar with the basic technologioal know-how, although they cannot be utilized direotly in the production of instruments because of the differenoes between handicraft and medium-scale plant operations and due, particularly, to the different quality requirements.

## 1.3. Possibilities to provide for the semi-finished products and components required

When establishing an industry, it is rather important under what conditions of semi-finished product and component supply this undertaking will have to operate. It is very advantageous, of course, if a local semi-finished product and component manufacture is assured, but this occurs rather seldom, because of the special requirements of instrument production.

As long as local production cannot be developed to the level of meeting instrument industry requirements, good commercial relations must be created and maintained with advanced industrial countries from where these special products can be procured. The full development of local semi-finished product and component manufacture usually takes about lo to 15 years.

### 1.3.1 Steel and non-ferrous metal sheets, strips and bars

In a number of developing countries the metallurgical industry has either be already established, or is under build-up. These oountries have hot and cold roll mills which, in turn, enable them to enter the manufacture of profiles and dimensional assortment required in the instrument industry. If this were not feasible then, importing the necessary basic materials should not oause any difficulties, either.

1.3.2 The level of basic plastic material and printed circuit board supplies

Plastics used in today's modern technologies belong to one of two main categories: thermosetting and thermoplastic materials. Both are easily accessible in the world market and their local production can not be regarded anywhere as a precondition for the establishment of the instrument industry.

In most countries, including some of the highly advanced industrial ones some of these raw materials are acquired by imports.

Printed circuit boards continuously gain ground in the production of both electronic and electrical instruments. Initially they can be imported without any difficulties. Their local production, however, can be realized without serious difficulties at a more advanced stage of instrument production.

1.3.3 The level of wire supply

The extensive acceptance of printed circuit boards has greatly suppressed the need for instrument wiring. Today, enameled wires are used in the instrument industry almost only for the production of transformers, chokes and other inductive devices.

Dimensional assortment of the instrument industry demands very small dia /0,05 mm and over/ but uniform quality wires to be acquired usually from abroad for quite some time. But in a larger developing country, due to the extensive power and electronic application possibilities, the establishment of local wire production seems equally practicable.

1.3.4 Mechanical elements /bolts, nuts, rivets/

Provision for mechanical connecting elements is a task relatively easy to accomplish. The technological requirements can be readily met by using turret lathes, or screw machines.

Most of the developing countries have small-scale plants producing a rather wide assortment of connecting elements, even if by using fairly obsolete productive means.

However, a considerable part of the requirements set by the instrument industry represents a much higher level, such as the enclosed jewel bearings /threaded sapphire bearing units/, verges, control spindles, etc. In other cases sophisticated contacts made of special materials or spring contacts are required.

Experience proves that these components could always be obtained without difficulty as the suppliers are most willing to satisfy customer demands.

1.3.5 Power and weak current components, semi-finished products

Up-to-date instrument industry, particularly the production of electrical instruments, employs today mainly assembling and calibration technologies, with the precondition that the building block elements used in these instruments are commercially available, or supplied by specialized companies upon order. These will have to be imported until very large quantities are produced locally, or thus proves to be sufficiently economical.

Local production should be started with items conforming to the given conditions, meeting a wide demand and requiring little special know-how, as for example

- switches,
- connectors,
- transformers,
- choke coils,
- knobs and pushbuttons.

## 1.4 Assuring the supply of labor

One of the most important preconditions of the establishment of a plant in a new industry is to appropriately prepare a satisfactory technical and professional labor supply. Labor can be provided from two sources:

/a/ from among the skilled labor and engineering professionals engaged in the basic industries listed under Chapter 1.2., who have already mastered fairly sufficient knowledge for the production and oalibration of the instrumente in question by the time of the organization of the new job and who, by on-the-job training may reach the desired professional level with the assistanoe of the experts to be delegated by the donor oountry, or enterprise

/b/ wherever the above basic training from the affiliate industries cannot be provided for by the reoipient country, there a rather lengthy professional and engineering pretraining is needed, preferably in the workshops and laboratories of the donor enterprise.

It will have to be emphasized here that in oountries where none of the above alternatives seems feasible due to language problems, or professional reasons, the urgenoy of introduoing instrument industry should be seriously considered.

Let us examine now in detail the duties of professional and engineering training and post-graduate eduoation.

1.4.1 <u>Skilled and semi-skilled labor supply</u>

Here we start again from the assumption that instrument production is commenoed by the assembly of the oomponents and fittings supplied by the donor enterprise and the installation as well as calibration of the instruments thus assembled. In such oases, regardless of the instrument type involved, skilled and semi-skilled labor familiar with mechanioal and electric assembly operations will have to be provided.

It will be only in a later stage when the reoipient plant might ohange over to the produotion, electroplating, painting and other production treatment of the pressed, stamped, bent and out components whioh would demand several years of skilled labor training in advanoe.

In addition, however, installation and oalibration technioians and skilled labor will be needed from the very beginning, but this will be disoussed separately.

Assembly, wiring and soldering operations are performed mainly by semi-skilled labor under the supervision of appropriately qualified foremen.

These foremen will have to teach the new assembly and soldering /wiring/ operations to men and women of who have hardly been engaged earlier in such work. If the majority of this semi-skilled labor had been recruited from factories or workshops engaged in different industrial activities, then courses of 2-3 weeks might be necessary to make them acquainted with the materials, tools and operations involved. This could be best accomplished in an apprentice workshop installed and equipped provisionally.

Performance of these operations /assembling, wiring, soldering/ does not require significant physical efforts. There is nothing but attention and manual skill needed in most of these activities, just like in a dressmaking shop. In Europe, the majority of such operations is entrusted to women. How far this can be achieved in the developing countries, it depends on the local social conditions.

About 8o per cent of the employees working in such an assembly plant is semi-skilled labor and with 4 assembly lines served by 5o employees each, quite a considerable quantity of mechanical or other measuring instrument might thus be produced. Half of the leftover 2o per cent of labor carry on supervisory duties, while the other half unskilled auxiliary activities /material handling, etc./.

In the second stage of plant organization, when the recipient will gradually change over to component production and processing, it will be necessary to train skilled labor for cutting, tool making, sheet-metal work, electroplating and paint jobs. They should be recruited from local plants of similar profiles, and retrained partly in the plants of the donor company and partly on-site by professionals delegated from abroad for this purpose. The approx. 2oo assembly workers mentioned above should be complemented by about loo skilled workers for component production.

Part of the skilled labor referred to above, however, cannot be provided for in the further course of plant development from the reserves of the related industries, so if the instrument industry is to be further developed and expanded, it is strongly suggested to introduce regular skilled labor training parallel to that in the plant to be established, either additionally within the same plant, or in another separate municipal or state institute set up for the purpose. The training course need not be separated from the general mechanical or electric instrument apprentice education, perhaps only the practical exercise should be completed in this direction.

1.4.2 Provisions for higher technical level employees

It has already been mentioned under 1.4.1 that the supervision of the work of skilled and semi-skilled labor requires at least medium level technical supervisors. The same qualification is necessary in the instrument industry by many other positions as well, such as

- plant managers and senior foremen,
- installation and test experts,
- adjustment technicians and mechanics,
- calibration mechanics,
- quality control inspectors.

These, too, must be trained either in one of the relevant professional institutes /technical, skilled labor or apprentice schools/, of an advanced industrial country, after the necessary language education, or through an in-plant training program of sufficient duration, provided for by the donor company. Here we have to start again from the assumption, that the recipient organization will be in the position of supplying professionals with a sufficient qualification background for mastering the required high-school level knowledge. This includes familiarity with the world language used in the geographical area in question, and acceptable mechanical skill.

Obviously the two post-graduate education forms may be employed in parallel as well, depending on the local conditions of both the donor and recipient organisations. If the recipient country has at a moderate distance from the plant to be erected an apprentice or technician institute where the extension training could be organized in the national or in a foreign but regularly spoken language, this possibility must not be neglected, either. In this case, however, the donor organization will have to render considerable assistance in the composition of the curriculum and the educational aids.

Since those in this category hardly amount to even as much as 10 per cent of the total, the establishment of separate local technical schools, engineering faculties or department cannot be recommended. As the most efficient solution of the problem, the above extension training courses either locally or abroad, mainly the in-plant training method should be recommended.

## 1.5. General industrial environment

This Chapter deals with some factors to be carefully weighed when deciding on the establishment of an instrument industry plant. These include the problems of site selection and environment, correct decision on the area size and building requirements, public utility and other communal service demands, the possibilities of how to satisfy these demands and requirements, etc.

### 1.5.1 Location as related to other industries and training centres

With respect to regional location, a new instrument industry plant does not set special requirements, but can flexibly serve the "multi-centre" industrialization and provincial industry allocation plans of any developing country.

The regional allocation of a national instrument industry needs, nevertheless, thorough and careful consideration, as some of its peculiar features like labor requirement and composition, its position and supplementary role played in the complex industrialization of certain areas demand long-term planning and foresight.

In general, the main economic characteristic of the instrument industry is its low material requirement in weight as compared, for example, to that of the machine industry. Consequently, it has a similarly lower demand for material and finished product deliveries, for transport and communication, compared to industry in general. Its transport cost index either as related to weight and value, or in an absolute sense /e.g. cargo hold cost, etc./ is similarly low. Beyond the domestic relations, this is particularly advantageous, if certain materials and components must be imported.

### 1.5.2 Environmental requirements

Two main requirements deserve here particular attention: instrument production prefers a clean, dust-free environment and its relatively high or specific labor requirement should preferably be provided for locally.

Experience shows much more favourable production conditions in out of town locations. An instrument production plant should not be located near to a high-power broadcast station, or airport, as such cases mean, that disturbances may be expected from interference signals.

Under torpical or subtropic climatic conditions the calibration and control facilities and premises should be air-conditioned.

As for the labor requirement, it must not be forgotten that in the instrument industry the specific demand for skilled or even highly qualified labor is rather high. In order to ensure this type of labor, and with respect to expansion and further development the plant site should be selected in an area where a trade school, or a technical high-school is existing, or is in the development plans.

In the instrument industry another feasible location alternative is - and many examples prove this - the establishment of the production plant in a provincial area corresponding to the existing employment requirements. At the same time, the research and development basis of production can be set up in a town with a technical university and highly qualified professional staff.

### 1.5.3 Plot and building requirements

Instrument production and assembly halls are constructed usually with light building structures. The weight load represented by the assembly lines is readily withstood by the floor structures employed.

The plot size depends on the capacity assumed by the investment. The attached "Profiles" contain detailed data sets elaborated for several different instrument families.

If the new plant is established on a "green area", then the machine and equipment costs will be approximately identical with the construction costs proper, if the problems arising from currency differences are disregarded.

In the determination of the area and building requirements it is best to fresee a plant somewhat below the optimum size, while the energy supply /water, gas, electricity/ required for further expansion and the possibilities of building extension should be secured in advance.

1.5.4 <u>Services /current, water, transportation/</u>

As for the communal services, the instrument industry should be considered as a minor consumer. Its current, gas and water consumption requirements are much lower than those of the other industries.

The specific energy requirement of the instrument industry is similarly small, the lowest next to that of the telecommunication industry. The 1 to 1,4 kW/employee index of the instrument industry is less than 5o per cent of the value observed in other mechanical engineering industries.

As for water, besides a minimum quantity of industrial water the potable water supply is rather important, just the same as an adequate canalization.

A direct railway line is not absolutely necessary, but at least feeder roads to the main routes should be available. This way the transport of materials required for construction and production and the delivery of the finished products might be accomplished by road vehicles, due to the small volume and weight, as well as easy packaging possibilities of these products.

1.5.5 Financial and other incentives

The attached "Profiles" reveal that the required foreign currency credit grants are in the order of magnitude of a few million dollars. Thus the financing of the planned establishment may not cause any serious difficulty.

The basic problem is that the developing countries wish to create new employment possibilities, for example, by the introduction of instrument production and would like to develop industrially at the same time. This in itself is a fundamental incentive.

Development of the national industry is indespensable, just like the satisfaction of the home demand. These are not always only ecomomic problems. A direct incentive is decided upon and given by the time when the technological and educational preconditions required for such a development would have been created /a basic staff of adequate qualification, etc./.

The fixed assets demand of instrument production is relatively low, that is, the same production value is reached by making use of considerably less fixed assets in this field than elsewhere. Comparing with the figures of the industry as a whole, the requirements of the instrument industry for fixed assets is about 25 to 3o per cent lower.

The yearly growth rate in the instrument industry is often 18 to to per cent, even over a long-term course. This is generally much superior to the growth rate of the average industry.

This is readily understood if it is taken into account that the world industrial production has increased annually on the average by 6,3 per cent, manufacturing by 6,5 per cent, while metal and engineering product by 7,6 per cent.

## 2. Grouping of instruments from the point of view of manufacturing techniques and application

### 2.1. Mechanical instruments

Instruments and medical devices produced mainly by mechanical methods are of a significant importance in the industrialization of the developing countries since their manufacture, as compared to that of other instruments, is relatively simple and requires the training of a much lower number of professionals. The instrument families listed in detail below have been selected exactly from this aspect, and the family of length measuring instruments was deliberately omitted /micrometers, calipers/, as their production demands the employment of highly qualified skilled labor.

For the purpose of the present study, the scope of mechanical instruments will therefore be restricted to scales, medical tools and educational aids.

### 2.1.1 Commercial and industrial scales

As mentioned before, scales represent important tools in trade and industry, required in large quantities in the developing countries as well.

From their wide assortment certain types most frequently used in everyday practice can be readily selected:

- 15o kg desk type steelyards,
- 1oo, 2oo and 5oo kg weigh beam balances,
- 2o kg lever balances,
- 1o kg baby scales,
- 15o kg person scales.

