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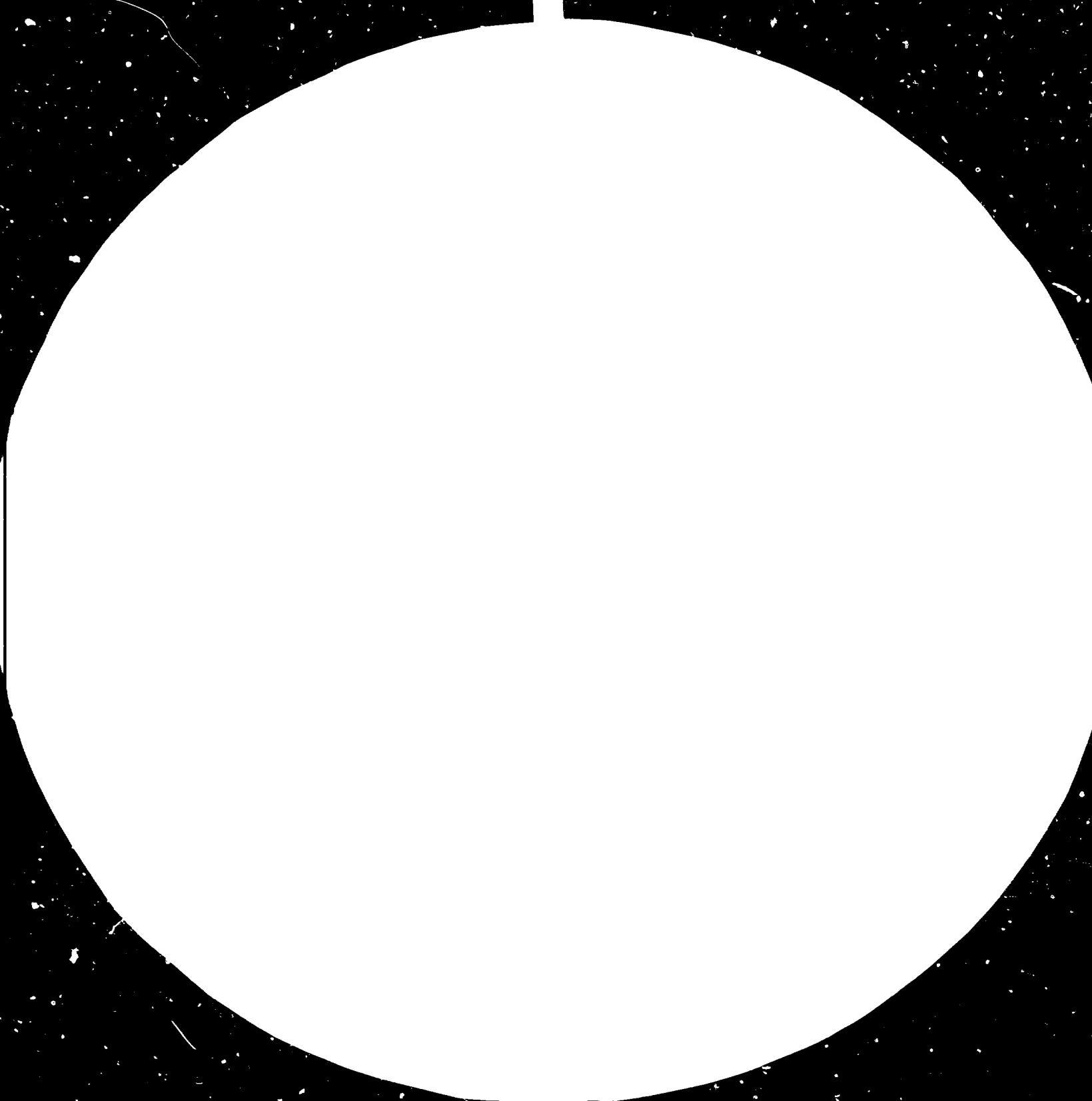
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STRENGTHENING OF THE PLANT FOR SCIENTIFIC DEVICES

SI/BUL/82/801

BULGARIA

Terminal report*

Prepared for the Government of Bulgaria
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Mikhail M. Butusov,
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Explanatory Notes

1. The average value of the Bulgarian Leva (Lv) in terms of United States Dollars during the period of the Project is as follows:

Lv 1.- = US\$ 0.985

2. Abbreviations used in the text:

SI - Scientific Instrumentation/Instrument
BAS - Bulgarian Academy of Sciences
NPC - National Programme Co-ordinator
NPP - National Project Personnel
ISSP - Institute of Solid State Physics, BAS
CLOZOI - Central Laboratory of Optical Recording and Information Processing.
MD - Modular Design

ABSTRACT

The expert was attached to the Plant for Scientific Devices, Bulgarian Academy of Sciences (BAS), Sofia, the People's Republic of Bulgaria under the project "Strengthening of the Plant for Scientific Devices" - SI/BUL/82/801.

