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07376

Distr.
LIMITED

ID/WG.245/2
23 February 1977

ENGLISH

United Nations Industrial Development Organization

Consultative Meeting on the Telecommunication
Equipment and Related Industries

Budapest, Hungary, 7-11 March 1977

THE HUNGARIAN TELECOMMUNICATION INDUSTRY: TECHNOLOGIES OFFERED TO DEVELOPING COUNTRIES[1/]

Prepared by the

Hungarian Telecommunication Industry

1/ The views and opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the secretariat of UNIDO. This paper has not been formally edited.

id.77-1050

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INTRODUCTION

The Hungarian telecommunication industry presents here some industrial technologies for which on the one hand particular experience and resources exist in Hungary and for which it can be assumed that the developing countries may have particular interest. The presentation is primarily intended to serve as a basis for discussions at the joint UNIDO/Hungarian consultation meeting on the telecommunication equipment and related industries as it describes some specific projects for possible international co-operation in this branch. The information presented may, however, be found useful not only for the actual participants at the meeting, but also quite generally for managers and planners in industry and telecommunication organizations in developing countries as a source of reference when conceiving and implementing development programmes.

It should be noted that the selection of projects presented here does not constitute an exhaustive list or optimal choice of Hungarian telecommunication technology nor does it reflect any distinct policy recommendation as regards the pattern of industrialization of developing countries. Each individual developing country obviously must define its own development objectives and establish its priorities as to the choice of industries and technologies and the form for international co-operation. For this decision-making process in the developing countries, the paper may be able to contribute pertinent information. By describing Hungary's experience and indicating possible offers for technology transfer to developing countries the paper attempts to widen the range of alternatives and stimulate discussion on the choice of technologies.

Some of the described technologies may warrant a brief comment. The plant for assembling microwave radio-relays (chapter III) obviously constitutes a highly sophisticated type of industry. Generally, developing countries would require a previously developed infrastructure to be able to take advantage of such manufacturing, and they would normally also first have to establish a viable, basic electronics industry before embarking on this technology. In regard to manufacturing technology of electroacoustic equipment and public-address systems (chapter IV) the described project on radio and TV broadcasting equipment may similarly be of interest mainly for the more advanced of the developing countries, as it involves highly sophisticated equipment and tight quality control. The establishment of production facilities for electro-acoustical equipment would, on the other hand, seem to present fewer difficulties.

Also, the manufacturing technology of hybrid circuits and liquid-crystal displays (chapter VI) still ranks among the few very sophisticated ones, requiring a well-developed infrastructure of support industries, training institutions, and internal (and export) marketing outlets to become a viable industry. The description given of this technology may therefore be of interest primarily for those developing countries that already have most, if not all, of the necessary industrial infrastructure. In particular, the aspect of manufacturing passive electronic components such as resistors, capacitors and inductors using the thick-film technique would be of prime interest to developing countries since requirements for training and support for industry are limited, quality control is easily achieved through semi-automatic monitoring methods, and the final products are in great demand on the world market.

The presentation of the repair plant for transmission engineering instruments and equipment (chapter VIII) should not be allowed to obscure the fact that, as a rule, the installation of a specific type of telecommunication equipment in a country should include the establishment of an appropriate repair centre from the time of installation. Developing countries should thus normally ensure the inclusion of repair facilities in the delivery contract for the actual equipment. When local manufacture of the equipment is eventually started, the repair unit becomes an integral part of the production plant. Quite obviously, it is therefore only in exceptional cases that the setting up of a repair centre is done separately by a technology supplier different from the one supplying the actual equipment.

Readers are invited to forward any comments, suggestions and requests for further information concerning these or related technologies to the Global and Conceptual Studies Section, International Centre for Industrial Studies, UNIDO, P.O. Box 707, A-1011 Vienna, Austria.

I ASSEMBLY PLANT FOR UHF EQUIPMENT

Description of the equipment

All equipment is up to date, utilizing modern semiconductor and integrated circuit technology. It is made in portable, stationary and van-mounted models and for all currently approved frequency ranges, i.e., 80, 100, 160, 200, and 450 MHz bands, and all modes of operation. The technical specifications meet those of sets available on the world market and of the various postal and international prescriptions and recommendations.

Besides the basic equipment, UHF application techniques have also developed to a considerable extent. Various locally and remotely controlled UHF exchanges, handling units with selective calling devices, signalling networks for industrial use, and UHF networks with free-channel searchers suitable for performing complex tasks have been developed according to the requirements of the end-users.

BRG (Budapesti Rádiótechnikai Gyár = Radio Engineering Factory, Budapest) produces various rejector units, aerials, aerial systems for relay stations. The factory is in a position to meet all demands of the clients, from the simplest device up to intricate UHF systems. The factory's facilities permit the production of the equipment at a high technical level. Special care is devoted to the quality control of components, partial units, partial assemblies; consequently, the quality of the finished product is very high.

The quartz crystals that determine the frequency stability of the transmitter-receiver are controlled individually and measured at extreme temperature limits before being built-in. They are fitted in only in the case of perfect operation. Building up of the circuit units is done on printed circuit plates. An equally special care is given to preparing the printed circuit plates themselves. The components are soldered on the circuit plates with an up-to-date wave-soldering machine, thus guaranteeing uniform, trouble-free connexions.

In testing the circuit units, a large number of single-purpose instruments are used. These special instruments are built in a separate division of BRG, and as early as in the phase of circuit planning the facility of measurement by means of a single-purpose instrument is a fundamental requirement the development engineers must fulfil. In this way, possibilities are offered for producing large series at a uniform technical level.

Following measurement, each printed circuit unit is subjected to cold-warm loading prior to being forwarded to the assembly shop, where the assembly of the devices into complete units is done

Among circuit units, the so-called hybrid circuits merit special emphasis; these are made by means of thin-film or thick-layer technology. Their application is mainly in portable devices, where the reduction of size is an essential requirement. These circuits are partially assembled at a special division of BRG, ensuring favourable circumstances for the production of microcircuits. Recently, hybrid circuits have appeared also in van-mounted and in stationary devices, mainly with a view to achieving greater reliability

Final measurement of the ready-made assembled devices is performed in a separate area, where both special and single-purpose instruments are used. An integral part of the final measurement is the control of the fulfilment of mechanical and climatic requirements. For this end each basic equipment (transceiver handling unit) is subjected to vibration and climatic stresses prior to being passed on to testing as a complete station. At this ultimate measuring stage, the main emphasis is on ensuring that every requirement has been fulfilled.

For the convenience of clients, BRG undertakes the installation of relay stations, together with the installation of aerials, if required. As previously mentioned, BRG produces a full range of aerials for their sets, as well as aerial systems with special array characteristics for particular requirements. The Network Planning Group can be of assistance to end-users as early as the planning stage, by assuming the complete project of the UHF system wanted, including connexions. The specialists can also undertake the supervision of the preliminaries to installation: installation of antenna masts, mounting of aerials, preparation of the site etc.

Obviously, it is imperative for end-users abroad to become acquainted with the way the equipment is built. Training facilities are offered at BRG. The client may delegate specialists for a period of 3-4 weeks to BRG, where they will go through all phases of the work in practice, thus acquiring knowledge of the build-up of the circuits and of the entire equipment. In the case of larger orders, and if required, a specialist of BRG may provide for education of a restricted number of staff on the spot.

With a view to securing the maintenance of operation of equipment installed abroad, it is indispensable to organize a repair service. BRG is in a position to offer assistance in the field of supplying servicing instruments, including single-purpose instruments.