As shown in detail by Appendix No. 1, the delicate parts and mechanical components of these scales would be produced for quite some time by the "donor" company, while assembly operations, testing and calibration of the scales should be at the "recipient". The attached company profile contains detailed data on the establishment of an instrument assembly plant representing a production value of 1,5 to 2 million dollars /approx. 2oooo scales/ per year.

### 2.1.2 Medical and surgical tools and instruments

Experience shows that medical practice requires a large quantity of medical and surgical tools and instruments. These include, among others, surgical scissors, artery forceps, tongues and scalpels. Due to the simplicity of their production they might be suggested, as against many other medical tools and instruments, to the developing countries for manufacture.

Appendix No. 6 supplies detailed information on the technical and economic conditions of series production of such items.

### 2.1.3 Educational /teaching/ aids and media

A serious obstacle to the development of public education is the slow rate at which the newly established schools are being equipped. This applies particularly to the natural science inventories of grade-school level educational institutions whose equipment is often very deficient.

It seems, therefore, reasonable to organize the local production of educational aids relatively easy to manufacture required for teaching mathematics, chemistry, and biology. This can be accomplished within a program like this if appropriate international co-operation will support it, although it involves not so much measuring instruments, but rather instrument models and strictly educational aids. In the following we shall list in technological grouping the educational media which could be produced in the developing countries proper for teaching various subjects, naturally in many cases only with a significant support by the "donor".

/a/ Metal shop products, e.g.
- for physics: scalebeams, plumb bob
- mechanics: iron, copper and aluminium pendulums, arm swings, metal discs
- thermodynamics: calorimeter cup

/b/ Woodworking products, e.g.
- for physics: decimal balance model, Roman scale model
- mechanics: screw model made of wood, wooden pendulum, cylinder wheel
- acoustics: reed pipe, quill
- biology: planting fork

/c/ Glassware, such as
- for physics: suction well, compound well, communicating vessels, Segner wheel, Torricelli tube, water-suction vacuum pump
- biology and chemistry: test tubes, blow tubes, drippers, miscellaneous glass tubes

/d/ Plastic articles, like
Botany:
for biology: various mushroom models, apple blossom, wheat and oak efflorescence, leaf structure, phytocell
Anatomy:
for biology: human skeleton, human skull, eyes, heart, tongue, hearing system, human brain, larynx, human skin section, ovum
/e/ Products made of natural raw materials, such as
for biology: sponge, red algae, medusa, coral, porcupine fish, spider, leech, snail
/f/ Educational slides
black-and-white slides, colour slides

2.2. Power measuring instruments

The heavy current electric measuring instruments are related to one of the most fundamental industry of key importance: power production, distribution and management.

Electrification is always a long-term project, thus the requirements for power measurements and control are similarly of a long-term character.

Accordingly, electrical instrument requirements can always be associated with given industrialization, power economy and accounting possibilities and the rate of housing, too, exerts an effect on the development of this demand.

2.2.1 Power consumption and economy create instrument requirements that may be satisfied, above all, by watt-hour meters.

Local production is rather advantageous if watt-hour meters are to be produced. In the recipient country, production should be started by the of single-phase watt-hour meters. The advantages of this are:

- about 9o per cent of the country's requirements can be satisfied by this type /residential buildings and shops/, and
- the demand for single-phase watt-hour meters will exist during the entire period of industrialization.

Furthermore:

- calibration, repair and service can be integrated in practice, since all these operations are under the authority of the measurement laboratories of the electric power works;
- assembly and calibration can be performed mainly by semi-skilled labor;
- the existing technological equipment may also serve the manufacture

of other electrical instruments, which helps the extension of product range and in encreasing the economic efficiency of production.

Establishment of a watt-hour meter plant demands considerable capital, so it simply cannot be realised without a donor company, or considerable state financing. The establishment of such an enterprise must be supported and justified by economic calculations. A plant of this type will turn profitable within 6 or 7 years.

The technology employed combines the characteristics of mass production and electrical instrument manufacture, so its introduction is all the more advantageous as from the technological viewpoint, it does not belong to the category of highest precision industries.

Hungary has rendered assistance so far to the establishment of a total of 4 such assembly plants in developing countries.

2.2.2 Moving iron measuring instruments

A good supplementation of the watt-hour meter range is the so-called moving iron type electrical measuring instrument production, because of the following reasons:

- the production facilities of watt-hour meters are suitable, up to about 80 per cent, for the production of moving iron instruments as well;
- the fields of application of the two instrument categories are quite close to one another;
- the maintenance requirement of these instruments is very low;
- with a relatively simple basic assembly a rather wide assortment of ranges can be covered;
- instrument production can make good use of the skill mastered during the production and repair of power machinery in
    - coil winding,
    - iron core production and
    - cold moulding.

If instrument production is started as an independent line, then manufacture of the following instrument families might be commenced additionally:

- moving coil meters,
- measuring transformers.

The relevant fields of application include

- electrical switchboards and laboratories,
- power units.

2.2.3 Industrial testing instruments

/Measuring bridges, insulation resistance meters/

In their application, these instruments differ from the above in that they are not related to power consumption, voltage or current measurement operation but primarily to test electric operational conditions. Their main duties are, accordingly, quality control and the solution of service problems /e.g. grounding and other resistance measurements/.

Their design is quite different from that of the previous two groups, since

- they contain a larger number of mechanical components, and
- demand a greater amount of skilled labor work.

2.3. Electronic instruments

These represent the most up-to-date branch of instrument production today.

Fast technical development is associated with a continuous change in instrument components and in a continuous advancement in construction design. Design will become obsolete in as short a time as 5 to lo years.

This is where continuous co-operation of the donor is most indispensable for the improvement of instruments thus transferred.

The following paragraphs enumerate some instrument categories whose production might be initiated in the developing countries as well. Service availability, however, is a fundamental precondition of their general acceptance.

2.3.1 Telecommunication meters and basic service instruments

These instruments perform the fundamental measurements in both wired and wireless telecommunication. Demand for such instruments exists wherever a wired or wireless postal communication system is in operati

The range of their application is rather wide but their production methods, too, are much more comprehensive, than, for example, those of the watt-hour meters. They cover the following main groups:

/1/ solid-state voltmeters and mV meters,
/2/ sound-frequency generators,
/3/ oscilloscopes,
/4/ signal generators,
/5/ attenuation bridges,
/6/ measuring test receivers.

Professionally, the requirements are higher than in the production of, say, a basic electrical instrument which is fully justified, among others, by the short-run production character in manufacturing the individual models.

2.3.2 Radio and TV instruments

The wide-spread use of radio and TV sets is accompanied by the need of their continuous servicing and repair. This is the field where the demand is largest for such instruments.

The build-up of these units is fully electronic. Their most important types include

- solid-state voltmeters,
- low-frequency oscilloscopes,
- high-frequency oscilloscopes,
- laboratory voltmeters,
- transistor test sets,
- laboratory and service type radio frequency signal generators.

Among all the instrument industry products this is where the ratio of components to be imported and the skilled labor work requirements are the highest, but similarly this is the area where, owing to the fast improvement of electronic circuitry a rapid rate of technological development is necessary.

2.4. Optical instruments

2.4.1 Surveying instruments

A fundamental task in every developing country is to create the conditions of surveying measurements. The re-arrangement of land property conditions, preparation of investments, industry allocation, town development planning, construction design and contracting, etc. all require maps and geodetic data.

These tasks, in turn, demand a large number of instruments. Similarly measurements need a large number of medium and high-grade professionals, and, therefore, the relevant educational institutions must also be equipped with modern measuring means. Acquisition of the many valuable surveying instruments, the maintenance, completion and replacement of the existing stock, if by imports, impose a rather heavy burden on the economoy of the developing countries, thus the possibilities of local production should be most certainly reckoned with, all the more so, as actual examples on such undertakings can already be found. /See Appendix No. 2/

Production of optical parts for the component supply of a single product family cannot be realized economically. On one hand, the high-level performance of too many specialized operations /optical cutting, plane and spherical grinding, polishing, grading, cementing, depositing thin films, optical control, etc./ would be needed for short-run manufacture and, on the other hand, the personnel requirements could not be met, either, as nobody, but skilled labor with years of practice and experience would be able to perform these operations in a satisfactory quality.

Products to be manufactured or assembled in a developing country might be selected with taking into account the following aspects:

Low-precision instruments can be produced in a rather simple way, and demand for such units is usually higher in any given country. Such instruments are, for example, the 1 min reading theodolites of the glass circle design, that is, relatively quite up-to-date, or the 5 mm/km mean error levelling instruments. The production of low-precision automatic levelling instruments can also be envisaged in some of the developing countries, although the acquisition of the compensator as an assembly from the donor company should be continued even in such cases. An important possibility is here, that jointly with the basic instruments, the accessories like the stand, target plates, levelling rods, carrying cases, etc. might also be produced and marketed locally, and the eventual leftover capacity could then be devoted to the production of small measuring devices employed generally.

If in the given developing country there exists a small-scale plant or service station engaged in surveying instrument repair activities, then the development of a manufacturing plant may be advantageously based thereon.

Taking the aforesaid into account, as well as the production possibilities of the given developing country and furthermore the existing market demand, a local assembly type production of the following surveying instruments and accessories may be seriously considered:

Instruments: small theodolite
minute reading theodolite
levelling instrument
engineers' automatic levelling instrument without compensator

Accessories: optical plummet
target plates
instrument stands
levelling rods and tacheometric staves
2 m invar subtense bars
carrying and battery cases for surveying instruments
wall tripod
drawing board for plane table equipment
alignment rods
angle prism
2, 5, 1o, 25 and 5o m measuring tapes.

## 3. Provisions for starting production

### 3.1. Process to determine and create the conditions of production

#### 3.1.1 Identification of the production basis /recipient/ to be established

After the competent government or trade authority has decided, on the basis of criteria discussed above, on the product family to be manufactured, an existing industrial establishment suitable to act as "recipient" and to organise the production of the instruments in question will have to be selected.

As referred to earlier, the first stage in the industrial production of the instrument family to be introduced is the local realization of the assembly and test operations by using imported subassemblies and components. Accordingly, in the first phase the recipient company must provide for mechanical /perhaps optical/ and electrical, or electronic assembly operations, so these must be thoroughly acquired in advance. Subsequently, one or two years later, metal working operations will also have to be provided for, such as sheet metal working and machining, or pressing.

Thus it is quite clear that the assembly operations usually do not represent everything, so the recipient company should be selected with the idea a priori in mind, that beyond the assembly work, they will later have to produce fittings, structural elements and components, not available commercially.

Depending, therefore, on the character of the instruments to be produced, in selecting the recipient it is best to chose a

mechanical /machine industry/,
electrical /power engineering/, or
electronic /radio engineering/

plant, or institution.

The factory thus selected will obviously be ill-prepared both as to mechanical facilities and professional skills, but should secure the fundamentals for starting and developing production basis. Every possibility of instrument production can then be "superimposed" to a satisfactory level, assuming an adequate build-up of equipment and knowledge.

3.1.2 Identification and selection of the donor country or company

An industrial enterprise is suitable to act as a donor if it has, in the professional field selected, an appropriate engineering, commercial and financial background. In detail:

a. it must have a well-established line available from the instrument range selected, in a form suitable to permit the selection of the most marketable models for assembly abroad;

b. it must have a suitable professional staff, capable to undertake the job of information transfer in a common laguage with the personnel to be trained at the recipient's;
c. it must supply in the desired language the necessary drawings, parts list and production specifications on the basis of which first the assembling, then the manufacturing operations can be performed;
d. it must have professionals, who with a satisfactory knowledge of the foreign language required are capable to render professional assistance for starting production;
e. it must be willing and capable to render assistance in organizing marketing and service activities;
f. in addition, the donor company must be able to supply certain assemblies and later on, machined or fabricated components of the instruments first to be assembled, later fully manufactured, until such time, that the recipient attains complete independence;
g. the donor must specify the measuring devices required for the calibration and testing of the products and provide for commercially not available test rigs either from its own production, or otherwise;
h. finally, the donor company must be in a position to supply plans, if necessary by the intermediary of a competent project bureau, on workshops, equipment, etc. suitable for the performance of manufacturing, assembly and testing operations, including the machines, tools, etc. whereby the plants and shops of the recipient can then be constructed, equipped and extended.

### 3.1.3 Determination of the product assortment to be manufactured

It is widely known that in advanced industrial countries the assortment of instruments produced in any technological category is rather wide. Thus even a relatively small industrial country, like Hungary, is producing almost 5000 different types of instruments. It is, therefore, quite obvious that the very few instrument models the recipient company intends to deal with in the first 10 years, and the manufacture whereof that company must prepare itself, should be very carefully selected.

Such a selection will be governed by two factors:

a/ domestic and expected export requirements
b/ the simplicity or complexity of the production techniques.

The company profiles enclosed and the instruments enumerated in Chapter 2 supply a starting point for determining the initial product line, although it should be emphasized that the final assortment will be determined by the market experiences of the donor enterprise and the expected demand of the market area around the recipient company.

3.1.4 Provisions for a basis of material and component deliveries

As discussed in detail under 3.3.5 the development of close connections between donor and recipient companies will govern the material supply process in the first years. The donor company will provide almost all required materials in the first 2 or 3 years and the recipient will purchase independently only those which might be acquired more advantageously this way.

In the subsequent years, as discussed under 3.3 an independent material and component supply will develop gradually from either local sources, or imports, which, however, lead to increased independence.

3.1.5 Preparation of the manufacturing drawings in the language required by the recipient

Production documentation must be supplied, of course, by the donor company, in a world language widely used in the recipient area. Translators familiar with the technical wording must be employed.

3.1.6 Planning and procurement of the machines, instruments and buildings required for production

These tasks can be handled in several different ways, depending on the possibilities of the recipient country in question.