The expert was to work in close co-operation with the National Project Personnel (NPP) and to perform the following activities:

- to advise on organizational and structural problems;
- to assist the Plant in selection of items to be developed, produced and implemented;
- to assist in establishing contacts and links with similar plants abroad;
- to prepare a technical report in order to outline the findings of the mission and the recommendations on future actions.

The duration of the mission was 9 weeks splitted into two parts. The first part (4 weeks long) was organized in February, 1983 and was terminated by a Technical Report DP/ID/SER.A/433, 10.03.1983 and the corresponding recommendations and instructions given to the National Project Personnel.

The second part of the mission with a duration of 5 weeks was held at the final stage of the Project (September-October, 1983). The contents of this Terminal Report presents the main findings and recommendations of the whole mission.

The basic conclusions are as follows:

1. UNIDO assistance is considered an extremely important factor especially in the field of Scientific Instrumentation;
2. Project objectives are carried out with the substantial help of the Government and BAS; the competence of the NPP being the other important factor of progress;
3. Scientific instruments already designed and produced are up-to-date and strong demands exist towards them in BAS;
4. The Modular Design (MD) concept for scientific instruments production is worked out to be of substantial interest for other developing countries.

The basic recommendations are as follows:

1. The technical and economic confirmation of the advantages of MD concept is to be achieved, the field of optical and analytical devices being one of the most effective for the application of the given concept.

2. The new branch of the Plant has to be organized in order to meet the demands in optical and analytical devices. In order to keep the close contacts with BAS institutes it should be situated in Sofia.

3. The substantial help of BAS institutes is needed for the Plant progress based on consultations, lending production facilities, testing and delivering of scientific instruments.

4. Development of MD-Concept for scientific instrumentation will be more effective for implementation in other developing countries provided that further UNIDO assistance is obtained.

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MD = modular design

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INTRODUCTION

Project Background

Taking into account the rapidly increasing importance of Scientific Instrumentation in the progress of science and industry, the Bulgarian Government made a decision to establish a plant for production of scientific instruments and automation of scientific experiment with the aim of creating conditions for intensification of research and development activities and raising efficiency of production and export for other countries.

Relying on the research and development work carried out at the Bulgarian Academy of Sciences this production plant should become a basis for the scientific instrumentation branch. It was established on 20 February 1981 in Sofia, by Decree of the Bulgarian Government. It is envisaged in the future to establish subsidiary factories in other towns of the country.

Taking into consideration all the difficulties that it will encounter during the organizational period of the plant establishment the Bulgarian Government decided to refer to the United Nations Industrial Development Organization for technical assistance. It is expected this assistance to find expression mainly in the following aspects:

- expert to provide assistance in the plant's organization, creation of appropriate production structure, as well as in the determination of the immediate and perspective production nomenclature;

- several items of equipment to support the start-up of the R & D activities.

Last but not least is the technical support expected to find expression in the preparation of the list of necessary equipment for the plant, as well as in providing the delivery of some specific devices.

Official Arrangements

The Official Government Request for technical assistance was handed over by the Ministry of Foreign Affairs of the People's Republic of Bulgaria on 20 November 1982. The project proposal submitted by the Engineering Industries Section was approved at the 21st Meeting of the Project Review Committee, held on 27, 28 and

29 January 1982. The Project Document for US\$ 27,300 was approved on 12 March 1982. Later, on 2 July 1982 a revised PAD was issued for a total of US\$ 29,000. Actually the Project became operational in February 1982.

A new revision of the Project budget has been requested by the Government and approved by UNIDO on 7 April 1983 and a revised PAD issued under No 83-0481 on April 12, 1983. The latter involved no increase but a small change of the expert and equipment components, aiming at a more flexible utilization of the assistance.

Contributions

According to the Project Document and the latest revised PAD the UNIDO contribution is US\$ 29,000, covering expert assistance (B/L 11-01 - US\$ 15,600) and equipment supply (B/L49-00 - US\$ 13,400).