For the realization of local production or assembly, and in accordance with local requirements and possibilities, an agreement can be made for BRG to provide:

- Education of specialists in Hungary and on the spot
- Delegation of consultants
- Supply of single-purpose instruments
- Supply of documents
- Supply of components

Recommended number of pieces for production or assembly: yearly schedule

Without determining the type of the product the schedule of production can be suggested only in principle. Assuming that the plant's production will include 1,000-3,000 units of UHF equipment, together with complementary units (supply units, aerials etc), the following schedule is suggested (the first three stages will take 1-1.5 years):

Stage 1

- Adaptation of designs to meet local prescriptions and practice
- Determination of the range and the number of pieces to be produced
- Organization of the service to customers

Stage 2

- Training performed with partial units previously supplied; mastery of measurements and alignment
- Training in the measurement of specified data
- Practice in assembly work
- Checking the adaptation of the documentation

Stage 3

- Final assembly of components (90% ready-made)
- Measurement
- Output reaches the intended annual rate

Stage 4 (1-2 years)

- Supply of completely assembled and calibrated partial units, without mechanical components
- Independent local production, assembly, measurements

Stage 5 (2-3 years)

Depending on the development of local possibilities, (components, basic materials, skills of labour), assembly of part-assembles and production

Stage 6 (Starting with approximately the fourth year)

Completely independent production or assembly

II. ASSEMBLY PLANT FOR PRIVATE TELEPHONE EXCHANGES

General aspects

The dynamical development outlined in the introduction asserts itself pointedly in the field of automatic telephone exchanges, since the organization of modern industrial, commercial and other enterprises is inconceivable nowadays without automatic telephone exchanges. Steadily increasing demands permit reaching a high profitability of plants building private automatic branch exchanges (PABX) and continually expanding them.

The general trend is that PABX builders produce a considerable variety of exchanges with a capacity from 20 to 2000 extensions. In this way, it is possible to produce the minimum quantity of lines required for a given application with a high degree of flexibility of production.

Experience has shown that the most expedient method of establishing plants for building PABX is to install an assembly plant, the activities of which can be continually expanded, at the same time adopting ever more intricate and delicate technologies, to arrive at last at building complete exchanges.

The suggestions here deal with the establishment of a plant for the production (initially for the assembly) of subexchange models CA-22, CA-42/B, CA-102 and CA-1002 built at the Hungarian BHG Works.

Subexchange models of the CA series

The CA (crossbar) series was designed for performing the internal and external telephone service of the following kinds of economic units and institutions:

Offices

Factories

Warehouses

Institutes

Hospitals

Stores

Transport facilities (railway stations, airports)

Armed forces

Internal and outgoing calls take place automatically (without operator). Incoming calls are received by the operator and connected to the wanted station.

A common feature of the CA models is that they include the same twin-bridge crossbar switching machine. The build-up of their circuits is similar. Fundamental constructional elements are relays and the twin-bridge crossbar machine. Many audio circuits are of electronic structure. The individual hands and printed circuit plates are executed as plug-in units, consequently putting into service, maintenance and expansion can be performed in a simple way.

The individual members of the series offer a wide range of possible special services, e.g., conference calls, joining in remote dialling service, facility of ringing back, automatic transmission of call, reception of night calls and connexion to conjugate exchange. Features of the individual members of the series and their most frequently used variants are as follows:

Model No	Range of variation		Most frequent variants
	Mainlines	Extensions	(Main lines/extensions)
CA-22	4	20	4/20
CA-42B	5-10	40-80	8/40, 10/80
CA-102	10-30	100-300	20/160, 30/200 10/100, 15/100
CA-1002	20-200	200-2000	40/400, 60/600

Problems in production and running-in

General

Starting from the initial stage of production, consisting essentially in assembling, the final objective is to achieve local production that is as complete as possible, utilizing locally manufactured components and material. The pace of adaptation of production to reach the objective is influenced by many technical, economic and financial factors. In many cases only 80% of the objective is reached. Experience has shown that it should not take longer than six years to reach the objective, as such a delayed adaptation involves a poor economic efficiency. Therefore, one should at the onset take into account the planned final production capacity, the better to avoid material obstacles to a fast rate of growth.

The most important data for planning factories with capacities of 15,000 and 30,000 lines a year in the CA series are described above. Since certain components and partial units of the exchanges are used in a comparatively small number of pieces, the production of the same will be profitable only if the given line capacity is exceeded. On this basis, it is suggested, first of all, that a factory having a yearly capacity of 30,000 lines be established. A possible scheme of development production capacity is as follows:

Years after start	Production (thousand lines)
1	5
2	10
3	15
4	22
5	30

System engineering of PABX

The equipment recommended for assembly is built up of similar units in respect of both construction and system engineering. Many circuit units are identical, many components coincide and connecting elements are all uniform. An extensive application of plug-in circuits and cables permit fast assembly and rapid testing. The identity and similarity in respect of construction and system engineering result in a mechanical mass production of the individual circuit units, components and connecting elements and ensure the profitability of the enterprise.

Technological features of local production

Owing to the production of components and partial units in large quantities it is possible to realize all phases of the work by way of machining or mechanical treatment. Apart from a few operations to be performed manually, the manufacturing technique uses machines or mechanization:

Phase of work	Technology
Production of components	Machining
Production of fittings	Mechanized
Assembly of fittings	Mechanized, manual
Soldering	Manual
Testing of circuit units	Instrumental
Testing the exchange	Manual

Specific requirements of technological capacity

For the purpose of assessing the quantity of production equipment to be used and of incidentally necessary jobs, it can be assumed that the total time requirement per line of the lumped technological operations (production of components, sheet-metal work, production of cable forms, soldering, testing, ancillary operations) is on the average 27 h. The total and partial times will obviously vary as a function of how much is supplied by the co-operating partner (e.g., certain operations may be dispensed with or reduced when supplies increase).

Power requirements

Electric power

Electric power requirements do not exceed the average work needs, i.e., the estimated requirement is 0.9-1.2 MW for a plant with an annual capacity of 15,000 lines and 1.8-2.2 MW for one with 30,000 lines.

Compressed air

Compressed air is needed only for the automation of technological operations; the rate of use is only 1 m^3/h.

Quality control

Quality testing includes controls in the course of production and final control. Tests are performed on components and fittings according to the sampling method; on circuit units, piece by piece. For the purpose of testing certain apparatus (e.g., relays, crossbar machine and bands), special machinery is required.

Manpower requirement

Using the time requirement given above, the labour requirement is calculated as follows:

(a) 27 h/line x 15,000 line/a=405,000 h/a;
405,000 h/a ÷ 2000 man-h/a = 203 workers;

(b) 27 h/line x 30,000 line/a = 810,000 h/a;
810,000 h/a ÷ 2000 man-h/a = 405 workers.

Adding the personnel not directly concerned with production, the total staff amounts to:

(a) 320 for the 15,000 line/a plant;

(b) 575 for the 30,000 line/a plant.

The additional workers perform those activities where fixing norms is not feasible, e g , repairs of machinery, instruments and testing devices; materials handling; preparative work; surface protection; storage of materials and finished products; forwarding. In order to assess the total staff number of the factory there must be added to the figures quoted above the number of the office and management staff. The composition of labour according to qualification should be such as to permit the distribution of productive operations according to the technology, so that a high degree of specialization is available, from unskilled work to special skills. Female labour can be occupied in approximately 80 % of the production, part-assembling and testing work. Thus approximately 70 % of the total volume of production may be realized by female labour.

Required floor space

The floor space required for the assembly plant, including offices, storage areas, social areas and engineering workshops (to be used later for the production of components) is 3,400 m for the smaller plant and 5,000 m for the larger.

Consultancy and training

At the very outset, advantage should be taken of the assistance offered by Hungarian experts and of the opportunities for training in Hungary. The table shows the scale of this effort:

	Hungarian experts		Indigenous specialists	
Capacity (line/a)	Number	Period of stay (months)	Number	Period training in Hungary (months)
15,000	6 - 7	3 - 12	8 - 10	6 - 12
30,000	8 - 10[a]	3 - 12	10 - 15	6 - 12

[a] Two or three of these experts should stay 24 months.

III. ASSEMBLY PLANT FOR MICROWAVE RELAY EQUIPMENT

Description of the equipment

The high-capacity GTT radio-relay type series serve for building up main-line network communications operating in the 4- and 6-GHz frequency bands. The number of duplex radio channels correspond to CCIR recommendations: in the 4GHz band, six; in the 6-GHz band, eight. Each radio channel is suitable for transmitting a fundamental telephone band of at most 1800 speech channels and service signals, or a colour-TV picture signal and four sound signals simultaneously. The technical specifications of the equipment are more than adequate to ensure fulfilment of CCIR recommendations in respect of the quality of transmission of the communications.