It is indispensable, of course, that the donor company should supply detailed data on the machines and equipment, the number of working stations and their arrangement and the special production phases to be realized. Thereafter, the recipient company, in the possession of these and other data, may design the plant and purchase the required productive means and facilities.

In the majority of cases, however, the recipient will request the donor to provide for, either directly, or through the intermediary of a contractor or a consultant bureau, the plans and entire investment documentation of the plant to be established and the recommendations on the training of professionals. For relevant detailed information on this, see Par. 3.2.5 "General contracting."

3.2. Provisions for non-productive /peripheral/ requirements

3.2.1 Establishment of an independent official instrument testing station

From calibration aspects the measuring instruments may be divided into three categories:

/a/ instruments with compulsory calibration
/b/ instruments with only in-plant calibration
/c/ instrument industry products with no need for calibration.

Ad /a/ - In the highly advanced industrial countries, calibration is compulsory in the case of all instruments required for commercial business transactions including above all the various scales, volume and linear measures. The same applies to the instruments for metering electricity, gas and water supply, which render accounting data.

Their production and marketing can only be introduced, if at the same time, a control laboratory maintained and controlled by the state metrological service is also established /perhaps in the immediate vicinity of the plant proper, as is frequently done in practice/. Planning, design and installation of this official calibration laboratory should be, of course, preferably secured by the same donor as that undertaking all the other plant facilities.

Ad /b/ - Production of the instruments requiring only in-plant calibration does not need the establishment and operation of a governmental control station. These instruments will have to be tested by staff specialists in the quality control department of the manufacturer proper.

Design and installation of these plant level calibration and testing bases represent, of course, an integral part of the services undertaken by the donor.

It will have to be noted here, however, that the standard instruments of the local calibration and test laboratory must be submitted periodically for inspection to an internationally acknowledged measurement calibration institute. Working relations for this purpose should be created as soon as possible with the assistance of the donor.

Ad /c/ - Products in the third category are actually not so much measuring instrument, rather than chemical and medical tools, laboratory ware, educational aids of a precision mechanics character. In the case of such "instruments" no calibration problems arise.

3.2.2 Education and training of technicians, skilled and semi-skilled labor for the recipient enterprise

Starting production and its increase require competent technical and physical employees. Making this personnel learn about their new duties takes much time even by well-organized training programs. In this field the donor company /institute/ must render considerable assistance for success. Training at the level of engineers and technicians should be at the donor's plant in every case, but it might be similarly useful if a certain number of foremen and skilled labor, too, would learn about the production methods of the donor in site. However, the majority of those participating in production should be trained at the recipient enterprise, by those, who have mastered a basic knowledge at the donor's. This might be greatly promoted if the contracting parties agree that the donor should delegate to the recipient factory a few professionals thoroughly familiar with both production and testing, for a period of several months.

3.2.2 Medium and high-grade professional training through foreign fellowship grants

As mentioned under 1.4. organization of instrument production requires the training of quite a number of technicians and university graduates The specialized training may be obtained either at the donor's establishment in the form of in-plant training, or at an appropriate level medium or high-grade educational institute, whose lecture language is mastered by the fellowship candidates, or learned through a one-year course. Such language courses have been successfully organized by the educational institutions of a number of countries. Depending on the language-barrier, training courses may be organized any time at middle- or high-level schools majoring instrument engineering. Examples are the Instrument and Telecommunication Engineering College of Budapest, Hungary, founded almost 2o years ago, or the Instrument and Measurement Engineering Department of the Budapest Technical University.

Preparation of such fellowship study tours is usually through intergovernmental agreements, concluded by the competent educational authorities.

### 3.2.4 Establishment of repair and customer service centers in trade or industrial centres

In order to promote the satisfactory operation of the instruments sold and installed for a sufficient period of time, it is definitely advisable to set up repair and customer service units in the most important industrial and/or trade centres of utilization. The staff and equipment supply of these stations must ensure the installation and continuous operation of all models sold, or else, owing to defective installation or neglected maintenance, the expensive investment represented by the acquisition of a commercial, or industrial purpose instrument stock might lose its value within a very short period of time.

These customer service and repair stations are workshops and/or laboratories of 5 to lo employees, well equipped with control and calibration instruments, for the accomplishment of the following duties:

- determination and assessment of the demand before marketing
- identification and interpretation of any special application requirements
- provisions for professional mounting, installing and commissioning
- identification of eventual defects and operational deficiencies at installation and drafting an immediate service report
- assistance in training of local operators
- execution of guaranteed and non-guaranteed repair jobs

- regular annual supervision
- collection of field experiences and their forwarding to the home plant.

These activities obviously require highly qualified and experienced professional engineers who need a training of at least 1 to 2 years.

About one-third of the service station personnel consists of highly qualified technicians and skilled labor to continuously perform the required manual duties of installation, maintenance and repair.

Companies sometimes neglect the establishment of a high-level, organically built-up repair and customer service system. This soon leads to repercussions, particularly in the developing countries, and causes much annoyance to customer and supplier alike.

3.2.5 Contractor problems

Developing countries sometimes demand that, instead of building up an instrument industry establishment in the traditional multi-stage manner, some phases of the industrial development be omitted and immediately a complete instrument factory be constructed. In these cases the customers frequently prefer turn-key plant delivery.

Creation of a national instrument industry this way might be wanted because of the local labor situation, or since there is no sufficient local knowledge for the establishment of a complete industrial enterprise. In other cases, especially favourable financial conditions may induce the developing country to establish a complete plant almost exclusively by foreign assistance. In recent years, for example, considerable demand could be observed for complete food industry installations including, beyond the necessary machines as well as the various instruments and devices required for production process, quality control, etc.

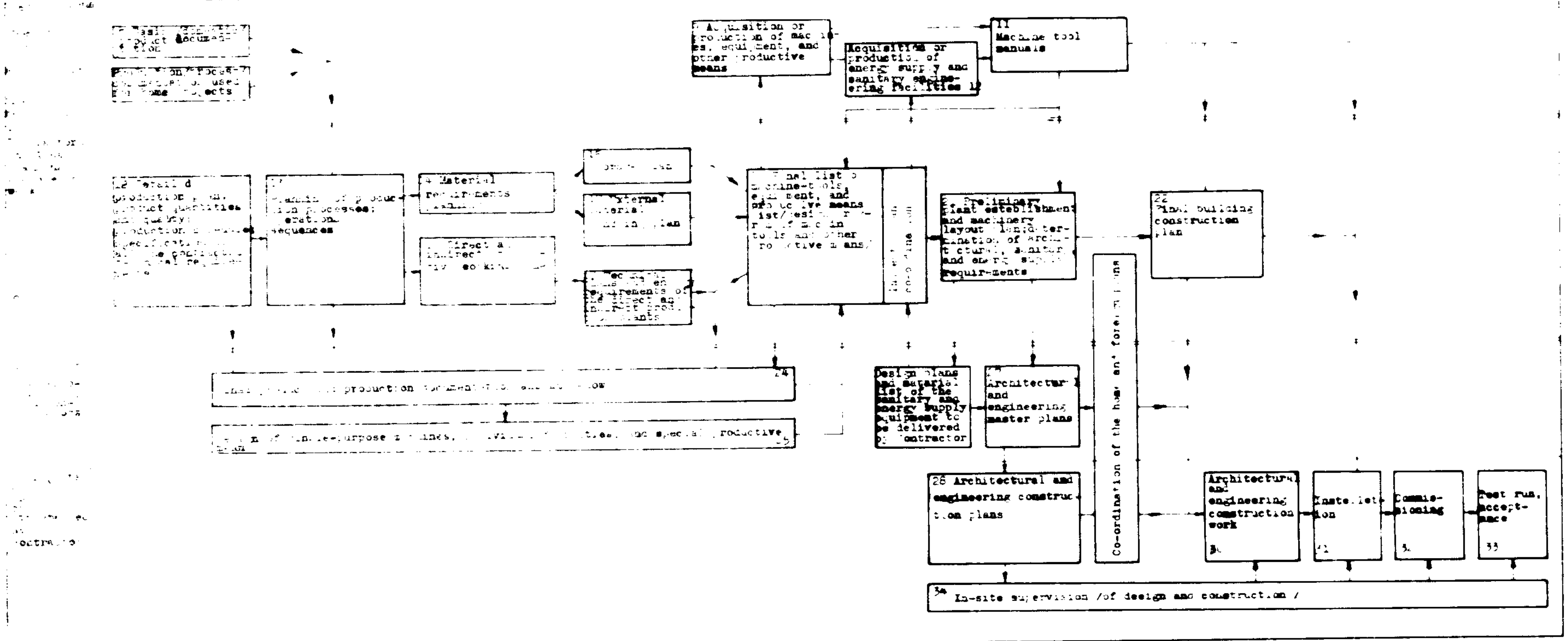
Many developing countries started the establishment of large-scale industrial enterprises, including instrument production plants, for which the necessary building capacity was not available, just like the required labor, from either number or qualification aspects and for which neither an acceptable home contractor could be found, nor was the desriable infrastructure existing. A solution in such cases is the conclusion of an agreement with a f o r e i g n c o n t r a c t o r, on the establishment of the enterprise in question.

Technical and other requirements set to complete factory or plant deliveries are rapidly increasing. The investor requirements vary, their demands and conditions differ. While earlier the contractor activity was usually completed by the delivery of the machines and equipment, nowadays the "turn-key" transfer form prevails. Contracting is nowadays a high-level complex intellectual activity involving, however, considerable engineering and commercial risks. It includes the following main phases: preparatory technical-economic survey, submission of a tender, planning and design documentation and know-how supply, commodity transport, construction, assembly, installation, as well as the advisory services, training and hand-over for the control of all those above. The contractor type industry allocation form demands a very cautious procedure from the contractor company proper in the identification of the possibilities of industrial establishments and in creating the appropriate conditions. In addition to the in-site work, the contractor must be in a position to enlist the services of experienced design bureaus familiar with design work concerning public utilities, such as the organization of water supply including, if needed, that of a potable water purification scheme, or the layout of a gas supply, canalization, power transmission, etc. system.

The contractor must furthermore, provide for systematic and well-harmonized deliveries, the organization of material and component transports to ensure continuous production, extensive organizational activities related to the entire investment and the co-ordinated solution of all emerging financial problems.

The design and associated engineering activities are presented in the enclosed schematic flow-chart. Such activities are carried on for several years by now by quite a number of contracting organizations in the advanced industrial countries.

## DESIGN AND ASSOCIATED ENGINEERING ACTIVITIES OF THE MAIN CONTRACTOR



3.2.6 Professional advisory and consulting services

In the case of both the traditional multistage industrial development /see Chapter 3.3./ as well as that of the single-stage implementations /including turn-key deliveries/ the problem of recruiting local or foreign professionals is of great importance.

The training of instrument specialists for a given developing country is, in addition to making use of the existing or potential possibilities of that country, mainly through foreign assistance. As a basic solution, such training is always feasible by the foreign partner entrusted with the delivery of the entire instruments plant, or manufacturing the instruments in question.

Thus the duties of the donor include not only the introduction of instrument production, but also provisions for making the personnel required for this purpose available. Here usually a certain tension is created, since the donor is not always in the position to delegate competent professionals in a sufficient number and for an extended period of timeto the recipient country. Moreover, if the professionals to be delegated are not sufficiently familiar with the requested language, certain problems will have to be faced regardless of their satisfactory qualification.

Contractors usually can solve the problem of delegating a small-number advisory team to the new plant, or of training a few employees of the recipient in the donor country.

If a higher number of consultants or tranees is involved, usually the participation of a consulting engineering service is needed. Such agencies operate in several countries. These organizations possess enough knowledge on the technical-scientific achievements of the instrument industry and have sufficient experience in the

- professional training of foreign specialists, including their engineering post-graduate education,
- delegation of consultants through intermediary action,
- design work and implementation of these duties.

Upon a contract with either the donor or the recipient, professional training can be realized at several different levels simultaneously by the assistance of a consulting engineering service bureau, including

- skilled labor training in which apprentice schools offer theoretical and practical education to the trainees, plus actual work in model shops or productive plants;
- training of technicians;
- specialized education of foremen and other professionals in instrument factories or other important industrial enterprises associated with the field;
- post-graduate courses for engineers of the recipient in the donor country.

3.2.7 <u>Other possibilities for the supply of professionals</u>

Instrument expert training is feasible within the framework of intergovernmental bilateral agreements projecting the transfer of technologies to developing countries to promote their industrial development.

Another very efficient method of training professionals is through UNIDO Special Industrial Services. Within their contributions to UNIDO, certain highly developed countries undertook the training of a pre-determined number of professionals from the developing countries upon their request. UNIDO informs the developing countries concerned on these possibilities by circulars, specifying in each case the professional fields involved. Possibilities exist, however, in certain cases without area specification. In such instances the applicants specify the professional field desired, the reference data of the suggested training personnel, the training period, etc. The competent body of UNIDO will then inform the applicant on the acceptance of his request, and the delegation as well as the implementation of the practical training will be executed accordingly. Furthermore, in UNIDO organization a developing country may invite professionals of appropriate qualification for a pre-determined special purpose, like the establishment of an instrument industry basis. Upon such a request UNIDO will announce an open competition in all of its member states.

The competition responses will be evaluated by UNIDO in co-operation with the representatives of the applicant country's competent authorities, whereafter the country thus selected is notified on the acceptance of her proposal. Finally a contract is concluded with the professional concerned who then will start his activities in the recipient country.

3.3. <u>Initiation and continuous expansion of the production process</u>

3.3.1 <u>Assembly work with the components delivered by the donor</u>

The fundamental and most general form of starting instrument manufacture is the assembly and calibration by the recipient of sets delivered by the donor.