The Government contribution in 1982 was more than Lv 1,800,000 local currency to cover assignment of the national personnel, equipment, office facilities and buildings, operating costs, etc. In 1983 the Government contribution is planned to get an increase of about 30 per cent.

The approximate distribution of that money between the main items of activity during the years of interest was the following:

<u>Item</u>	<u>1982</u> (Bg Lv)	<u>1983</u> (Bg Lv)
Assignment of the personnel	72,000	95,000
Equipment and material supply	1230,000	1550,000
Construction investments	500,000	650,000
Managing and operational costs	86,000	110,000

Due to the coming organization of the Plant facilities in Sofia and the broadening of the existing Plovdiv subsidiary factory the Government contributions for the next two years are planned to be higher.

Objectives of the Project

The development objectives of the project are to increase the national capabilities in development and production of scientific instruments for different institutes of the BAS. The technical support and organizational assistance must be provided in order to establish a special plant producing small batches of scientific instruments. This will boost the development and implementation of scientific achievements in the national economy.

The immediate objectives of the Project are as follows:

a) to establish and strengthen the plant for development and production of scientific devices through the formation of an appropriate organizational structure;

b) to develop an expedient modern production nomenclature that will meet the world market requirements taking into consideration also the devices designed, developed and needed at different research institutes of the BAS;

c) to prepare elaborate lists of the necessary equipment, machines and measuring systems;

d) to improve the plant management and leading specialists qualification in the field of instrumentation, computing techniques, fine mechanics and electronics.

The objectives of the split mission were tightly connected with those of the project.

Training

No official training of the personnel involved in the project was arranged within its framework. The problem of training is rather complicated concerning the specific nature of the project, i.e.:

- because the plant to be established is dedicated to be of service for the institutes of the BAS, the project personnel should have a very wide and fundamental knowledge in all fields of scientific instrumentation in order to be able even to foresee its progress;

- the R & D scientists within the BAS institutes should get an appropriate information about the facilities and intentions of the growing SI plant and should formulate their ideas and demands to it in the most economic and unified form.

Thus a great deal of informal training had to be arranged with both groups of specialists in order to reach the closer coincidence of their viewpoints and concepts. Substantial efforts were done in this way during the expert's mission on different levels of BAS, its institutes and other organizations involved.

The participation of the Plant in the autumn Plovdiv Trade Fair for 1983 by exhibiting its first products, served by itself as a promotional step in accumulating the necessary experience; the NPP was provided the opportunity to compare the first products

of the Plant with the demonstrated achievements of leading international companies in the field of SI, thus creating a righteous evaluation level. The list of SI produced by the Plant and exhibited at the Fair is included in Annex IV.

I. RECOMMENDATIONS

1. Further technical and economic confirmation of the advantages of MD concept should be worked out within the framework of SI Plant activities. As shown by analyses and experience, optical and analytical SI of various types form an appropriate area for this activity. It is recommended to consider these reasons in management and planning performances of the Plant.

2. Further applicability of MD concept to SI design is of utmost interest for other developing countries. It is recommended to the NPC and NPP to establish closer contacts with the corresponding UNIDO Divisions and discuss the possibilities of executing a project on MD concept for SI design at the conditions of developing countries.

3. The new Plant branch for optical and analytical devices should be established within Sofia district in order to promote MD and production of scientific instruments which are to be tested and used at the institutes of BAS, mostly situated in Sofia.

4. It is recommended to several BAS institutes and to the Plant personnel, as well, to fasten the links between the Plant and those institutes not only with respect to estimation of the fields where SI are of utmost need, but also in lending production and testing facilities of BAS to the growing Plant.

II. ANALYTICAL ACCOUNT OF ACTIVITIES

A. Mainstreams of Scientific Instrumentation in Bulgaria and Other Developing Countries

General Considerations

The progress of science in Bulgaria during the last decades is the impressive result of the combined efforts undertaken by the Government, Bulgarian people and competent international organizations.

The human aspects of such a progress are connected with the substantial prestige which is awarded by Bulgarian science within the country and abroad. It helps to appeal the young people to the universities, the most talented becoming scientific researchers at different institutes. It should be mentioned that the country also strongly supports the progress of other developing countries by educating their students and postgraduates, by participating in international projects and by creating a great amount of goods and trades to be delivered to these countries. Nowadays, more than 2,500 students from developing countries are studying in the Bulgarian educational institutions.