The transmission system consists of frequency modulation (FM) with pre-emphasis. The pre-emphasis characteristics, frequency sweep and junction data are in accordance with CCIR recommentations. Modulation and demodulation are performed at 70 MHz; an intermediate frequency (IF) of the carrier frequency signal passes repeater stations without demodulation. In addition to forwarding telephone and TV signals, the CTT type series permits various services for increasing reliability and facilitating running maintenance of the equipment as follows:

(a) A channel-reservation device permits automatic switching of the traffic of a channel to a reserve channel in case of adverse propagation conditions (fading) or of an equipment defect;

(b) A remote manipulator device permits repeater stations to operate unattended. The controlling main or terminal station can verify the operational state of the annexed repeater stations and in the case of a defect localize the defective station and equipment, switching in or out certain equipment by means of remote control;

(c) Service telephone channels permit maintaining connexions between the attendants of the individual stations. The sectional service telephone channel provides connexions within the section between the terminal or main stations limiting the section and the intermediate repeater stations, while the distance service telephone channels (express speech channels) create the connexion between terminal and main stations along the entire length of the line (maximum three telephone channels);

(d) Accessory transmission of 48 telephone channel signals is feasible from a terminal or main station to a repeater station or to the next main station (in the case of a 1800-channel fundamental telephone band);

(e) A diversity switching device is available which permits, within radio sections having adverse conditions of propagation, the automatic selection of the channel of best quality among the radio channels forwarding identical traffic.

The transmission of channel reservation, remote manipulation and service telephone signals, as well as that of the accessory 48 telephone channel signals does not require a separate radio channel since their relaying takes place in a radio channel of the accessory band below the multi-channel fundamental telephone band.

The circuits of the GTT equipment are accommodated in standard frames 2064 mm high, 225 mm deep and 600 or 300 mm wide. The broad-band transceiver frame and the current distribution frame are 300 mm wide, the width of all other frames is 600 mm. Most of the circuits are built in sub-rack assembly units of a height conforming to one, two or three modules and constituting self-contained, mechanically complete units. The seating and the internal wiring of the transceiver frame, the channel reservation frame, the service frames of terminal, main and repeater stations, as well as the current distribution frame, are fixed, but type varieties of certain assembly units may be different and other assembly units may be dispensed with in accordance with the requirements of the station. The seating of the frames containing the modulators, the demodulators, as well as the diversity switch, is not fixed and is adaptable to the requirements of the station.

The filter set and transceiver switch unit are accommodated in the space above the transceiver frames, above the upper plane of the frames. The total height of assembly amounts to max. 2800 mm. The range of the equipment is completed by horn-paraboloid aerials and rotating paraboloid aerials.

The circuits are entirely of silicon semiconductor type, except the final stage of the radio-frequency transmitter, which uses a travelling-wave amplifier. A great number of integrated circuits are used, especially in the service and channel reservation equipment. The travelling-wave tube in the magnetic assembly unit can be replaced at the station and does not need forced cooling.

GTT equipment is fed with dc at 24, 48 or 60 V, with positive ground. Accordingly, inverters are available in three varieties, to be selected to match the supply voltage of the station. Some independently serviceable sub-rack assembly units (e.g., portable modulator or demodulator, diversity switch) are suitable also for operation at 220 V ac. The equipment can be operated continuously in closed premises. The service temperature range is 0-50°C. Within those limits, specifications are guaranteed in any partial range of 40°C width.

Informative data for the establishment of a plant

The final capacity of a factory producing microwave equipment, taking into account technological and economic aspects, should be such as to be able to build up a line 2400 - 2500 km long, assuming a one year's production cycle During the period of realization of the investment it is expedient to develop full productive capacity within 5 - 7 years, depending on the country's economic and technological capabilities, as follows:

Years after start	Annual production (km)
1	200
2	1000
3	1300
4	1800
5	2500
6	2500
7	2500

Assuming that the factory is designed for an annual production of 250 sets of transmitter-receiver equipment, which would enable building up a 2+1-type section 2400 km long, the essential characteristic data, the requirements of realization of the factory to be established would be, as a matter of information:

Floor space required for producing mechanical components, mechanical and electrical assembly and final assembly: approximately 6000 m^2.

Electric power:	600 kW
Gas supply:	5 m^3
Industrial water:	8000 m^3/a
Inherent productive standard hour capacity:	500,000 h

The composition and quantity of the technological equipment of the factory to be established should be planned in consideration of the internal capability and the range of production of the country. The factory conceding the technology is in a position to assist the country intending to build high-capacity radio-relay equipment through the following services:

Technological data for planning the factory

Design of the equipment and its manufacture

Delegation of expert consultants for starting up the production

Training of indigenous specialists in Hungary

Co-operation in production according to demand

Supply of technological equipment and components of the equipment to be built, as manufactured in Hungary

By agreement, it is feasible to have the entire factory project elaborated at a Hungarian project institute. For the purpose of the maintenance and repair of the lines supplied by the factory, the Hungarian counterpart will make up a plan regarding the requirements of technological means of a repair centre and supply the documentation required for repair work. In accordance with the demands of the end-user, a plan for a training centre for the attendant staff will be made up and the required equipment supplied.

IV. MANUFACTURING TECHNOLOGY FOR ELECTRO-ACOUSTIC AND PUBLIC ADDRESS SYSTEMS

Establishment of radio and TV studios, maintenance, completion and development of their equipment

When a developing country establishes a radio and TV centre, it will be expedient to also establish installing, operating, maintaining and developing departments near the centre. These departments could form an on-plant support unit which, over and above the operating, maintenance and service, could have a partial manufacturing and developing function, equipped with application technology and component parts from Hungary and with a staff trained in Hungary. Hence, it would be an on-plant servicing enterprise. A developing country should embark upon industrial manufacturing and production activities only if transport and other circumstances toward neighbouring countries are such that the country in question can undertake this servicing function for several countries. In such a case this on-plant servicing enterprise can be transformed, with Hungarian assistance, into a business contractor enterprise.

Service activity for radio and TV studios

The following data characterizes a smaller workshop that is engaged in servicing and partly in assembly.

The market possibilities of this workshop depend practically on to what extent the use of the building blocks (plug-in units) manufactured in Hungary is required for equipping smaller studios, theatres, cultural centres etc.

In case of studio equipment, the normal amortization time is between 5 and 10 years. Naturally, that does not mean that the necessary operating supervising, testing and maintaining requirements can be dispensed with. At the same time, it is also obvious that in the course of this servicing activity, the operating staff acquires a technical knowledge that can form the basis for establishing a smaller workshop.

Requirements are automatically matched to the environmental requirements of the radio and TV centre.

The characteristic technological distribution of manufacturing would be 80% high-level electronic and technical testing and 20% component parts production. Constitution of the staff: two electrical engineers three electrical technicians and five precision machinists. In the course of the occasionally putting studio systems into operation, the scale of operation attains full growth. The establishing of a smaller manufacturing basis becomes possible after this.

Necessary manufacturing conditions:

Area: approximately 80 m^2

Machines:

	Quantity
Bench drill	2
Desk-top air press	1
Floor-stand grinder	1
Machinist's lathe	1

Instruments:

Vacuum-tube voltmeter (VTVM)	2
Oscilloscope	2
Generator	2
Multimeter	2
Distortion meter	2
Portable tester	2
Mains stabilizer (1 kW)	1

Sound systems for closed and open areas

Public address (PA) systems

Because of the great distances involved, and from the point of view of creation of local industry, it is expedient if the Ministry of Works in a given developing country establishes at first a planning, executing, installing, operating, servicing and development enterprise, which can be gradually extended to manufacture the electroacoustic modules required in the greatest volume. Hungary is prepared to assist in helping such organizations, which should also include the manufacture of high-quality loudspeakers and sound radiators

Creation of a production basis

Starting out from the operating activities, a significantly wider range of work in electronics or electroacoustics can be imagined.

Taking into consideration the local market possibilities, both amplifier and loudspeaker manufacturing may be possible.Obvious markets are state institutions, sport institutions, public educational institutions and home entertainment centres. Taking into consideration the widespread use of this product it is obvious that the demands of the neighbouring developing countries can also be covered.

In the case of amplifiers, small-scale production would be 500 to 1,000 pieces, medium-scale, 8,000 to 10,000. For loudspeaker production the corresponding ranges are 1,000 to 2,000 and 15,000 to 20,000.