These sets contain not only components but also semi- or fully-assembled units.

Accordingly, the recipient activities in the initial phase cover nothing, but assembly and calibration work. This phase takes 2 to 3 years, during which the recipient

- will learn how to assemble, calibrate and quality control the instrument in question
- makes the necessary preparations for the local production of certain components in the next phase.

Installation of a kilowatt-hour meter assembly plant, for example, takes 5 steps, from assembly to gradual local production.

The first assembly phase is of particular interest, as

- the equipment of assembly must be tested
- the working phases of assembly must be practiced
- the equipment required for local production must be delivered, installed and assembled
- by learning from the quality deficiences of the finished products, the technological chain must be repeatedly supervised.

The next phase can only be started if this assembly and calibration work has been performed unobjectionably.

3.3.2 During the assembly phase as described under 3.3.1 it is most expedient to create possibilities for the local production of the mechanical components involved. Here such mechanical components and fittings are considered whose

- transport is rather uneconomic because of an excessive bulk /e.g. boxes, frames and similar units made of plates or castings/,
- acquisition is commercially impossible as they had been designed specially for the product to be manufactured;
- production technique is easy to master, can be readily tooled and which can be manufactured with but moderate skills.

The necessary production equipment /metal plate working machines, foundry facilities, sand blasting, painting and electroplating installations, etc./ and its potential layout must be planned early during the design of the instrument factory and its acquisition as well as set-up and the training of its personnel must be performed in the course of the first 2 or 3 years, if the donor is willing up to this time to continuously deliver these components and fittings in finished condition.

3.3.3 In the set-up phase discussed in par. 3.3.1 the donor company delivers the assemblies in question to the recipient in finished condition and appropriately tested. In phase 3.3.3 the in-site assembly of these units must be performed. Thus in the first 2 or 3 years of the production by the recipient preparations should be made for the subsequent local assembly of electric or mechanical subassemblies and then for their production and quality control.

In this phase, depending on local conditions, the recipient company purchases certain components of the assemblies, which are commercially available, while the components designed specially for the purpose /e.g. printed circuit boards, special coils and transformers, etc./ should be delivered by the donor enterprise like before.

A professional preparation and control of the assemblies would require, of course, the training of further technical and production control personnel who, in turn, could train the semi-skilled labor of the recipient company to perform the various operations of the process.

Arrival in due time of the component assemblies to be continuously delivered by the donor company in an acceptable quality to the recipient must be carefully organized in order to ensure an uninterrupted production from the very beginning.

3.3.4 The production phase described under 3.3.3 should characterize for 1 to 2 years the relation between the donor and recipient companies. During this time professionals can then be trained for the local production of special components commercially not available, such as those mentioned under 3.3.3 which require special mechanical, or electric production techniques. First the production of those components must be started by the recipient company whose manufacture is economic even in short run, and for whose manufacture the eventually required special machines and equipment can be utilized with an acceptable efficiency.

3.3.5 After the accomplishment of phase 3.3.4 with the meantime experiences made use of, the recipient company should prepare to acquire complete independence as far as the purchase of semi-finished products and components available on the international market would be concerned, except some specific parts that

a/ could be purchased from the donor against the most advantageous price and deadline conditions,
b/ would be items produced for or delivered to the donor by third companies which could be purchased in the simplest or most advantageous way from the donor proper.

3.3.6 Establishment of a marketing and service organization

In a developing country, instrument production would promote the accomplishment of two objectives:

a/ promotion of the industrialization of that country,
b/ satisfaction of the demand in that country and in those in close commercial connections therewith, for the product in question.

The latter makes it indispensable to establish at the beginning of production or even prior thereto a commercial service to provide for the necessary relations with both the home and foreign market areas. As mentioned before, this must be a technically well prepared trade organization with an adequate public relations service associated.

It is similarly important to establish if possible in the recipient enterprise proper, a repair and service department to provide for the elimination of any breakdown as soon as possible. Such a service department must have, of course, a spare parts storage and a well qualified professional staff, familiar with all instruments manufactured earlier by the enterprise.

SCALES ASSEMBLY PLANT - A Profile Appendix No. 1

## Introduction

The present paper describes in detail a medium-size enterprise conforming to the objectives of the developing countries which would be suitable for the assembly and after further development, the full production of scales.

The appendix contains a floor plan together with estimated economic and manpower data. The financial estimates include the capital requirements of investment and working capital as well as the costs of technical assistance. The magnitude of home and foreign financial needs was estimated.

## Engineering aspects

In preparing the plans of a scale assembly plant the following aspects have been considered:

a/ The scale assembly plant should be suitable for the assembly of a range of scales listen in the plan, without any local component production whatsoever, as well as for the quality control of both the assembly work and the finished products.

b/ The scale assembly plant might introduce subsequently the gradual establishment of component production and expand, thereby, into a full-scale manufacturing enterprise.

c/ By gaining experience in the construction and assembly technology of the scale models actually assembled in the plant, the enterprise might introduce the assembly of further new models as well.

d/ The plant may carry on the periodical repair, calibration and guaranteed as well as normal after-sales service maintenance of the scales supplied.

e/ In such a standard plant the following range of products could be assembled:

- 1oo, 2oo and 5oo kg weigh beam balances, 1o and 2o kg lever balances, 1o kg baby scales, 1o kg fish scales and 15o kg person balances.

The plant should be capable of assembling a total of 2oooo such scales annually, in a uniform distribution. Economic runs are 1ooo to 3ooo scales, except the lever balances where the same figure is 5000 to 8000.

f/ The assembly plant should operate with about 320 employees in a one-shift production.

Financial aspects

The value of such an establishment, including the technical expenditures required for reaching the stage of profitability, would amount to about

3.400.000 dollars

at a 6 per cent discount. The non-discounted financial requirements, assuming 2 years of construction period and 5 years up to profitability, are as follows:

Foreign currency requirements

| | |
|---|---|
| Investment | 300.000 $ |
| Initial installation costs | 2.000.000 $ |
| Total | 2.300.000 $ |
| UNDP or other technical assistance | 625.000 $ |

Local funds requirement

| | |
|---|---|
| Real estate investment | 1.000.000 $ |
| Installation costs | 2.880.000 $ |
| Total | 3.880.000 $ |

| | |
|---|---|
| Total costs | 2.300.000 $ |
| | 625.000 $ |
| | 3.880.000 $ |
| Costs grand total | 6.805.000 $ |

1. Factory planning and design

| | |
|---|---|
| Investment program, specifications, construction, engineering plans | 40.000 $ |

. Funds requirement

Real estate investment.

a/ Real estate /to be provided by [illegible]/
b/ Buildings

| | |
|---|---|
| Administrative and purchased material storage premises | [illegible] |
| Assembly plant | [illegible] |
| Finished product storage and miscellaneous | 1.000 $ |
| Total | 200 $ = 1.000.[illegible] $ |

c/ Equipment, furniture, facilities

| | |
|---|---|
| Equipment, tools, instruments, machines | 110.000 $ |
| Furniture, documentation | 55.000 $ |
| Transport means | 40.000 $ |
| Storage equipment | 60.000 $ |
| Total | 265.000 $ |

| |
|---|
| 1.000.000 $ |
| 265.000 $ |
| 1.265.000 $ |

3. Production and maintenance materials

| | |
|---|---|
| a/ Imported components for scales assembly per year | 625.000 $ |
| b/ Maintenance materials | 75.000 $ |
| | 700.000 $ |

4. Power, fuel, water

| | |
|---|---|
| a/ Power to be ensured for the assembly operations: 100 kW, load factor approx. 30 per cent, 5 cents/kWh | 5.400 $ |
| b/ Water, 60 lit per capita | 2.500 $ |
| c/ Fuel | 2.500 $ |
| Total | 10.400 $ |

5. Transport and communication

a/ 2 passenger cars
1 micro-bus

| | |
|---|---|
| Total | 7.5oo $ |

| 6. Labor | Number | Annual cost |
|---|---|---|
| a/ Production | | |
| Engineers /6.ooo $ per year average/ | 1o | 6o.ooo $ |
| Technicians /4.5oo $ per year average/ | 3o | 135.ooo $ |
| Skilled labor /3.ooo $ per year average/ | 16o | 48o.ooo $ |
| Unskilled labor /2ooo $ per year average/ | 1oo | 2oo.ooo $ |
| b/ Indirect labor | | |
| Administration /4.5oo $ per year average/ | 2o | 9o.ooo $ |
| Total | | 965.ooo $ |
| c/ Training | | |
| Initial training costs /96 man-months for 2 years/ by delegated professionals | | 1oo.ooo $ |
| During the 1-year construction and installation of the plant a total of 22 engineers, technicians and skilled labor acquaint themselves at the donor's plant with the drawings and assembly techniques | | 176.ooo $ |
| Educational costs in subsequent years | | 12.ooo $ |

7. Total costs per annum

at full capacity production

| | |
|---|---|
| Direct material /components/ | 625.ooo $ |
| Direct wages | 875.ooo $ |
| Production overhead | |
| Direct wages | 9o.ooo $ |
| Training | 12.ooo $ |
| Overhead material | 75.ooo $ |
| Energy | 1o.5oo $ |
| Transport | 7.5oo $ |
| Total | 195.ooo $ |

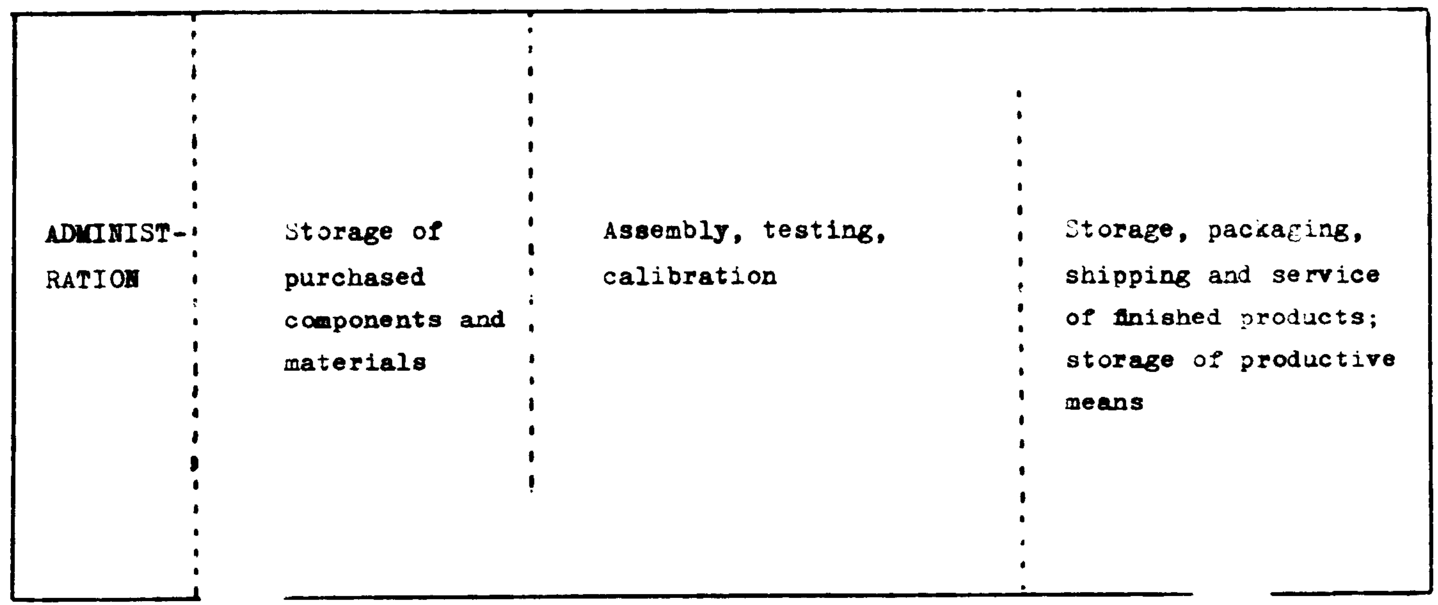
| | |
|---|---|
| Investment amortization /5 %/ | 63.000 $ |
| Administration and miscellaneous | 20.000 $ |
| Total production | 1.234.000 $ |

8. Total input

Investment, training, assembly up to starting operations

| | |
|---|---|
| Investment | 1.265.000 $ |
| Training | 820.000 $ |
| Amortization | 110.000 $ |
| Miscellaneous | 20.000 $ |
| | 2.215.000 $ |

9. Establishment value, including the engineering costs up to the break-even point, at 6 % discount — 3.390.000 $




SCALES ASSEMBLY PLANT

5200 m²

| Funds required for the establishment of a scales assembly plant in US dollars | Pre-project costs | Investment time 1. | 2. | Running-in period /year/ 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|---|---|
| IN FOREIGN CURRENCY | | | | | | | | |
| Investments in 1ooo $ | | | | | | | | |
| Planning and design | 4o | | | | | | | |
| Equipment, furniture, tools, machines, transport means, facilities | | | 265 | | | | | |
| Amortization lo % | | | | 26,5 | 26,5 | 26,5 | 26,5 | 26,5 |
| Direct material | | | | 15o | 25o | 35o | 5oo | 625 |
| Total initial capital requirement in foreign currency | 4o | | 265 | 176,5 | 276,5 | 376,5 | 526,5 | 651,1 |
| Technical assistance in foreign currency | | 125 | 3oo | 2oo | | | | |
| IN LOCAL CURRENCY | | | | | | | | |
| Investment, buildings /without plot/ | | 4oo | 6oo | | | | | |
| Overhead materials | | | 2o | 2o | 3o | 4o | 65 | 75 |
| Power and water | | | 4 | 4 | 5 | 6 | 8 | 1o,4 |
| Transport and communication | | | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
| Employees, direct production | | 4o | 14o | 28o | 4oo | 54o | 74o | 875 |
| indirect production | | 2o | 4o | 7o | 9o | 9o | 9o | 9o |
| Educational costs | | | | | 12 | 12 | 12 | 12 |
| Administrative costs | | | | 1o | 1o | 1o | 1o | 1o |
| Marketing, dispatch and shipping, travelling costs, miscellaneous | | | | 1o | 1o | 1o | 1o | 1o |
| Total costs in local currency /a/ | | 46o | 8o1,5 | 397,5 | 564,5 | 715,5 | 942,5 | 1o89,o |
| COSTS GRAND TOTAL in foreign and local currency | 4o | 585 | 1366,5 | 774 | 841 | 1o92 | 1469 | 1741 |
| Expected price revenue | | | | 478 | 731 | 992 | 1392 | 1768 |
| Difference /b/ | | | | -296 | -11o | -1oo | -77 | o |
| Initial capital required in local curr. /a-b/ | | 46o | 8o1,5 | 1o1,5 | 454,5 | 615,5 | 865,5 | 1o89 |

Appendix No. 2

PLANT FOR SURGICAL STEEL INSTRUMENTS - A Profile

## Introduction

Surgical steel instruments are needed steadily and in large quantities during the development of public health. Inspite of product-development, one can count with their becoming obsolete in the long run, only. The methods of manufacture facilitate a rapid and economic change-over of the range of products, to the manufacture of smaller hand tools and machine parts.