The scientific research in Bulgaria is carried out in universities, in industrial institutions and to a great extent - in the network of institutes of the Bulgarian Academy of Sciences (BAS). A great deal of research within the technical branch of BAS is intended to be rather helpful in solving the common problems of mankind:

- the protection against pollution and environmental control;
- the abolishing of the hard labour and the increase of labour efficiency by industrial automation;
- the information processing and the communication problems;
- the increase of the agricultural efficiency;
- the extensive research in the medical and biomedical fields.

The co-operation of the efforts made by the different BAS institutes and their co-ordination with the national plans and international obligations are adjusted within the framework of a certain number of national programmes established in Bulgarian economy during the last years of development.

The picture drawn should not result in the impression that

the remaining problems in Bulgarian science and industry are only the marginal ones. On the contrary, there is a certain amount of troubles and "bottlenecks" which should be overcome by the combined efforts of domestic and international institutions with the hopefully same degree of consolidation as before.

The Problems of Scientific Instrumentation in Developing Countries

Most of the developing countries undertake a great deal of efforts and invest substantial resources, often strongly needed in other branches, into establishing and support of their national sciences. As it is frequently emphasized, the national science is not only the matter of the nation's pride or prestige, it also gives a strong support to the economic progress and for developing the human abilities of the nation.

What major problems the progress of national sciences encounters in developing countries, taking into consideration those scientific branches which are connected with the industrial development?

First of all it should be clearly realized that there is no "local" or "regional" science, science is an international matter. Thus it is of vital importance in each country to keep the level of scientific research approximately uniform which also means to be of a substantial aid in meeting the targets of the Lima Declaration and Plan of Action.

It does not, of course, result in the conclusion that the scientific power of different countries should be equal, but provided that a scientific institution is established, its research work should be kept at the international level or close to it.

On the other hand the significant feature of a modern science is that besides upon the human resources and creative capabilities, the level of scientific research nowadays dramatically depends upon the level of SI used in a given laboratory.

And, finally, the modern SI industry reflects the growing needs in highly accurate and easy-to-handle devices by manufacturing specialized SI with permanently improving parameters.

As a result the tendency of growing prices is one of the characteristic features in modern SI in contrast with many other industrial branches where this trend is often defeated by means of the proper measures undertaken, such as the unification and standardization. So labels like "Prices increased by 10% effective Janu-

ary 1st" are almost inevitable components of the pricelists on SI.

Such a dangerous tendency hardly bothers the main SI customers in developed countries, rich universities and prosperous companies, finding the proper way to compensate this effect.

But for developing countries with their limited resources the real menace appears to the plans and ambitions of their scientists.

Thus the main contradiction developing countries encounter in their attempts to organize well-equipped scientific laboratories is that between the limited resources of a country or its academic institution and the continuously growing prices of the modern SI.

E. How to Get More SI with the Limited Resources?

In order to achieve this target it is hardly advisable to copy the ways of SI progress in developed countries. Even if having been performed, such a concept will bear the similar contradictions as in those countries but deeply sharpened due to the specific conditions of a less powerful science.

If certain batches of traditional SI are to be produced in a developing country, the demands in the number of such instruments will be substantially lower compared to a developed country.

Thus the low scale production is only needed, resulting in almost hand-made instruments to be produced. Such a way hardly gives a possibility to attain lower prices for these SI.

Of course, the growth of the production rate of SI of the same type can be obtained in a given country by substantial efforts on international co-operation and specialization between developing countries in SI production, a situation hardly to be expected in the nearest future.

Also, it is undesirable to produce more SI than the needed at a time relying on a future progress in national science and on subsequent growth of the number of customers. A big danger exists that when desirable these SI will be completely out-of-date.

One of the possible solutions to be adopted in such a contradictory situation is to change the current concept of the modern SI as of a highly specialized device with strongly limited areas of application. The widening of the functions performed by a given SI leads to the growth of the items needed and enlarges the number of scientific problems to be solved due to the use of this SI.

In order to solve the problem the new concept of SI design and production is to be recommended, similar to the principle which is now used mainly in electronics. It is the so called modular principle of design. The broad application of such a principle may help to substantially save the production power and to meet more users' demands at the same time. Being produced as a set of united blocks or separate units the SI of such a type can easily be rearranged for application in quite a wide variety of R & D areas.

C. On the Modular Design of the New Generation
of Scientific Instruments

The principle of MD will be considered with its application to optical and electrochemical devices, in order to give not only general speculations but the concrete recommendations, concerning the branches where the modern (and also the most expensive up to now) instruments are produced.