The environmental requirement is an area free of dust pollution. Considering that the factory does not cause any external pollution, it can be established in an inhabited area.

The manufacturing of component parts is nearly 40% of the full capacity. These are:

- Pressing and stamping
- Joinery
- Upholstery (leather coverings)

The assembly work is nearly 60%, broken down as follows:

- Preassembly 30%
- High-quality loudspeaker assembly 10%
- Final assembly 10% - 20%

The composition of staff is as follows:

	Number
Electronic engineer	3-4
Technicians	5-6
Semi-skilled worker	28
Joiner	15
Semi-skilled assemblers	100

The work should be started with assembly of amplifiers as the first step. The second step may be assembly of the loudspeakers and the third, manufacture of the magnet systems.

Conditions of the manufacturing are:

Space requirement: 10,000-12,000 m^2. The production area is approximately 5,000 m^2 in the following distribution:

	Area (m^2)
Pressing and stamping	500
Joinery	450
Upholstery (leather coverings)	350
Loudspeakers	300
Sound radiators	400

	Area (m^2)
Amplifiers (preassembly)	1500
Final assembly	1000
Testing	500

Machine requirements:

	Quantity
Cam press	5
Circular saw	1
Band saw	1
Trying-up plane	1
Belt grinder	1
Drill press	6
Stand grinder	1
Bench air press	1
Loudspeaker production line	5

Finishing workshop If electroplating and painting are not subcontracted, special plans will be furnished for this workshop.

Instruments (loudspeaker testing) (one each):

Rotating table
Measuring microphone
Cathode follower
Measuring amplifier
Level recorder

Power amplifier
Noise generator
1/3-octave filter
Audio-frequency (af) generator
Studio-quality tape recorder

Instruments (amplifier testing):

	Quantity
Audio-frequency generator	2
Oscilloscope	2
VTVM	2
Multimeter	2
Distortion meter	2
Breakdown tester	1
Mains stabiliser	1
Stabilised power supply	2
Dummy load	2

The typical production capacity is 500-600 amplifiers per month, and 1000-1200 sound radiators per month. The loudspeaker workshop has a capacity of 500 pieces per month. In storing there are no special requirements; 1500-2000 m^2 storage area is needed for storing of materials, semi-manufactured goods and finished goods.

Training facilities

Planning, manufacturing, installation and maintenance department

As was mentioned above, the establishment of a planning, manufacturing, installation and maintenance department would be expedient, with the intention that this could provide a full industrial function later. The requirements are:

The environmental requirements are the same as those of the institutions operating the equipment, hence no special requirements exist. Technological distribution of manufacturing:

80% high-level testing
20% component-parts manufacturing

Composition of the staff:

	Number
Electronic engineer	3
Draughtsman	3
Electro-technician	3
Precision-machinist	5

Required manufacturing conditions:

Space: 100 m^2
Normal public utilities

Machines:	Quantity
Drill press	2
Bench air press	1
Stand grinder	1
Machinist's lathe	1

Instruments (one each):

- VTVM
- Generator (af)
- Oscilloscope
- Pulse generator
- Distortion meter
- Mains stabilizer
- Stabilized power supply unit
- Multimeter
- Logical test set

Forming of manufacturing basis

For evaluating market requirements, the bases are the technical equipment needs of local educational institutions and of similar developing countries. For determining the magnitude of mass production, we took into consideration the group-training device for hearing-handicapped as a typical example.

Small-scale is 25-50 pieces, medium-scale, 150-200. The following data refer to medium-scale. Amortization is about 5-8 years. Component parts production is 30% of the total and consist of pressing, precision machining and joining. Assembly is 70%-80% and includes preassembly, final assembly and testing.

Staff:

	Number
Electrical engineer	6-8
Technician	10
Draughtsman	5
Designer	8
Semi-skilled worker	20
Turner	5-7
Joiner	5-7
Electrician	6
Precision machinist	8

It is expedient to establish in two steps:

First step: assembly of ready-made, purchased parts

Second step: production of mechanical and joinery parts and elements.

Conditions of manufacturing:

Total space 4500–5000 m^2
of this 2000 m^2 are needed for manufacturing,
200–300 m^2 for the developing and designing departments

	Area (m^2)
Pressing	400
Turning	450
Joining	450
Preassembly	400
Final assembly workshop	300
	2000

Normal public utilities

Machines:

	Quantity
Cam press	5
Circular saw	1
Band saw	1
Trying-up plane	1
Belt grinder	1
Drill press	1
Centre lathe	4
Automatic lathe	2
Universal mill	1
Roll grinder	1
Drill press	5
Stand grinder	2
Automatic press	1

Instruments:

	Quantity
Generator (af)	2
VTVM	2
Oscilloscope	2
Pulse generator	2
Distortion meter	2
Mains stabilizer	2
Multimeter	2
Portable tester	2

Instruments:

	Quantity
Logical test set	2
Remote control slide projector	2
Tape recorder	1
Noise generator	1
Wow-and-flutter meter	1
Breakdown tester	1

Components to be obtained from outside suppliers:

- Circuit elements
- Integrated circuits
- Printed circuit boards
- Tape recorders

In group-training equipment for hearing-handicapped, the volume of production is 15-17 sets per mouth. Required storage area is 1000 m^2 with a volume of 30000 m^3, for storing of raw materials, semi-manufactured goods and finished goods. The equipment includes several patented parts. In case of necessity, licences or know-how can be furnished.

V. MANUFACTURING TECHNOLOGY FOR TELEVISION

The VIDEOTON Radio and TV Factory, employing nearly 25,000 workers, is one of the greatest telecommunication engineering factories in Hungary. This big enterprise was engaged in finding a possibility of an international co-operation in the past, and sees a possibility in transmitting technologies, which (a) Fit into her profile; (b) On the basis of the present proposal, fit into the system of technology of the receiving country.

When elaborating this technology-offer VIDEOTON keeps the following main points in view. It proposes a technology which does not represent the out-standing achievements of the telecommunications engineering industry, but at the same time in its quality remains permanently very close to these latest achievements in the coming 10-1? years. The technology guarantees the receiving country an automated production on a reasonable level, on the other hand it assures a suitable rate of employment. Depending on the technical level of the receiving countries, it enables to reach a flexible economic serial volume. The described system of technology will make possible - in the elaboration - a maximum annual output of 100,000 black-and-white, or 25,000 coloured TV sets.

This preliminary offer presupposes the existence of factory premises (buildings) required for the production. Since we had no accurate information about these data of the developing countries, when elaborating our preliminary offer we neglected these factors. VIDEOTON has the interests of the receiving countries in mind: in variation A it gives full and detailed documentation containing construction drawings, tooling charts and production schedules; documentation for manufacturing instruments, tools, equipment and single-purpose machines and instruments; and accurate type-designations of machinery and equipment (in several versions, wherever necessary). It also contains information on all materials required and applied for the production, and, as a consequence of it, the receiving country will be in a position to prepare the production, purchase the necessary tools and instruments, and provide the fundamental conditions of production. Of course, VIDEOTON provides expertise and technological aids at each stage of the process.