The present paper contains the capital requirement of the investment and the costs of technical training /assistance/ and those of plant operation in US $.

## Products to be manufactured

Surgical instruments made of stainless steel with polished surface, tempered, the artery forceps and scissors with centre screw, the forceps spot welded, cleaned and packed in PVC-foil.
Average production capacity: 2ooooo pcs./year.
Max. capacity after the entire running-in period: 26oooo pcs., as follows:

| | |
|---|---|
| 16 cm dissection and tenaculum forceps | 25 per cent |
| 16 cm "Kocher" artery forceps | 25 per cent |
| 16 cm surgical scissors | 25 per cent |
| 16 cm surgical scalpels | 25 per cent |

If necessary, part of the capacity may be extended to the manufacture of smaller tools /different pincers, screw-drivers, sets of keys, etc./ by broadening the means of production.

## Technical aspects

Entire running-in period: 7 years.
2 years are needed for investment and the preparation of production.
In the first 6 months the commercial, technical and installing questions have to be cleared up.
In the next 18 months the architectural and mechanical planning and executing, the technological planning, manufacture, delivery and mounting of the special means of production and the teaching of experts in the plants of the country of the "donor" are to be accomplished.
Production begins in the 3rd year, under the guidance of leading

experts of the "donor" and with in-plant training /assistance/, and reaches the level according to the average capacity in the 5th year. The plant is working with max. capacity from the 7th year.

The products are surgical, resp. industrial instruments and tools, which do not become obsolete within reasonable time.

Without further investment, but with the introduction of the 2nd shift, the production program may - in principle - be doubled, by a staff increase of about 7o-8o per cent.

Average number of shifts: 1

Power consumption: Electrical current:

| | | |
|---|---|---|
| | built-in current consumers | 39o kW |
| | peak load | 3oo kW |
| | Industrial water requirement in peak 1o cu.m/hour | |
| | Compressed air 6 att 1o cu.m/hour /in peak/ | |

Staff requirement: in case of 1 shift and 25o working days a year

| | |
|---|---|
| productive persons | 95 |
| indirectly productive persons | 24 |
| temporary helps | 5 |
| administrative ones | 1o |
| technical persons | 15 |
| Totally | 149 |

Building: necessary area 1152 m² /24 x 48 m/
12 x 6 m module light iron construction, mechanically complete, one of the naves with closed air spaces, with office and social premises, as follows /see enclosed arrangement scheme/:

| | |
|---|---|
| 1. Stock of raw materials | 72 m² |
| 2. Press forging shop | 216 m² |
| 3. Chemical cleaning and abrasion workshop | 36 m² |
| 4. Machine shop | 132 m² |
| 5. Grinding and polishing shop | 144 m² |
| 6. Mechanics workshop | 54 m² |
| 7. Tool room | 3o m² |
| 8. Maintenance and tool shop | 1o8 m² |

| | |
|---|---|
| 9. Stock of finished products and packing room | 54 m² |
| 10. Offices | 72 m² |
| 11. Social premises | |
| Traffic routes | 180 m² |
| Totally | 1152 m² |

Necessary ground-plot: 0,5 ha = 5000 sq.m, on which traffic routes and an open-air warehouse have to be established.

## Financial plan

1. **Establishment costs** — $

**Planning**

| | $ |
|---|---|
| - Architectural and engineering plans | 35.000 |
| - Project Report | 25.000 |
| - Technologic plans /product and production plans, plans of the means of production/ know-how | 60.000 |
| | 120.000 |

**Investment**

| | $ |
|---|---|
| ground-plot ~ 0,5 ha /3.- $/sq.m/ | 15.000 |
| building ~ 1152 m² with complete engineering | 400.000 |
| machines, equipment and general production appliances | 365.000 |
| special production appliances | 132.000 |
| furniture, office furnishing | 23.000 |
| other furnishings | 45.000 |
| | 980.000 |

**Training**

| | $ |
|---|---|
| Preliminary in-plant training at donor 3 engineers and 10 skilled workers, 6 months | 70.000 |
| Conducting of installations and training on the spot | |
| 3 engineers, 1 year | 113.400 |
| 6 technicians, 6 months | 97.200 |
| | 280.600 |

2. **Costs of plant operation relating to the average capacity**

**Material requirement for 1 year production**

| | |
|---|---|
| - Basic materials /at the stainless steel type/ | 60.000 |
| - Auxiliary materials for manufacture | 15.000 |
| - Office supplies, printed matters | 2.000 |
| | 77.000 |

**Energy consumption for one year**

| | |
|---|---|
| Electric energy 360000 kWh /$ 0,06/kWh/ | 21.600 |
| Water 20000 cu.m/year | 1.000 |
| | 22.600 |

**Manpower for 1 year**

| | | |
|---|---|---|
| 5 engineers | $ 5.000/year/person | 25.000 |
| 10 technicians | $ 3.500/year/person | 35.000 |
| 10 administrative employees | $ 3.000/year/person | 30.000 |
| 40 skilled workers | $ 2.500 /year/person | 100.000 |
| 74 semi-skilled and unskilled workers | $ 2.000/year/person | 148.000 |
| | | 338.000 |

3. **Production value**

| | |
|---|---|
| 1st year | - |
| 2nd year | - |
| 3rd year /50 per cent of average capacity/ | 315.000 $ |
| 4th year /80 per cent of average capacity/ | 504.000 $ |
| 5th year, average capacity | 630.000 $ |
| 6th year /84 per cent max. capacity/ | 693.000 $ |
| 7th year, full capacity | 819.000 $ |

4. **Rate of return**

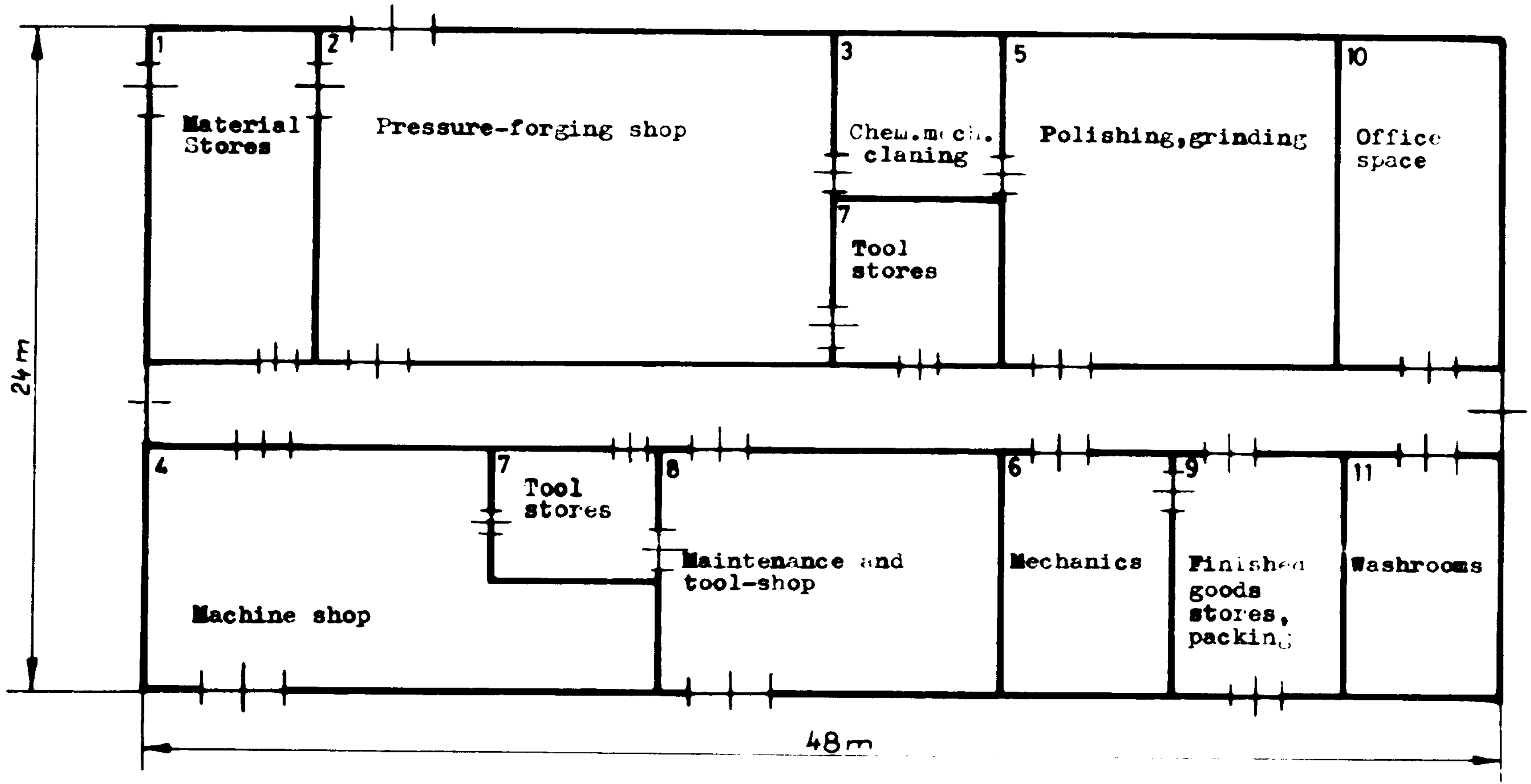
The investment is recovered after 6 years of production.

From that time on, the yearly allocations make 55 per cent of the production value.

**Remark:**

The plant needs about $ 70.000.- working capital, considering a rotation period of 60 days.

PLANT FOR MEDICAL STEEL INSTRUMENTS ARRANGEMENT SCHEME



Appendix No. 3

SMALL-SCALE PLANT FOR THE MANUFACTURE OF SURVEYING INSTRUMENTS - A Profile

Products to be manufactured

Theodolite with a reading accuracy of 1 minute, glass circle reading system, optical micrometer, guided centering, in a wooden case, with accessories

400 pcs./year, $ 600.- each

Target plate for traversing, pair-wise in a wooden case, with accessories

300 pairs/year, $ 150.-/pair

Wooden tripod for surveying instruments

600 pcs./year, $ 60.- each

Fields of application of the instruments: surveying measurements, i.e. traversing, small triangulation, engineering surveys. The theodolite can be used alone, as well, possible with accessories and target plates already available; this was the basis for choosing the piece ratio of the products.

The above given prices are conservative estimates, a donor enterprise introduced and known on the market could even reach approx. 20-25 per cent higher prices. The selling possibilities and the attainable price are influenced by the different items of taxation in each country.

Manufacture is started in the following phases:

Preparatory stage: Planning of the establishment, projecting and constructing of the building, purchasing of the assembling technology.
Introduction of assembling: Equipping of assembly department, joinery and offices, purchase of component parts from the donor enterprise, training in assembling, starting of continuous assembling.
Introduction of the manufacture of parts: Purchase of the technology for the manufacture of components, obtaining of jigs, fixtures and special tools from the donor enterprise. Equipping of the metal cutting and finishing departments. 25 per cent of the parts of the released products are manufactured by the recipient enterprise. Finally, changing over to the own manufacture of component parts,

except for the optics and the manufacture of some components, which are more advantageous to obtain from the donor enterprise.

Phase of return: Continuous assembly and own manufacture of parts, excluded the optics and those of high accuracy. In order to protect the trained labour-power, the wages of employees have to be raised about 2o per cent.

Phase of obsolescence: Enlarging of production is not expedient, due to the gradual obsolescence of products. Beginning from the 9th year, even a lo per cent decrease of the selling prices becomes necessary, in order to keep the level of sold quantities. In this stage already, appropriate measures have to be taken to change over to new, more up-to-date products.