The advantages of MD on the customers' level will be discussed at first, then the reasons for the profitable application of this concept on the level of the manufacturer will be considered. It is taken a priori that the manufacturer's interests coincide in general with those of the given developing country.

Why the MD-Instruments Are to be Appreciated in Scientific
Laboratories of the Developing Country?

MD devices are containing a certain amount of prefabricated blocks or modules, each module to be used in a great variety of different instruments. For that significant reason:

- MD devices can strongly change their functions and application range which is achieved by simple rearrangement of the order and the mutual positions of the modules.

- MD devices mostly comprise a certain amount of modules with different physical functions. In the case of optical SI there are optical, fine mechanical and electronic modules. (For the necessary technical details see Annexes I and II) The use of electronics on the level of microcomputers is caused by the necessity of improving a certain lack of accuracy that MD devices may have in comparison with their rigid body and narrow specialized counterparts,

- MD devices form a plurality with the borders hardly defined because all new inventions, made in the field of modules involved, may significantly enlarge the number of possible combinations and thus move these borders apart.

- MD devices are to be compiled, adjusted, scaled, etc., by the personnel of a given scientific laboratory - the task being of certain degree of responsibility but fascinating and giving rise to designers' talents and imagination.

- MD devices are most flexible scientific instruments with wide range of applications thus demanding the personnel they serve to be as flexible and wide minded.

- MD devices thus help the staff to create a deeper knowledge of the structure, abilities and limitations of the instrument in usage compared to the attitude which exists within the users of highly-automated "push-the-button" machines.

- MD devices give an impetus for a certain "creativity attitude" of the scientists in question which is initiated at the time of assembling and adjustment and is maintained by the mere fact that almost everyone having the device already constructed but with some modules compatible to that device still lying on the shelf, will try to find proper uses for the latter.

-MD devices promise a great variety of instruments to be assembled from one set of modules thus giving the personnel a demand to study all the schemes and corresponding methods used in other possibilities given by a set.

The further particularizing of MD concept and several possible applications are considered in the Annex I and Annex II.

These are the expected gains obtained on the "laboratory level". It is evident that not only purely scientific but also humanitarian targets are achieved which is especially significant to the developing countries with their lack of scientific traditions and possible inconsistencies in the educational process. Not only experimental skills but also a degree of scientific training are to be seriously improved within MD devices concept.

Economic Aspect of the MD-Concept for SI Manufacturing in Developing Countries

Even more serious advantages are to be achieved on the "branch level" or "state level", i.e. when a certain amount of MD sets is to be produced or bought, used, rented and repaired. The

matter is that the degree of autonomy of a given state (or some academician or R & D institutions in it) is higher when MD devices are concerned. In the current situation, the significant fact that a given buyer or customer can produce, say, 70% of the components of an instrument in question by his own abilities, is actually the insignificant, the minor item in his relations to the sales office, because it cannot influence the price. In the case of MD instruments only certain pieces of a given modular set may be purchased, while the rest of the units are to be produced "at home". The strict interdependence between the local abilities of a given country or branch or institution and the expenses necessary for importing the residual modules is obviously achieved. This factor strongly encourages the industrial progress and helps to diminish the gap between the different countries.

As a conclusion it is seen that the MD principle gives a triple gain:

- it helps to reach a certain level of scientific progress in a country with limited financial and industrial resources;
- it stimulates the progress of domestic industries by providing a possibility to put into balance and then change to a positive direction the shares of domestic and foreign components, comprising each modular set;
- it originates and maintains at a human level a spirit of creativity and widens the knowledge of the personnel.

Further progress of a modular design concept is expected at the level of systems composed of different SI and control devices, as it is shown at the Modular Chart of Annex II and Annex III.

III. ACHIEVEMENT OF THE MISSION OBJECTIVES

Due to the Job Description the objectives of the mission were the following:

1. To advise on organizational and structural problems;
2. To assist the Plant in the selection of items to be developed, implemented into production and produced;
3. To assist in establishing contacts and links with similar plants abroad;
4. To formulate the findings and recommendations addressed to the Government in a technical report.

As to organizational and structural problems the basic information collected was reported in (1) - DP/ID/SER.A/433. At the terminal stage of the project the Plovdiv Subsidiary Division having a structure shown in Annex III to (1) was found to carry out all duties laid upon successfully. The list of personnel enrolled contains 160 engineers, technicians, high-qualified workers, scientists and management staff. The main orientation of R & D in the Plovdiv Division as confirmed by the list of SI already produced (see Annex IV to this report) is the design and production of:

- Analytical SI, such as oxygenmeters and hygrometers;
- Chemical systems for pure technologies such as catalytic systems "Oxel M", separator "Phaset", etc.;
- Microprocessor-based systems for different scientific applications.