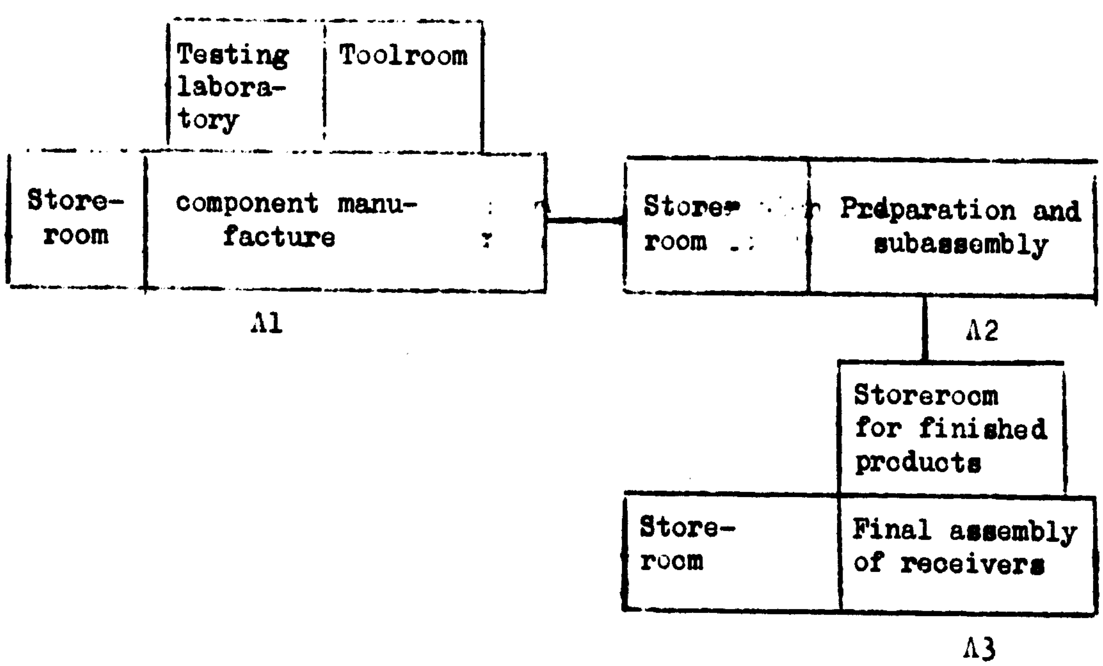
In variation B, in addition to the complete documentation of variation A, upon request of the receiving country, VIDEOTON will fabricate the single-purpose machines, instruments and tools, as well as the assembly lines, and provide other manufacturing equipment, that can be obtained from Hungary.

Finally, VIDEOTON presents a third proposal, variation C. With the delivery of the complete documentation mentioned in variation A, and on the basis thereof, VIEDOTON, acting as a general contractor, provides all installations and devices required for the production, including shipment to the spot and start-up of production. With a view to a timely and economic start-up of production, the specialists of VIDEOTON will draw up a production start-up plan on the basis of consultations with the specialists of the receiving country, with which the entire process can be kept in control. In this way, a continuous rise in production will be made possible, at the rate required by the receiving country.

The probable circumstances and costs of each of the three versions will now be described.

Variation A: Production plant with an annual capacity of 100,000 black-and-white TV receivers

VIDEOTON, as a tenderer, takes into account the use of the internationally recognized thick-neck (17"-24") cinescopes with 110° or 114° deflection and a modular chassis design. We deem it practical to divide the production plant into three sectors, as shown in the block diagram below:



A1 - Component manufacturing shop

This sector includes the production of turned, cold-shaped metal parts, printed-circuit boards, plastic parts and springs. The production of the above-mentioned componant manufacturing shop consists of three indepentent cycles located on one building complex. The receiving country will perform here the production of components of the following units:

Fasteners
Pl stic cabinet, including front and back covers
High-voltage transformer and deflection coil
Loudspeaker
Coils
Tuner
Assembly frames

The cost of documentation will be $6,000. Other requirements are as follows:

Labour requirements

Personnel		Number
Semi-skilled		130
Skilled		20
Technological		6
	Total	156

Floor area

		Area (m^2)
Production		480
Storage		200
	Total	680

The storage rooms have sufficient area for a two-weeks supply of stock.

Investment costs

Activity		Cost (thousand dollars)
Turning and cold-shaping		175
Plastic part production		420
Production of printed-circuit (PC) boards		22
	Total	617

Production equipment

Activity	Cost (thousand dollars)
Turning and cold-shaping	88.0
Plastic part production	101.5
Production of PC boards	8.3
Total	197.8

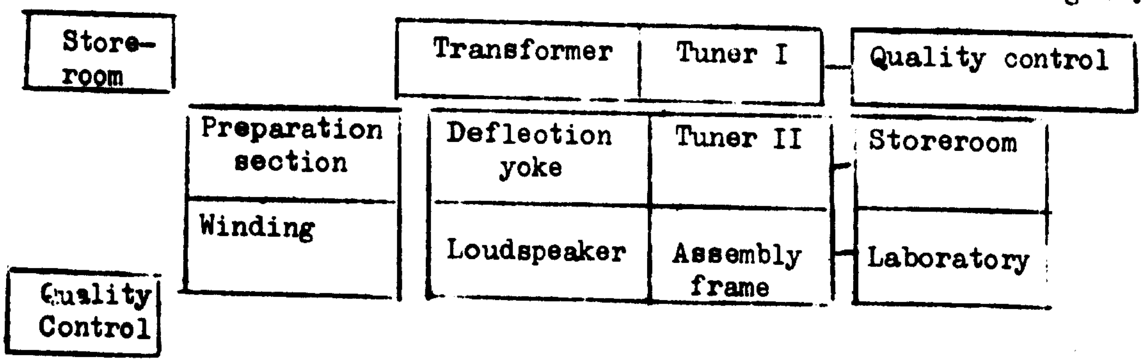
Closely related with the components manufacturing shop is a testing laboratory and a toolroom employing 72 workers on a floor area of 450 m^2, requiring an investment cost of $339,000. The measuring instruments will cost $6,000 and the documentation $2,900.

A2 - Subassembly plant

The plant which includes a preparation section, will assemble the following subassemblies:

High-voltage transformer
Defleotion and other coils
Loudspeaker
Tuner
Assembly frame

The overall block diagram of the plant is shown in the block diagram:



In this plant there are six assmebly lines, each consisting of standard elements. Depending on the receiving country, the assembly lines can be operated in three different ways.

The assembly frames, adjustable at different angles on the line, allow conveneint and quick assembly. The work-places feature carefully selected colour dynamics.

Labour and cost requirements for A2

Assembly or other operation	Labour requirement (persons)	Costs (thousands of dollars) Investment	Equipment	Documentation
High-voltages transformers	34	41.5	2.3	1.35
Deflection yokes	30	36.0	7.0	0.9
Loudspeakers	22	29.5	6.3	1.5
Miscellaneous coils	29	292.0	10.2	8.0
Tuners	118	203.0	18.0	10.0
Assembly frames	71	17.5	2.5	8.0
Preparation section sector	92	5.8	4.3	1.5
Quality control before final assembly	21	8.6	3.0	0.5
Total	417	633.9	53.6	31.8

The total requirement of floor area of subassembly manufacturing plant 1,566 m^2.

A3- Final assembly

After an adequate quality control, the components and assemblies are transferred to the feeding storeroom of the final assembly shop together with the commercially available parts passed by the quality control department. This storeroom can keep stocks sufficient for one week's production. The supplies are transferrrd from the storeroom to the assembly lines in accordance with the rate of production. The duration of the assembly cycle can be varied (upon request of the receiving country) from 2 to 59 min. 59 s. Here, the electricity tested PC boards are assembled and incorporated into the cabinets. The complete assembly, electrical start-up, alignment and the quality control-tests (life test), as well as packing of the receivers are performed on these lines.

Labour and floor-area requirements

	(Persons)	(m^2)
Assembly of PC boards	78	400
Soldering	3	20
Inspection and assembling of assemblies	16	70
Final assembly, alignment, troubleshooting	52	220
Life test	5	100
Final inspection	10	50
Packing	8	50
Transfer	10	
Total	182	910

Investment costs: 310,000

Tools requirement: 12,000

Documentation costs: 8,000

Variation B: Colour television receiver plant with an annual maximum capacity of 25,000 sets

The production and assembly of components and assemblies identical with those of the black-and-white receivers have already been included in the capacity of the plant shops A1 and A2. The substantial change is in the number of working places, in equipment and instruments of the final assembly plant. The modified number of personnel, floor area requirements and costs are shown hereunder:

Labour and floor-area requirements

	(Persons)	(m^2)
Assembly of PC boards	163	200
Soldering	3	40
Inspection and assembly of assemblies	100	300
Final assembly, alignment, troubleshooting	80	220
Inspection	15	60
Life test (85 stations)	4	120
Packing	6	150
Transfer	6	-
Total	377	1,090

Investment costs:	720,000
Tool costs	20,000
Documentation costs	15,000

Variation C VIDEOTON as general contractor

C1 - Short description and technical data of modular television receivers recommended for manufacture by VIDEOTON

The modular design divides the television receiver into distinct sections, each of which is capable of performing the definite subfunction. The parts of each circuit section - transitors, integrated circuits, etc. - are mounted on separate PC boards (modules). Then the modules are aligned using a special-purpose instrument. Finally, the receiver can be assembled by soldering or plugging the modules together.