Estimated standard times /for small series/

Standard times by min.

| | Theodolite | 1 target plate | tripod |
|---|---|---|---|
| turning | 17oo | 85o | 6o |
| milling | 35o | 6o | - |
| drilling | 25o | 5o | 3o |
| grinding | 2oo | 1oo | - |
| finishing | 2oo | 12o | 8o |
| woodwork | 2oo | 12o | 35o |
| other | 3oo | 15o | 1oo |
| assembling | 3ooo | 5oo | 1oo |

Planning of the required machines, staff and area

The number of machine tools, resp. number of fitters /assembly workers/ can be obtained with the help of the following formula:

$$N = \frac{\text{standard time x number of pieces}}{60 \times 8 \times 300}$$

Number of pieces to be manufactured per annum, after complete running-in:

400 pcs. of theodolites
300 pairs = 600 pcs. of target plates
600 pcs. of tripods

| Work | N | Number of machines/shifts | Staff | Area |
|---|---|---|---|---|
| turning | 8,51 | 3 lathes/1,4<br>2 turret lathes/1,4 | 19 | 180 m² |
| milling | 1,22 | 1 milling machine/1,2 | | |
| drilling | 1,03 | 1 drilling machine/1 | | |
| grinding | 0,97 | 1 grinding machine/1<br>1 piece cutter | | |
| finishing | 1,39 | tubs, varnishing equipment | | |
| joinery | 2,51 | woodworking machines | | |
| other | 2,79 | | | |
| assembling | 10,42 | final control collimator<br>2 precision lathes<br>hand tools, bench,<br>measuring gauges | 10+2 persons | 880 m² |
| non-productive | | 1 engineer, 1 technician, 1 stock-keeper, 2 accountants, 1 administrative employee, 1 work superintendent | 7 persons | stock 25 m²<br>35 m² |

Totally — 38 persons — 320 m²

Basic area with other establishments / + 30 per cent / — 400 m²

Returns from sales and expenses — Values in 1000 $

Preparatory stage

| 1st year | Expenditure | Earnings |
|---|---|---|
| Aim: mounting of 200 pcs. of theodolite and 300 target plates from parts, production of parts and mounting for 300 tripods | | 160 |
| Installing of the assembly department /main items: precision lathe, final control collimator, drilling machine, benches, hand tools/ | 25 | |
| Furnishment of offices | 3 | |
| Equipping of joinery /main items: 2 woodworking machines, hand tools/ | 5 | |

| | Expenditure | Earnings |
|---|---|---|
| Training, assistance | 15 | |
| Wages for 19 persons, $ 3.ooo.- per annum /8 fitters, 3 joiners, 8 non-productive workers/ | 57 | |
| Material cost | 15 | |
| Price of parts | 97 | |
| Operating costs | 6 | |
| Totally: | 224 | 16o |

2nd year

| | Expenditure | Earnings |
|---|---|---|
| Aim: mounting of 4oo pcs. of theodolite and 6oo target plates, production and mounting of parts for 6oo tripods, production of O-series from own parts | | 321 |
| Completion of the outfit of assembly department | 1o | |
| Purchase of the production technology of parts for theodolite and target plates | 3o | |
| Training, assistance | 2o | |
| Wages for 26 persons, $ 3.ooo.- per annum /12 fitters, 3 joiners, 3 others, 3 non-productive ones/ | 78 | |
| Material cost | 19o | |
| Depreciation | 3 | |
| Operating costs | 8 | |
| Totally: | 423 | 321 |

3rd year

| | Expenditure | Earnings |
|---|---|---|
| Aim: mounting of 3oo pcs. of theodolite and 3oo target plates from parts, production of parts and mounting of 6oo pcs. of tripods, production of O-series of 1o theodolites and 2o target plates from own parts, production of further 9o theodolites and 28o target plates from own parts, except for the optical and more problematic components | | 321 |
| Purchase of machines for the machine shop /3 lathes, 2 turret lathes, 1 milling machine, 1 drilling machine, 1 grinding machine, 1 piece cutter, finishing tubs/ | 7o | |

| | Expenditure | Earnings |
|---|---|---|
| Obtaining appliances and special tools from the donor enterprise | 3o | |
| Training, assistance | 3o | |
| Wages for 32 persons, $ 3.ooo.- per annum /12 fitters, 3 joiners, 6 cutting workers, 2 finishers, 2 others, 7 non-productive ones/ | 96 | |
| Material cost | 25 | |
| Price of parts | 147 | |
| Depreciation | 13 | |
| Operating costs | 12 | |
| Totally: | 423 | 321 |

**4th year**

| | Expenditure | Earnings |
|---|---|---|
| Aim: production of 4oo theodolites, 6oo target plates and 6oo tripods from own parts, except for the optical and more problematic ones | | 321 |
| Training, assistance | 15 | |
| Wages for 38 persons, $ 3.ooo.- per annum, /12 fitters, 3 joiners, 12 cutting workers, 2 finishers, 2 others, 7 non-productive ones/ | 114 | |
| Material cost | 45 | |
| Price of optical and other imported parts | 33 | |
| Depreciation | 13 | |
| Operating costs | 12 | |
| Totally: | 232 | 321 |

**5th-8th years**

| | Expenditure | Earnings |
|---|---|---|
| Aim: production of 4oo theodolites and 6oo target plates, as well as 6oo tripods from own parts, except for optical and other imported components | | 321 |
| Wages for 38 persons, $ 3.6oo.- per annum | 137 | |
| Material cost | 45 | |
| Price of optical and other imported parts | 33 | |
| Depreciation | 13 | |
| Operating costs | 12 | |
| Totally: | 24o | 321 |

| 9th-10th years | Expenditure | Earnings |
|---|---|---|
| Aim: as above, but 10 per cent price reduction is necessary | | 288 |
| Wages for 38 persons, $ 3.600.- per annum | 137 | |
| Material cost | 45 | |
| Price of optical and other imported parts | 33 | |
| Depreciation | 13 | |
| Operating costs | 12 | |
| Totally: | 240 | 288 |

**Return of the invested capital**

Values in 1ooo $

| Number of years | Prep. | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 1oth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total costs | 86 | 224 | 351 | 423 | 232 | 24o | 24o | 24o | 24o | 24o | 24o |
| Return from sales | - | 16o | 321 | 321 | 321 | 321 | 321 | 321 | 321 | 288 | 288 |
| Profit | - 86 | - 64 | - 3o | -1o2 | + 89 | + 81 | + 81 | + 81 | + 81 | + 48 | + 48 |
| On the present value | - 86 | - 6o | - 27 | - 86 | + 71 | + 61 | + 57 | + 54 | + 51 | + 28 | + 27 |
| Cumulative value | - 86 | -146 | -173 | -259 | -188 | -127 | - 7o | - 16 | + 35 | + 63 | + 9o |
| | Prep. | Introduction of mounting | | Introduction of parts production | | Return | | | | | |

The amount of profit on the present value was derived assuming a 6 per cent discount rate.

For realization an investment of max. $ 259.ooo.- is needed. The individual amounts should be available according to the cumulative value.

Amounts to be paid to the donor enterprise

Values in 1ooo $

| Year | Amount | On the present value | Cumulative value |
|---|---|---|---|
| Prep. | 35 | 35 | 35 |
| 1st year | 1o4 | 98 | 133 |
| 2nd year | 225 | 2oo | 333 |
| 3rd year | 177 | 149 | 482 |
| 4th year | 33 | 26 | 5o8 |
| 5th year | 33 | 25 | 533 |
| 6th year | 33 | 25 | 556 |
| 7th year | 33 | 22 | 578 |
| 8th year | 33 | 21 | 599 |
| 9th year | 33 | 19 | 618 |
| 1oth year | 33 | 18 | 636 |

Totally 772

Appendix No. 4

WATT-HOUR METER MANUFACTURING PLANT - A Profile

## Introduction

The product to be manufactured satisfies both, the household and industrial requirements and plays an outstanding role in the industrialisation- and the housing programs.

## Products to be manufactured:

Single-phase watt-hour meter with single-tarif counter, in metal casing.
Max. number of pieces to be manufactured: about 60000/year.
Three-phase, four-wire watt-hour meter with single-tarif counter in metal casing.
Max. number of pieces to be manufactured: about 10000/year.

## Technical aspects:

Entire running-in period: 10 years.
This includes the term from the assembly and calibration stages up to the complete local manufacture.
Preparation of the establishment of the plant may take 1-2 years.
During this time all technical, commercial and economical questions have to be cleared up; preparations of installing should be started with and accomplished.
From the assembly, realization of the whole production is carried out in 9 different stages /see Table 5/.
Period of financial return: the last 3-4 years.

The financial estimate of this proposal contains the costs of machine-requirements of the ancillary plants, as well.

Present product series can be manufactured with the given technical parameters, for about 15 years, without becoming obsolete.

**Standard work-times:** single-phase /assembly, calibration, testing/ 170 minutes/piece

three-phase /assembly, testing, calibration/ 440 minutes/piece

Average number of shifts: 1

Manpower: 16 unskilled workers
110 semi-skilled workers
28 engineers and technologists
36 skilled workers
42 administrative employees

232 persons

Building: 3000 m², light construction steel structure /mechanically complete with heating, water and drainage, but without special ventilating equipment/

Ground-plot: 1 ha = 10000 m²

Financial plan:

| | $ |
|---|---|
| 1. Planning of the factory | |
| Architectural plans | 50.000 |
| Know-how | 15.000 |
| | 65.000 |
| 2. Investment goods | |
| a/ ground-plot | at cost price |
| b/ building | 1.100.000 |
| c/ manufacturing equipment /production of parts, surface finish, tool making, machines of ancillary plants/ | 1.350.000 |
| d/ testing and calibrating equipment | 145.000 |
| e/ furniture | 30.000 |
| f/ conveyors, in-plant transporting means | 40.000 |
| 3. Production and overhead materials | |
| see Table No. 5 | |
| dissous gas, office supplies | 2.000 |
| 4. Energy, gas, water | |
| 350 kW, 6 cents/kWh | 8.500 |
| gas 200000 cu.m/year | 6.000 |
| water 20000 cu.m/year | 1.000 |
| 5. Transport vehicles | |
| 3 trucks, 2 fork lift-trucks, 2 station wagons | 8.000 |

6. **Manpower**

| | |
|---|---|
| 4 engineers $ 5.000/year | 20.000 |
| 24 technicians $ 3.000/year | 72.000 |
| 36 skilled workers $ 2.500/year | 90.000 |
| 42 administrative employees $ 2.000/year | 84.000 |
| 126 other semi-skilled and unskilled workers $ 2.100/year | 265.000 |
| Training of 4 engineers on the spot $ 100.-/day, 100 days | 40.000 |
| Teaching of 4 technicians at the donor $ 70.-/day, 180 days | 50.400 |

Table No. 1

Purchasing price of complete sets of components from "donor"

| | single-phase | | three-phase | |
|---|---|---|---|---|
| | 100 % = 10 $ | | 100 % = 30 $ | |
| 1st year | 0 % | 0 $ | 0 % | 0 $ |
| 2nd year | 100 % | 10 $ | 100 % | 30 $ |
| 3rd year | 100 % | 10 $ | 100 % | 30 $ |
| 4th year | 70 % | 7 $ | 80 % | 24 $ |
| 5th year | 60 % | 6 $ | 60 % | 18 $ |
| 6th year | 50 % | 5 $ | 50 % | 15 $ |
| 7th year | 30 % | 3 $ | 30 % | 9 $ |
| 8th year | 30 % | 3 $ | 30 % | 9 $ |
| 9th year | 10 % | 1 $ | 10 % | 3 $ |
| 10th year | 0 % | 0 $ | 0 % | 0 $ |

<u>Sales price of finished meters</u>

Single-phase: $ 15.-

Three-phase: $ 34.-

Table No. 2

**Volumen to be manufactured**

| 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 1oth year |
|---|---|---|---|---|---|---|---|---|---|
| **SINGLE-PHASE METERS:** | | | | | | | | | |
| 0 | 25 | 4o | 5o | 6o | 8o | 1oo | 1oo | 12o | 14o |
| **THREE-PHASE METERS:** | | | | | | | | | |
| 0 | 4 | 6 | 6 | 7 | 8 | 1o | 11 | 12 | 12 |

Table No. 3

**Expenses of the volumen to be manufactured in foreign currency** /1ooo $, mt-price/

| 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 1oth year |
|---|---|---|---|---|---|---|---|---|---|
| **SINGLE-PHASE METERS:** | | | | | | | | | |
| 0 | 25o | 4oo | 35o | 36o | 4oo | 3oo | 33o | 12o | 0 |
| **THREE-PHASE METERS:** | | | | | | | | | |
| 0 | 12o | 18o | 144 | 126 | 12o | 9o | 99 | 36 | 0 |
| | 37o | 58o | 494 | 486 | 52o | 39o | 429 | 156 | |