The basic modules are as follows

- Tuner
- Video amplifior
- Audio-channed module
- Vertical-deflection module
- Syno-separator and line-oscillator module
- High-voltage transformer module
- Chassis board (regarded as an interconnecting module)

C2 - Specifications of black-and-white television receivers

The specifications of the black-and-white TV sets are

CCIR system for VHF I-III and UHF IV-V TV-bands

Variable capacitance tuner with preselection (push-buttons for 6 stations or touch-controls for 4 or 8 stations)

Easy maintenance and repair

Built-in antenne (on request)

Sensitivity: better than 10 µV

Audio output: min. 1.5 W

Climatic adoptation: temperature max. 45° C and relative humidity max. 80%

C3 - Specifications of colour television receivers

In addition to the perfect fulfilment of the specifications listed above for black-and-white receivers, the colour sets have high-level automation, the CCIR standard or the SECAM system and cinescopes that measure 20"-26" on the diagonal.

VI. MANUFACTURING TECHNOLOGY FOR HYBRID CIRCUITS AND LIQUID-CRYSTAL DISPLAYS

Hybrid circuits

In the past ten or fifteen years the hybrid integrated circuits have come into general use in two basic technological variations

Thin-film technique based on vacuum depos ion

Thick-film technique based essentially on silk screening

More recently the thick-film technology has been widely accepted for electronic application because of its relative flexibility and simplicity, low investment costs and ease of manufacture. Using this technology, complex circuits or devices can be manufactured by screen printing and firing adherent patterns of conductive, resistive and insulating circuit elements onto ceramic substrates. The subject-matter of this description deals with the thick-film circuits, including some problems relating to their manufacture and application.

The thick-film hybrid integrated technique forms an integral part of the integration of electronic components and of miniaturization, and thus hybrid circuits complement semiconductor monolothic integrated circuits. Application of circuits is advantageous, if

(a) A small series is needed and development of monolithic circuit is not viable,

(b) The circuit contains elements that are not realizable by monolithic techniques,

(c) More severe requirements are raised regarding the tolerances of the passive components, the limits of voltages and dissipations,

(d) A protopype of a custom-designed circuit is urgent;

(e) The required reliability (e.g. in severe climates) is high.

The available market of hybrid circuits can be seen from the statistics of application among all integrated circuits, the hybrids represent 15% in market value. The concept of the hybrid integrated circuit covers all kinds of integrated circuits from passive ones to large-scale hybrid integrated systems. More hybrid circuits may be used where the proportion of telephony, transmission technique, precision engineering, microwave technique, military electronics is greater th n the average. Because of their high reliability, hybrid integrated circuits lend themselves particularly well to application in professional equipment and, in consumer electronics, their use has been increasing.

The lower limit of economically viable production is 10^5 - 10^6 pieces per year, according to the complexity of the circuits.

The manufacturing technology needs a satisfactorily clean environment. Urban environment is generally suitable if the air is not too polluted with dust and aggressive chemicals and its carbon monoxide and carbon dioxide levels are constant. Special environmental demands in the building itself are restricted to small areas of about 50 m^2, where the air pollution must be of class 100,000, the temperature must be /22 ± 1°C and the relative humidity 50-60%.

A plant manufacturing some 10^5 pieces of circuits with medium complexity needs 450 m^2 area. The necessary working forces are 3 persons with university education, 3 middle-grade specialists, 2 operators and 30 unskilled workers. These numbers relate only to production and further research.

Two variations exist in the manufacturing technology of hybrid thick-film integrated circuits (a) The specification of the network or circuit to be integrated is available in form of a switching diagram and the design operation is limited to the hybrid transformation, (b) The integrated circuit is given by its input/output parameters (black box).

In the latter case, depending on the complexity of the circuits to be designed, more engineers and middle-grade specialists are needed. For a new plant, the first variation is recommended.

Establishment of manufacture takes place as follows:

- Setting up the different services of the building
- Installation of the machines
- Adjustment of the technological processes
- Pilot series made by the deliverer of the technology
- Teaching the technology
- Production control and product control, especially that of the pilot series

The power needed by the manufacturing process:

Mains power	50kW
Running water	0.6 m^3/h, 6 atm
Distilled water	0.1 m^3/h
Compressed air	6 atm
Vacuum	0.6 kp/cm^2

Equipment and instruments:

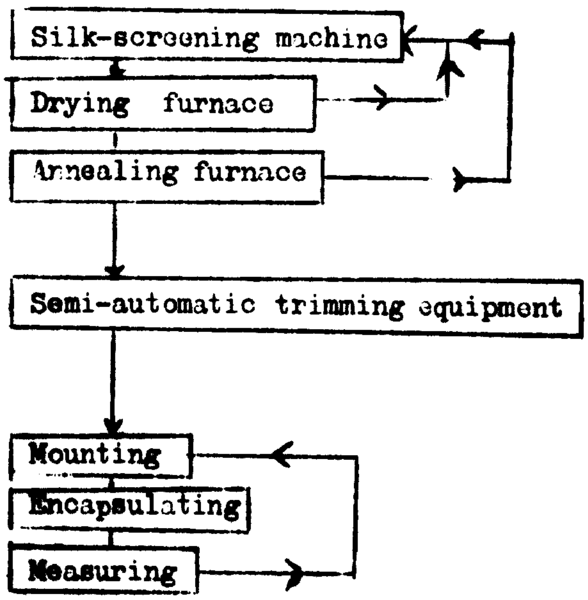
Continuously operating silk-screening machines
Conveyor drying furnaces
Conveyor firing furnaces
Semi-automatic trimming equipment
Chip-bonding equipment
Encapsulating equipment
Ohmmeters, broad-band voltmeters
Oscilloscopes etc.

Materials for networks of medium complexity:

Thick-film compositions for resistors, conductors and isolators
Ceramic substrates
Soldering material
Hybrid elements
Sealing materials

The manufacturing capacity with the above-mentioned size of staff is 10^4 pieces per month. The end-product does not require any special storage.

A rough flow chart is shown below:



Liquid-crystal displays

Mass-produced liquid-crystal displays (LCDs) were introduced about four years ago. Two basic types are in production one utilizing the principle of dynamic scattering, the other, the twisted nematic mode of operation.

LCD manufacturing technology is made up of some 4[illegible] operations (the suboperations of a given processing step are considered as a single operation). The main processing procedures are as follows

- Substrate cleaning and mechanical pretreatment
- Layer deposition and pattern shaping
- Orientation
- Mounting, filling, sealing
- Production control and product control

According to market forecasts, displays will represent 0.6% - 0.9% of the total value of the electronic component market by 1980.
Some 10% - 20% of that, depending on the internal structure of the industry, can be expected to be LCDs. The main fields of application are as follows:

- Watches and clocks
- Portable measuring instruments
- Equipment requiring large displays
- Displays with low power consumption

The lower limit of economically viable production of small displays is about 1.5×10^5 pieces per year large types can be manufactured efficiently in smaller series.

The LCD manufacturing plant must be established in a clean environment. Some of the operations are to be achieved in clean rooms of class 10000 or 100000 in laminar boxes or glove benches. The other services, e.g. hot water, cold water, compressed air, rough vacuum, ultraclean nitrogen etc., are the same as those in a common photolithographic laboratory or workshop.

A plant manufacturing in one shift some 1.5×10^5 pieces of small LCDs per year needs 350 m^2 area. The necessary working forces are 50 persons, among them 5 with university education and 5 middle-grade specialists.

In establishing a manufacturing plant, one has to begin with the training of the specialists and continue with the installation of the workshops.

The manufacturing technology cannot be separated into parts however, substrate glass with deposited layer can be obtained from an external firm (e.g., Hungary).
The plant needs 70-100 kW electrical power. The processing time is 5-10 days.
Some important problems related to the establishment of the manufacturing plant are as follows

(a) For the technical level and character of manufacturing a technical staff familiar with deposition and other microelectronic techniques is required;

(b) Services have to be assured on an adequate level

(c) Sale of the products takes place either on the general electronic markets or on internal markets as components to be applied. Suitable driving electronics and contacts that properly fit the displays must then be provided either by manufacturing or by purchase

(d) Considering that LCD design and technology are still young, managers will have to keep up-to-date in a rapidly changing field.

A laboratory-scale production of LCDs using the principle of dynamic scattering is going on in the Hungarian Industrial Research Institute for Electronics (HIKI). So far, experience with technology and reliability has been good. Work on LCDs using the twisted nematic mode of operation is planned to begin in 1977.

VII. ESTABLISHMENT OF VACUUM-TECHNICAL FACTORIES

Lamp factories and other light-source industries have been established in a number of developing countries during the past 15 years, financed by state enterprises or realized by private capital investment, depending on the economic and industrial policy of the country concerned. The capacities of such factories vary accordingly. The complete (more or less) vertical production of light-sources (to be analysed later) is justified in case either the local consumption has reached sufficiently high figures or the market of neighbouring countries can be counted on by means of customs preferences and market-division. Market demand, consumption figures, production capacity and verticality are interconnected factors.

Market research can be based on official or semi-official import statistics giving relatively reliable picture of the consumption of the previous 3-5 years. This is to be completed with the power generation planned within the frame of the industrialization programme. The above information combined with the electricity in kWh or percentage consumed for lighting purposes form a fairly good basis to estimate the increasing market demand for light-sources (electric lamps) in line with the increase of power generation.

This method may, however, be misleading if power generation and consumption is evaluated disregarding the electrification programme. The basic product of light-source industry is the so-called normal incandescent lamps (abbreviated as GLS), and the consumption rate thereof is in direct relation with the realization of the electrification programme supplying electricity to more and more areas of the country concerned.

The production of flourescent lamps (called TL) being the most wide-spread light source used in public areas (streets, parks, squares, etc.) is advisable in the first phase along with the GLS production. The investment programme should be based on the capacity of manufacturing machines of a technical level that does not require unreasonably high qualification from the operators. This is an important point of view not be be neglected when establishing a new industry. Starting from the usual production rate of 1800-2000 GLS/h and 650-800 TL/h, as well as considering a reasonable net output of quality product the machine-lines are capable of producing

$(6-7) \times 10^6$ GLS and $(1.2 - 1.4) \times 10^6$ TL in one shift annually. This has been the practical reason why the authorities in India have issued industrial licences of a standardized capacity of 6×10^6 GLS plus 1.5×10^6 TL, during the past decade.

At this point it should be mentioned that the above analysed assembly lines must regularly be supplied with all components from outside sources. These components are as follows:

> Glass shells for GLS, and glass tubes for TL, lead-glass tubes (exhaust-tube and flare-tube), filament, lead-in wire, GLS or TL caps and other productive materials such as flourescent-powder, cathode-paste and capping cement.

Taking into consideration that the glass components are the bulkiest items and involve high transport costs and moreover are subject to high breakage risk, glass production should be realized in the first phase, when the vertical extension of the lamp factory is decided. Vacuum-technical glass producing equipment consisting of a glass-melting furnace, bulb-blowing and tube-drawing machine lines have also been developed to meet the above capacities.

As a conclusion we can say that the minimum economical factory unit includes the following equipment:

2 GLS machine lines,	1800-2000 GLS/h
1 TL machine line,	650-800 TL/h
1 furnace,	16 m^2 melting surface
1 bulb-blowing machine line	
1 tube-drawing machine line	

The furnace can feed the two machine lines in parallel to produce $(16 - 18) \times 10^6$ GLS glass shells and $(3 - 4) \times 10^6$ tubes. The economical production of such factories can only be ensured in case the GLS and TL lines operate in two shifts, while the glass works must run around the clock for technological reasons. In such conditions the annual production of such a complex factory is $(12 - 14) \times 10^6$ GLS and $(3.4 - 2.8) \times 10^6$ TL.

It has been pointed out that a lamp assembly plant, which purchases all production materials and components from outside sources, usually outside the country, cannot be economical. Furthermore, it can generally be stated that the world market prices of light sources (GLS and TL alike) have a decreasing trend especially if inflation is also considered. This tendency applies to most mass-produced goods. It is also experienced that light source production starts in the developing countries at an early stage of industrialization, thus taking a share of the world market, which has recently been more or less the exclusive territory of a few transnational concerns in the field of vacuum-technical products. At the same time, these small new factories can hardly compete with the giants outside their own local market. On the other hand, during the same period the world market prices of vacuum-technical components have increased directly with raw-material prices. Over and above this phenomenon the world-wide production of components has not kept pace with the capacity increase of finished products, thus enlarging the gap affecting the profitability of a lamp factory of purely assembly character. To summarize: while there is a "sellers' market" in finished products, there is a "buyers' market" in components. Consequently the production of assembly character can only be made economical if backed by protective regulations enforced by government authorities to safeguard the interest of the national industry.

Taking into account, however, that light-sources are not considered as a primary commodity, such protection is usually not applied for the lamp industry in the majority of the developing countries. The lack of efficient protection paved the way for the transnational companies to keep these markets under control by establishing small capacity assembly workshops of their own affiliates. These factories meet the local demand, seemingly serving the interest of the national industry of the host country, with the additional advantage of creating facilities for employment.

The above logical argument leads to the matter-of-fact conclusion that such small-scale assembly-type factories being uneconomical by themselves serve - in one way or other - the interest of the mother company. First of all, the affiliated factories are supplied with components for the continuous production by the mother company where prices are, naturally, not subject to bargaining. At the same time the products manufactured by cheap labour are marketed through the mother company's sales-channels with a better profit margin. Although this method serves the national interest of the host-country with the foreign-exchange income gained from the export of the excess production, the primary aim of the mother company is to be compensated for the losses coming from taxation and profit-transfer limitation applied by the local government to protect the real national interest of these countries.

Due to the complexity of the problem many points of view should be considered when it is decided to set up a light-source factory. In a country lacking industrial experience in general, or experience in vacuum-technical industry in particular, it is highly advisable to find such a partner who can not only supply the machinery needed but also has long manufacturing and technological experience of its own. As a matter of fact the training of local personnel, the technical assistance during the erection, commissioning and the initial (running-up) period by means of delegating highly qualified experts of long experience should be ensured within the framework of the contract to be concluded. The necessity of a sound and all-round assistance has been recognized, and such investments are more and more frequently contracted on a turn-key basis, occasionally including the marketing organization as well. In most cases the demand for capital participation also serves guarantee purposes. The capital required for the establishment of a light-source factory is not considerable, therefore the foreign partner's participation with capital is usually intended more to get it directly interested in the efficient and profitable production than for financial reasons.

The need for such assurances is justified by the fact that the products of reputed brands have long been introduced into the market, consequently, the new factory has to calculate upon the possible counteraction of the transnational companies that previously controlled the market. This risk motivates the demand that the right to use internationally known brand names be granted by the foreign partner. In such a case, the owner of the brand name automatically becomes interested in the quality of the product and usually insists on having a certain control thereon.

In accordance with the internationally accepted practice, royalty should be paid for the use of a brand name at the rate of 2% to 3% on the ex-works price of the products marketed. On this basis the owner may be entitled to inspect the books of the factory.

Inspite of the opposing interest indicated above, experience proves that the transnational companies are prepared to observe the national interest of the developing countries and accept their conditions. These companies seem inclined to participate in establishing lamp factories with minority shares, which is a sign of change in their traditional business policy, evidently due to the changing world economic conditions.

Nevertheless, it can be stated that the basic interest of the developing countries requires close co-operation where the foreign partner can provide all facilities (training, technical assistance, know-how), including continuous supply of production material and components, while their guarantee on the quality of the product is not subject to purchasing the components from one particular supplier. At the same time, the foreign partner should undertake the obligation that production material and components will be provided at a competitive price level or that a specified price-index is applicable. Guarantee on quality, however, is connected to the use of material and components according to the specification of the supplier, regardless of the supply sources.

In addition to all this, it is in the real national interest of the developing countries that the participation of foreign capital needed only for guarantee purposes be limited in time. For this reason, the contracts usually stipulate that the shares are redeemable within 5 to 10 years. In some countries this condition is prescribed by law. Besides the right of partial or total repatriation of capital, the foreign investor is authorized to invest the capital or profit in other local ventures, as an alternative.