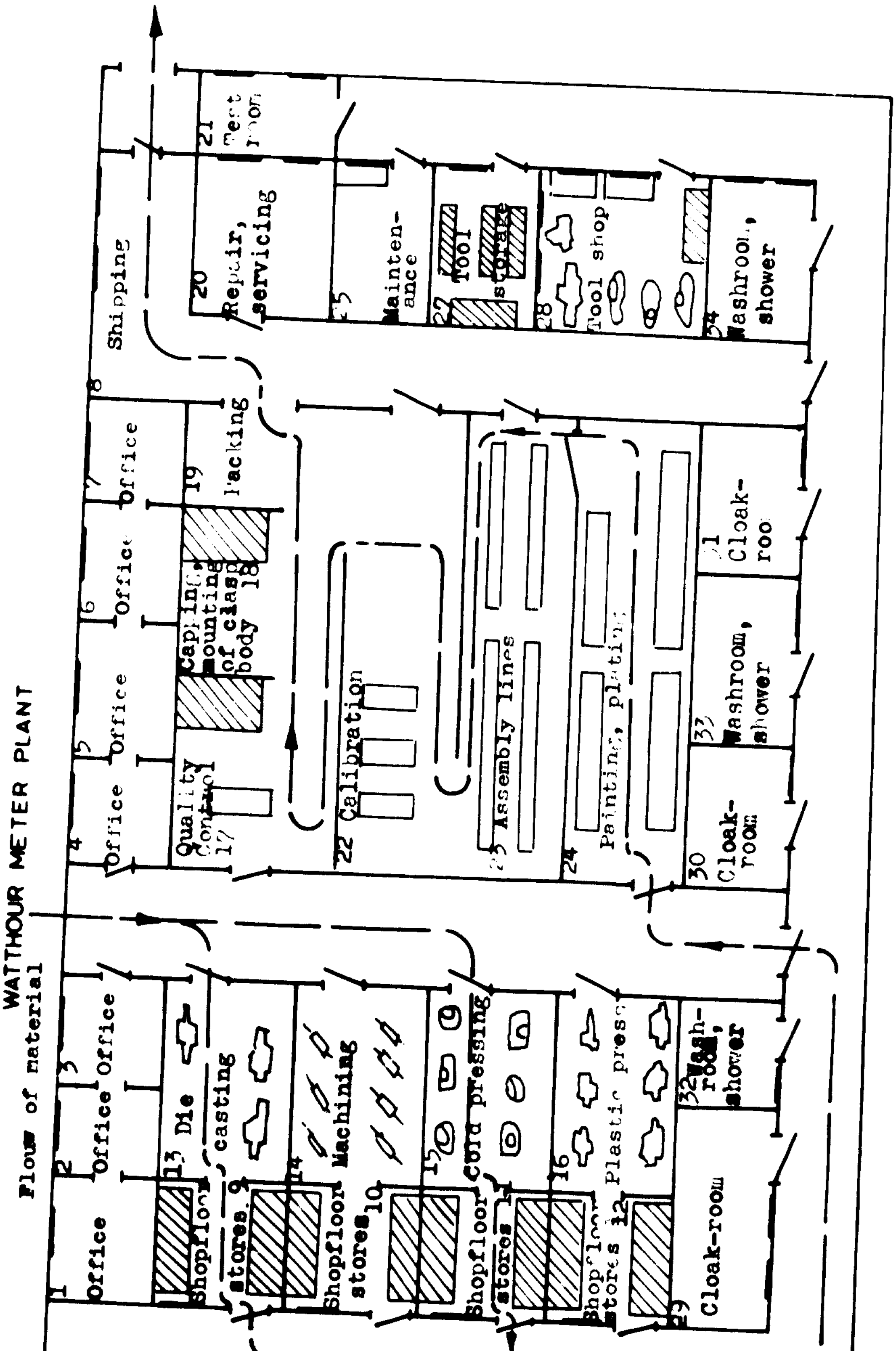
Table No. 4

**Total material cost of the meters to be manufactured** /1ooo $/

| 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 1oth year |
|---|---|---|---|---|---|---|---|---|---|
| **SINGLE-PHASE METERS:** | | | | | | | | | |
| 0 | 0 | 0 | 45 | 72 | 12o | 21o | 232 | 324 | 42o |
| **THREE-PHASE METERS:** | | | | | | | | | |
| 0 | 0 | 0 | 1o | 25 | 36 | 63 | 69 | 97 | 1o8 |
| | | | 55 | 97 | 156 | 273 | 3o1 | 421 | 528 |

Table No. 5

| | Pre-project costs | Investment time 1st | Running-in period 2nd | 3rd | 4th | 5th | Rate of return 6th | 7th | 8th | 9th | 10th |
|---|---|---|---|---|---|---|---|---|---|---|---|
| In foreign currency | | | | | | | | | | | |
| Plan, technology | 65 | | | | | | | | | | |
| Manufact./calibr. eq. | | 1495 | | | | | | | | | |
| Furniture, fittings | | 30 | | | | | | | | | |
| Conveyors, etc. | | 40 | | | | | | | | | |
| Amortization 10 % | | | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 |
| Sets, basic/overhead m. | | | 370 | 580 | 568 | 615 | 728 | 754 | 830 | 717 | 714 |
| Total start-up capital in foreign currency | | 1565 | 526 | 736 | 724 | 771 | 884 | 910 | 986 | 873 | 860 |
| In local currency | | | | | | | | | | | |
| Building /without plot/ | | 300 | 550 | 300 | | | | | | | |
| Energy, fuel, water | | | 8 | 9 | 9 | 12 | 14 | 15 | 17 | 17 | 17 |
| Communication | | | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 8 | 8 |
| Wages total | | | 150 | 250 | 400 | 531 | 531 | 531 | 590 | 750 | 850 |
| Training | | 50 | 40 | | | | | | | | |
| Sales, shipping, travelling and miscellaneous | | | 5 | 5 | 8 | 8 | 8 | 10 | 10 | 10 | 10 |
| Altogether | | 350 | 755 | 566 | 420 | 554 | 557 | 561 | 622 | 785 | 885 |
| Total costs /domestic + foreign curr./ | 65 | 1915 | 1281 | 1302 | 1145 | 1325 | 1441 | 1471 | 1608 | 1669 | 1745 |
| Returns from sales | | | 511 | 804 | 954 | 1138 | 1472 | 1840 | 2024 | 2208 | 2508 |
| Difference | | -1915 | -770 | -496 | -191 | -127 | +31 | +368 | +415 | +538 | +762 |
| Present value with 6 % discount | | | -705 | -445 | -760 | -150 | +26 | +230 | +275 | +335 | +450 |


WATTHOUR METER PLANT
Flow of material
Office
Shipping
Rest room
Repair, servicing
Mainten-ance
Tool storage
Tool shop
Washroom, shower
Packing
Capping, mounting of clasp body
Quality control
Calibration
Assembly lines
Painting, plating
Cloak-room
Die casting
Machining
Cold pressing
Plastic press
Shopfloor stores

Appendix No. 5

PLANT FOR PRODUCING ELECTRONIC INSTRUMENTS - A Profile

## Introduction

The proposed plant is of vertical character, hence production of a wider range of parts is possible.
The characteristic data of the instruments chosen provide a good basis for judging the setting up of an electronic instruments plant.

## The products to be manufactured

1. Radio-frequency laboratory and signal generator
1a Sound generator
2. Radio-frequency oscilloscope
2a Low-frequency generator
3. Transistor voltmeter

## Technical aspects

The whole running-in period of the plant is lo years. Preparation of establishment of the plant takes 1-2 years. During this time the technical and commercial questions have to be cleared up, the site of the plant has to be appointed, planning has to be started and the machines and equipment have to be ordered. There is no production yeat, but a significant part of the capital has to be invested.

Realization of the local production takes 9 years; rate of return: the last 4 years.

The budget contains, beside the establishment costs of productive plants, also these of the ancillary ones.

The rapid moral amortization of the electroni. ,struments makes a change of the products necessary every 4-5th year. This has no significant bearing on the ratio of fixed assets, but influences the demand for experts and for working capital, the stock of parts and semi-finished products, as well as the servicing stock.

## Standard times:

Instruments for group 1 and 1a

Production of parts: 24,5 hours/unit
Assembly, verification: 17o hours/unit

Instruments for group 2 and 2a

Production of parts: 44 hours/unit
Assembly, calibration: 3o5 hours/unit

Instrument of group 3

Production of parts: 6 hours/unit
Assembly, calibration: 3,45 hours/unit

Average number of shifts: 1,4

Building: 61oo m², light construction steel structure, mechanically complete, but without ventilation.

Ground-plot: 2 ha = 2oooo m²

Staff: 722 people - 124 technical, 55 administrative, 518 productive, 25 unskilled- and semi-skilled workers.

## Financial plan

| | $ |
|---|---|
| 1. **Planning of production** | |
| Architectural, mechanical plans | 5o.ooo |
| Know-how | 15.ooo |
| 2. **Investment goods** | |
| a/ immovable property /plot/ about 2 ha = 2oooo m² at cost price | |
| b/ building about 6ooo m² | 2.ooo.ooo |
| c/ producing eqipment /production of parts, surface finish, duration control equipment, winding apparatuses, tool making, equipment of ancillary plants/ | 1.6oo.ooo |
| d/ verifying and control equipment | 18o.ooo |
| e/ furniture and other fittings | 7o.ooo |
| f/ conveyors | 4o.ooo |
| | 3.89o.ooo |
| 3. **Production and overhead materials** | |
| a/ pre-mounted units and parts | see Table |
| b/ basic materials for production | " |
| c/ overhead materials | " |
| d/ dissous gas | 8oo |
| e/ office supplies | 1.2oo |
| 4. **Energy, gas, water** | |
| 63o kW 6cents/kWh | 16.ooo |
| gas 3ooooo cu.m/year | 9.ooo |
| water 2oooo cu.m/year | 1.ooo |
| | 26.ooo |

5. **Communication**

| | |
|---|---|
| 3 trucks | |
| 2 fork lift-trucks | |
| 2 station wagons | 8.000 |

6. **Manpower**

| | |
|---|---|
| Engineers, $ 5.000.-/year, 2o | 1oo.ooo |
| Technicians, $ 3.5oo.-/year, 1o4 | 364.ooo |
| Skilled workers, $ 2.5oo.-/year, 15o | 375.ooo |
| Administrative ones, $ 3.000.-/year, 55 | 165.ooo |
| Other semi-skilled workers, $ 2.ooo.-/year, 393 | 786.ooo |
| Totally 722 persons | 1.79o.ooo |

Training, teaching

| | |
|---|---|
| 8 engineers, training on the spot $ 1oo.- a day, 1oo days | 8o.ooo |
| 6 technicians, training at the "donor" $ 7o.- a day, 18o days | 75.6oo |
| | 155.6oo |

**S E T - price /average/**

| Year | | GENERATORS | OSCILLOSCOPES | TRANSISTOR VOLTMETERS |
|---|---|---|---|---|
| | | 1.8oo $ | 2.5oo $ | 7o $ |
| 1st | 0 % | 0 $ | 0 $ | 0 $ |
| 2nd | 1oo | 1.8oo | 2.5oo | 7o |
| 3rd | 1oo | 1.8oo | 2.5oo | 7o |
| 4th | 7o | 1.26o | 1.75o | 49 |
| 5th | 5o | 9oo | 1.25o | 35 |
| 6th | 4o | 72o | 1.ooo | 28 |
| 7th | 3o | 54o | 75o | 21 |
| 8th | 2o | 36o | 5oo | 14 |
| 9th | 1o | 18o | 25o | 7 |
| 1oth | | 0 | 0 | 0 |

**SALES PRICE /average/**

| GENERATORS | OSCILLOSCOPES | TRANSISTOR VOLTMETER |
|---|---|---|
| 2.1oo $ | 2.8oo $ | 8o $ |

<u>Volumen to be manufactured</u>

1000 pcs.

| 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th y. |
|---|---|---|---|---|---|---|---|---|---|---|
| GENERATORS | | | | | | | | | | |
| 0 | 0 | 0,1 | 0,25 | 0,4 | 0,5 | 0,6 | 0,8 | 1,0 | 1,2 | 1,5 |
| OSCILLOSCOPES | | | | | | | | | | |
| 0 | 0 | 0,15 | 0,3 | 0,4 | 0,6 | 0,9 | 1,1 | 1,3 | 1,5 | 1,5 |
| TRANSISTOR VOLTMETER | | | | | | | | | | |
| 0 | 0 | 2,0 | 4,0 | 10,0 | 18,0 | 25,0 | 30,0 | 35,0 | 40,0 | 40,0 |

<u>SET - price</u> /$/

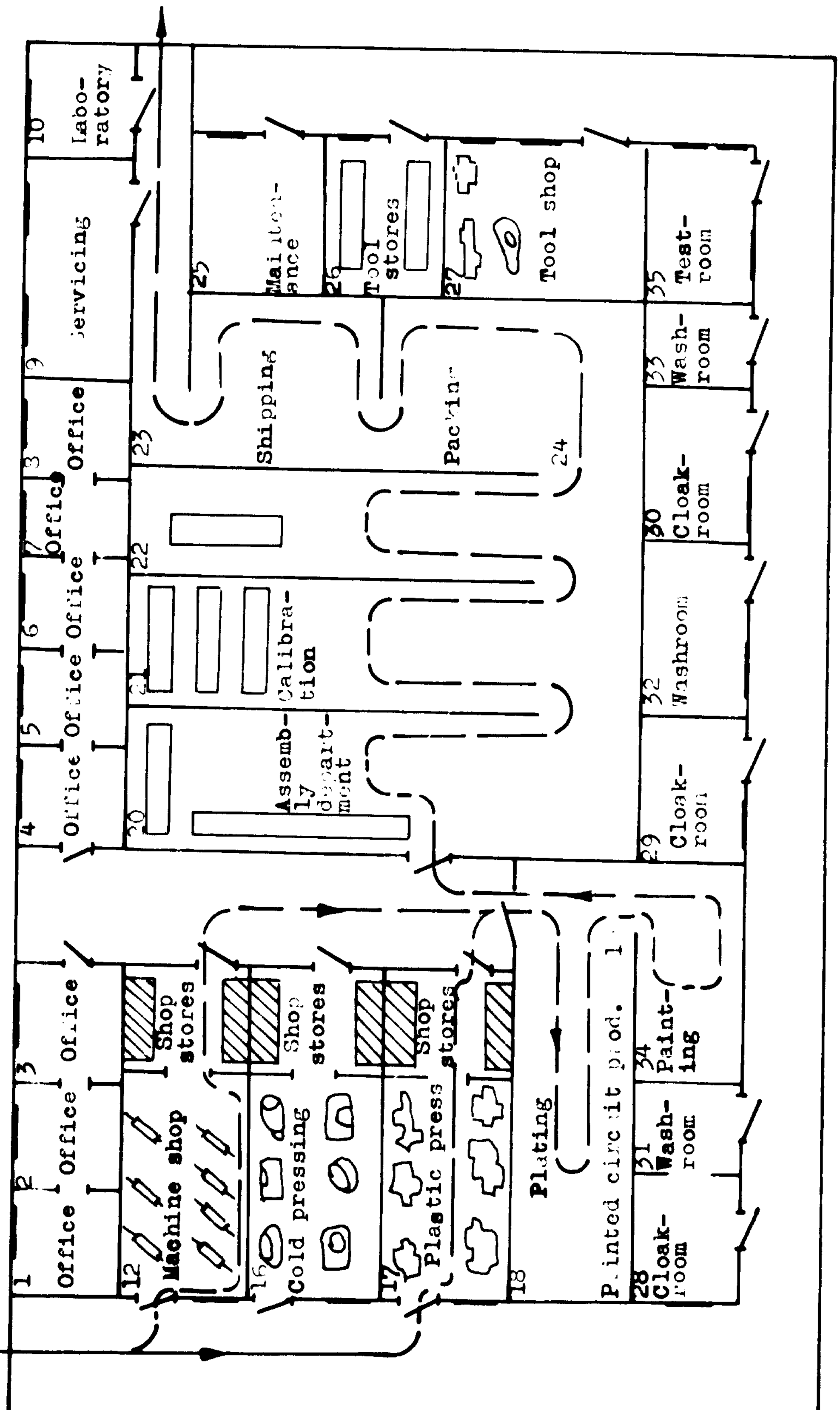
| 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th y. |
|---|---|---|---|---|---|---|---|---|---|---|
| GENERATORS | | | | | | | | | | |
| 0 | 0 | 180 | 450 | 504 | 450 | 432 | 432 | 360 | 216 | 0 |
| OSCILLOSCOPES | | | | | | | | | | |
| 0 | 0 | 375 | 750 | 700 | 750 | 900 | 825 | 850 | 375 | 0 |
| TRANSISTOR VOLTMETER | | | | | | | | | | |
| 0 | 0 | 140 | 280 | 490 | 504 | 700 | 630 | 490 | 210 | 0 |
| | | 695 | 1480 | 1694 | 1704 | 2032 | 1887 | 1700 | 801 | |

**Material, semi-finished product, electrical elements /$/**

| 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th year |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | GENERATORS | | | | | |
| 0 | 0 | 0 | 0 | 86 | 180 | 259 | 371 | 576 | 777 | 1080 |
| | | | | | OSCILLOSCOPES | | | | | |
| 0 | 0 | 0 | 0 | 120 | 540 | 540 | 770 | 1040 | 1350 | 1500 |
| | | | | | TRANSISTOR VOLTMETER | | | | | |
| 0 | 0 | 0 | 0 | 80 | 252 | 420 | 600 | 774 | 1008 | 1120 |
| | | | | 286 | 972 | 1219 | 1741 | 2390 | 3135 | 3700 |

| | Investment time | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th |
|---|---|---|---|---|---|---|---|---|---|---|---|
| In foreign currency | | | | | | | | | | | |
| Plan + technology | 75 | | | | | | | | | | |
| Prod. and verif. eq. | | 178o | | | | | | | | | |
| Furniture and fittings | | 7o | | | | | | | | | |
| Conveyors | | 4o | | | | | | | | | |
| Amortization lo % | | | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 |
| Set-price, basic + overhead mat. | | | 695 | 148o | 2o75 | 3ooo | 3658 | 42o6 | 4885 | 4992 | 4934 |
| Total start-up capital in foreign currency | | 189o | 884 | 1669 | 2264 | 3189 | 3847 | 4395 | 5o74 | 5181 | 5123 |
| In local currency | | | | | | | | | | | |
| Building /without plot/ | | 5oo | 7oo | 8oo | | | | | | | |
| Energy, fuel, water | | | lo | 14 | 18 | 22 | 26 | | | | |
| Communication | | | 2 | 2 | 3 | 5 | 7 | 9 | 9 | lo | lo |
| Wages total | | | 6oo | 8oo | 12oo | 15oo | 189o | 24oo | 28oo | 38oo | 45oo |
| Training | | 8o | 75 | | | | | | | | |
| Sales, delivery, travelling miscellaneous | | | | 5 | 5 | 8 | 8 | lo | lo | 12 | 12 |
| Local currency total | | 58o | 1387 | 1621 | 1226 | 1535 | 1931 | 2419 | 2819 | 3822 | 4522 |
| Expenses altogether /domestic + foreign curr./ | | 247o | 2271 | 329o | 349o | 4724 | 5778 | 6814 | 7893 | 9oo3 | 9645 |
| Expected return from sales | | | 8o5 | 1722 | 182o | 4245 | 587o | 73o8 | 869o | lo15o | lo775 |
| Difference | | | -13o6 | -1567 | -147o | -479 | + 2 | +494 | +797 | +1147 | +115o |
| Present value with 6 % disc. | | | -129o | -142o | -122o | -378 | +1,5 | + 345 | +52o | +73o | +735 |

ELECTRONIC INSTRUMENT PLANT



Appendix No. 6

## FACTORY FOR TEACHING AIDS AND MEDIA - A Profile

The plant is producing teaching aids required for science classes at low and medium level. These educational and demonstration media can be categorized as illustrative and demonstration means for

/1/ physics,
/2/ chemistry,
/3/ biology,
/4/ mathematics.

The production of slides facilitates up-to-date education. The diverse character of the individual subjects has led to a wide assortment of products.

As another important feature to be mentioned, in the establishment of such a factory is the short-run production /5o to 2oo per month/. It is most important therefore to ensure shops and tools from the various industries whereby the diversified demands can be met at relatively moderate cost.

The main product families planned include

a/ Metal shop products,
b/ Woodworking shop items,
c/ Glassware,
d/ Plastic articles,
e/ Products made of natural raw materials,
f/ Educational slides.

**Floor space requirement**

| | |
|---|---|
| 1/ Shop-floor | 1oooo m² |
| 2/ Storage buildings | 3ooo m² |
| 3/ Social premises /kitchen, mess-hall, etc./ | 1ooo m² |
| 4/ Offices | 1ooo m² |
| Total | 15ooo m² |

Appr. plot size recommended 4oooo m²

**Number of employees:** Two-shift production is foreseen, with a per capita rated capacity of 2ooo h/year. The employees would be distributed as follows:

| | |
|---|---|
| I. Storage dispatch | 4o |
| II. Technical and administrative staff | 16o |
| III. Direct production | 33o |
| IV. Indirect production | 1oo |
| V. Total number of employees | 63o |

## Energy planning

Built-in electric power: approx. 8oo kW
Coincidence factor: 0,5

Gas consumption, if a 6ooo cal. gas is supplied: 5oo cu.m/h

Compressed air, max. 8 atm.: 36o cu.m/min

Water consumption: 6 cu.m/h

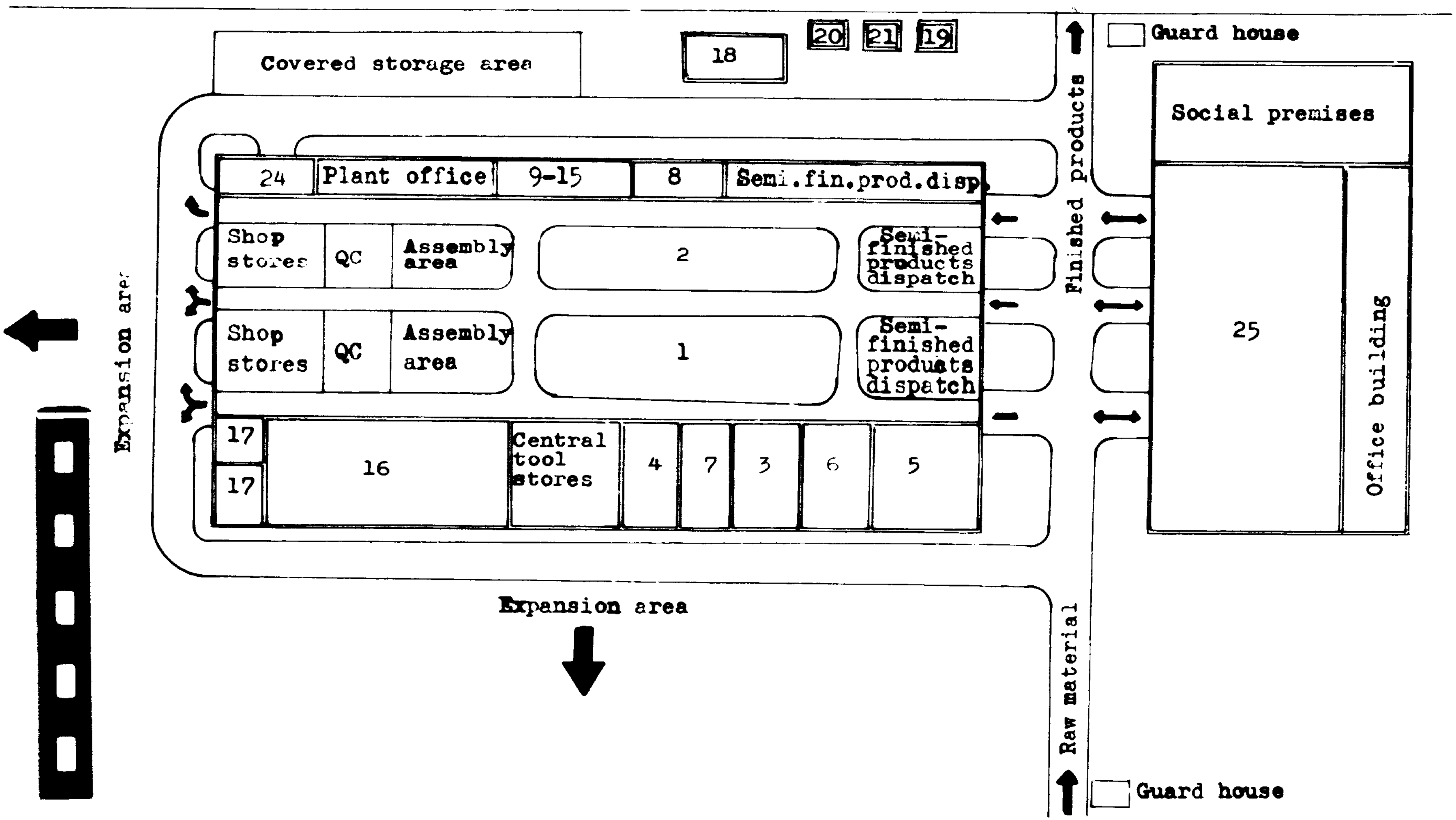
## Informative prices of the equipment for the plant departments

/see attached layout drawing/

| | US $ |
|---|---|
| 1. Machine shop | 225.ooo |
| 2. Woodworking shop | 56.ooo |
| 3. Plastics plant | 177.ooo |
| 4. Painting shop | 157.ooo |
| 5. Non-ferrous foundry | 121.ooo |
| 6. Glass technology | 43.ooo |
| 7. Surface treatment shop | 3o3.ooo |
| 8. Skeleton preparation | 233.ooo |
| 9. Microtechnical shop | 6o.ooo |
| 1o. Plant preparation | 49.ooo |
| 11. Biotechnical preparates | 46.ooo |
| 12. Slide production laboratory | 38.ooo |
| 13. Cutting room and test projection hall | 13.ooo |
| 14. Electrical shop | 45.ooo |
| 15. Optical assembly shop | 11.ooo |
| 16. Maintenance and tool shop | 367.ooo |
| 17. Measurements and mechanical laboratory | 128.ooo |
| 18. Boiler room | 327.ooo |
| 19. Transformer station | 416.ooo |
| 2o. Decyanidation plant | 15o.ooo |
| 21. Compressor plant | 48.ooo |
| 22. Transport means | 126.ooo |
| 23. Welding shop | 27.ooo |
| 24. Battery charger | 3.ooo |
| 25. Stores | 33.ooo |
| Air-conditioning equipment | 37.ooo |
| QC component acceptance | 7.ooo |
| Finished product inspection | 6.ooo |
| TOTAL | 3.252.ooo |

| Funds required for the establishment of an educational media factory in US dollars /1000 $/ | Design period | Investment period | | Production increase period | | | | | Totally |
|---|---|---|---|---|---|---|---|---|---|
| | | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | |
| <u>In foreign currency</u> - Investments | | | | | | | | | |
| Planning | 500 | | | | | | | | |
| Know-how | | | 400 | | | | | | |
| Machines, equipment, etc. | | 1000 | 2252 | | | | | | |
| Special production means | | | 450 | | | | | | |
| Amortization /10 %/ | | | | 565 | 565 | 565 | 565 | 565 | |
| Direct material | | | | 400 | 800 | 1200 | 1600 | 1600 | |
| Total initial capital requirement in foreign currency | 500 | 1000 | 3102 | 965 | 1365 | 1765 | 2165 | 2165 | 13.027 |
| Technical assistance in foreign currency | | 50 | 200 | 250 | 250 | 100 | 50 | | 900 |
| <u>In local currency</u> | | | | | | | | | |
| Buildings /without plot/ | | 1500 | 450 | | | | | | |
| Overhead materials | | | | 150 | 300 | 500 | 600 | 600 | |
| Energy and water | | | | 90 | 180 | 300 | 350 | 350 | |
| Employees, direct | | | | 150 | 300 | 450 | 600 | 600 | |
| Employees, indirect | | | | 50 | 100 | 150 | 200 | 200 | |
| Administrative costs | | 50 | 100 | 250 | 375 | 500 | 750 | 750 | |
| Miscellaneous | | | | 100 | 200 | 300 | 400 | 400 | |
| Total costs in local currency | | 1550 | 550 | 790 | 1455 | 2200 | 2900 | 2900 | 12.345 |
| Costs grand total in foreign and local curr. | | 2600 | 3852 | 2005 | 3070 | 4065 | 5115 | 5065 | 26.272 |
| Expected price revenue | | | | 1600 | 3100 | 4250 | 6100 | 6100 | 21.150 |

# EDUCATIONAL MEDIA FACTORY ESTABLISHMENT PLAN



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