From the practical aspect, it is to be pointed out that the above mentioned minimum economical factory unit should be considered when calculating the area required. In such a case the under-roof area is $(10 - 12) \times 10^3$ m^2 out of a total requirement of $(30 - 35) \times 10^3$ m^2. It is, furthermore, advisable to think of future expansion, either by increasing the capacity or widening the verticality of production. A land area of 70×10^3 m^2 can definitely ensure space for a complex vacuum-technical plant, with the total area of the factory buildings of $(20 - 22) \times 10^3$ m^2.

When selecting the plant site, the demand for services supply such as water, electric power and fuel, oil and gas (natural or city) should be considered. Road and railroad connexions should also be constructed for transportation of production material, components and other raw-materials into, as well as finished products out of, the factory. Special attention is to be paid to such transport facility in case of a glass factory that needs sand, dolomite and other additives in large quantities. It can generally be added

that skilled industrial labour is usually available in the big cities only and daily transportation thereof should be provided as well.
Total manpower needed to man such a complete project is in the range of 400-500.

Requirement of service-supplies is as follows

Electric power	700 - 800 kW
Water	30 m^3/h
Fuel oil	200 kg/h
Liquified petroleum gas (LPG)	65 Nm^3/h
Oxygen	50 Nm^3/h

The vertical extension of a light-source factory can be realized in steps, where the production of various metal caps (aluminium or brass) for GLS and TL alike should be the first step following the glass component production. This sequence is dictated by the economy, keeping in mind that glass components and caps represent 70% to 75% of the total value of production material and components, to say nothing of the transport cost thereof, if purchased from outside sources, since they are the most voluminous and heaviest items.

Storage area can be estimated from the transit period between material inflow and finished product delivery on the basis of production figures. The above-indicated (10 - 12) x 10^3 m^2 roofed over area of a light-source factory is calculated with 3-6 months storage of materials and components (excepting the glass components) and 1-2 months for finished goods and glass parts.

The specific questions connected with the basic products of light-source industry are being studied with special regard to the fact that the local production of normal incandescent and flourescent lamps is of primary importance for the developing countries.

The production of special light sources (mercury vapour lamps, automobile headlights, halogen lamps, sodium-vapour lamps etc.) requires a higher standard of technological knowledge and experience. During the first 2-3 years of manufacture in the basic factory, qualified engineers and technicians can be trained in sufficient number.

The market research to be carried on at the same time will give proper guidance for the decision as to which type of light source is wanted in a quantity that justifies further investment. Depending thereon, the production of the selected types of special lamps can be taken up in the sequence of economical consideration. Likewise, the vertical extension can also include the local manufacture of components like lead-in wire, filament, tungsten and molybdenum wire, floures e.t powder and cathode paste.

Some further vacuum-technical products are: TV picture tubes glass tumblers, vacuum flasks, ampoules and vials. The production of these items should, however, be based on the following considerations. A TV picture-tube assembly line has a capacity of (200 - 250) x 10^3 pieces annually.

Since, however, TV picture-tubes can only be produced with profit if the factory itself manufactures the glass shells thereof, the market should be in line with the minimum capacity of glass-shell manufacturing equipment of approximately 500 x 10^5 picture tubes a year. The production of glass tumblers and vacuum flasks being of secondary importance it is normally realized as the extension of any sheet or hollow-glass industry in existence. The manufacture of ampoules and vials presupposes a local pharmaceutical industry with a high enough consumption.

VIII. REPAIR PLANT FOR TRANSMISSION ENGINEERING INSTRUMENTS AND EQUIPMENT

Tasks and objectives

The task of the plant is the systematic, skillful repair of transmission engineering equipment and electronic, telephonic and electrical instruments.

Therefore, the plant has all kinds of up-to-date equipment, means and documentations available that are required for the repair work.

Furthermore, it is its task to produce repair parts that are not available on the regular market.

The objective of the plant is to perform small and medium-size repairs and general overhaul of the equipment in question, utilizing the up-to-date plant equipment and high-level professional skills. A plant of this kind is able to create the basis of a subsequent establishment possibly producing equipment fully processed in the factory proper. To this end the plant may start an independent production of instrument elements as early as in the initial period.

Location

Concerning location of the plant there must be taken into account:

(a) The extension of the reach of industrial effectiveness of the establishment

(b) The number and types of equipment operating within this region.

Organization

In consideration of the aspects of economical efficiency it is purposeful to provide for a plant employing a staff of at least 25. In this case, the cost of investment will be refunded most rapidly (inclusive of repair shop, stock of appliances, production workshop, stock of components, premises for administration and social services).

In the case of a large number of equipment to be serviced, or if they constitute groups situated at greater distances from one another, several service centres may be established, or even a national network.

The plant must be sufficiently provided with the necessary documentation for the repair work, i.e.:

Wiring diagrams of the instruments and devices
Mounting diagrams of the same
Instructions for testing, adjustment and repair

For the purpose of producing instrument elements it is expedient to build up a design department, which should consist of a project and a production engineering group.

The location of the buildings and the rooms, respectively, takes place according to the technological plan with a view to secure intraplant transport and communications in a most economical way.

Capacity

The capacity may be determined in consideration of a joint assessment of small and medium-size repairs and general overhauls, as well as of the intended independent production of instrument elements. For both repair work and production, the required capacities may be established on the basis of this technological sequence:

Transporting the devices and equipment to the plant
Defect diagnosis (determining the category or repair)
Repair (disassembling, checking components, repair, testing, classification)
Production of new(mechanical parts: repair and renewal ofmechanical parts; mechanical assembly (individual, small and medium-size batch production)
Electrical assembly (coil winding, necessary measurements and control tests)
Transport between workshops, materials handling, storage, packaging and completion

The category of repair work that should be undertaken depends on the sise of staff. General overhaul can be performed with satisfactory economic efficiency in the case of a service establishment having a staff exceeding 50.

Small repair

Maximum repair work time amounts to 25 h. It includes calibration and maintenance tests of the instrument or equipment brought in, and incidental simple repair work.

Medium-size repair

Maximum repair work time amounts to 100 h. Following defect diagnosis, it includes disassembling the device into partial units, repair work, assembly and subsequent calibration and control tests.

General overhaul

Maximum repair work time exceeding 100 h. It includes complete disassembling of the devices and equipment, repair work, control of the functional operation of partial units, assembly, control, calibration.

The daily performance of a repair mechanic taking into consideration an eight-hour working day, amounts to six or seven small repairs.

According to practical experience it is expedient to establish the staff size of the repair plant to enable the repair of (8 - 10) x 10^3 devices a year.

For a profitable production of new parts a minimum of 25 x 10^3 man-h should be spent on it.

According to the points stated above, the minimum staff size is 12 repair mechanics, 13 production workers.

The staff size may be increased in accordance with local conditions and on the basis of the assessments, up to a maximum of 200.

It may be complemented by a motorized group of four or five repair mechanics, who perform repair work at the clients premises as well, or who transport the equipment or partial units thereof to the plant.

Design

The plant may be on one or two floors.

Workshop units

Electrical repair and testing shop
Mechanical repair and assembly shop
Control and calibration laboratory
Metal-cutting and sheet-working shop
Welding shop
Surface finishing (metal plating, painting) shop
Workshop for producing PC boards

Other units

Production management unit
Department of technology
Planning and design unit

Specifications

Production floor area of the plant: 500-1600 m^2
Complementary space: 200-800 m^2
Staff: 25-200.
Kinds of energy required: Electric power
Water
Air

The quantities of which depend on the actual size of the plant.

The productivity of the plant is dependent on the qualification and professional skill of the staff employed.

As far as the education and training of labour is concerned there is the possibility of making them acquainted with the work on the spot, but practical training can be organized in Hungary as well.

Supplies and services

We undertake complete planning and establishment of plants, servicing centres, including supplies and services. According to the requirements determined in mutual understanding with the partner abroad, we plan the technology of the plant to be established, provide for the most up-to-date equipment and warrant a high technical level.

Services include, besides the necessary designs and location plans, the education and training of skilled labour.

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77.09.19