The list of SI and systems produced and the successful results at the Plovdiv Trade Fair, where these devices were exhibited and got positive reputation confirms the conclusion that the attempts undertaken by the NPP and BAS in the organization of the Plovdiv Division have substantial results.

It is worthwhile to mention that such SI as hygrometers, oxygenmeters and "Oxel" are designed in correspondence with the MD concept, as it can be seen in Annexes II and III. So, the basic ideas of MD concept which were thoroughly discussed with NPP during the first part of this mission seem to give fruitful implementation in several items designed.

The further discussions which have taken place during the terminal stage of the mission show that these ideas will find a broadening field of application.

The next organizational step recommended at (1) was to

strengthen the Sofia Central Plant in conformity with its future structure and way of functioning (see Annex 4 to (1)). This step was made in close correspondence with the enlargement of the list of items to be developed, thus giving the Central Plant the responsibility of designing and producing optical and fine-mechanical SI. During the short period of 7 months between the two parts of this mission a temporary location for the Plant headquarters' managerial staff and designers was found. Now further efforts are made by the NPP in the direction of obtaining the permanent location for the personnel placed in Sofia, and for fine mechanical and optical design and production facilities, as well.

Finally, it is necessary to admit that the capacities of the UNIDO expert appeared to be insufficient for establishing contacts with several SI companies abroad. All attempts performed in this respect by mail failed; for example, no response was obtained from Klinger Scientific Corp. of USA though four requests were sent there for their catalogues of SI produced. Several more such examples may be offered which confirms the idea emphasized earlier that the SI field manufacturers are not in the sponsoring mood in their attitude to developing countries. This regrettable situation may serve as an additional reason for UNIDO to support the attempts of developing countries in further steps aiming at the design and production of their SI basis.

IV. GENERAL CONCLUSIONS

1. Because SI design and production is one of the basic factors of scientific progress in developing countries, UNIDO assistance is considered as extremely important in this field.

2. Project objectives are carried out by the NPP with substantial help of the Bulgarian Government and BAS.

3. Modular design concept suggested during the first part of the expert's mission has already found its successful implementation in several SI designed at the Plant.

4. This experience and further analysis show that MD concept is of a substantial interest for other developing countries.

ANNEX I

ON THE APPLICATION OF MD CONCEPT FOR THE DESIGN
OF A WIDE GROUP OF OPTICAL SI

1. Optical Modules

- O₁ - Microobjective module. Contains a microobjective. (normally of 10^x- 20^x magnification value). The focal plane of the objective may be adjusted within 1-5 mm range along the module axis by fine screw motion of the objective. Serves to focus the light into a small focal point in an exit plane of the module.
Also the pinhole assembly (O₉) may be attached at the exit plane of the module ($\phi \sim 20 - 40$ mkm)
- O₂ - Collimating lense module. The lenses of equal diameter but with different focal lengths may be inserted into a fixed position. Serves to transform the diverging beam into a parrall one or for the inverse transform.
- O₃ - Diffraction grating module. Same construction as O₂ but includes the transition element for holding the transparent or reflecting diffraction grating which is normally of square shape. Serves to split the polychromatic (coloured) light beam into a set of beams of single colour, or to split the monochromatic (laser) beam into several diffracted beams.
- O₄*- Beamsplitter or mirror module. Contains a semitransparent plate (50-50) at 45° inclination relatively to the entrance axis or the mirror with variable position. The possibility of inserting other transparencies is foreseen. Serves to split the incident beam into two beams (one transmitted and one reflected) or to reflect the whole light in pre-determined direction.
- O₅*- Sample holder module. Same construction as O₂, O₃ but renders a possibility to attach a transparent or scattering specimen to be investigated or a container with the liquid. Serves to be a stray-light-protected housing of the illuminated body.
- O₆*- Holographic or photo plate holder. Same construction as O₂, O₃, O₅ but renders a possibility to fix a plate of photosensitive material and to shade it from stray external light. Serves to provide a stable position of the photo-

- recording material, vibration proof, easy to change.
- O₇*- Free space module. This module permits to increase the optical length of an instrument until the desired value is reached. Serves to permit the diffracted or converging light beams to reach the distance where focal point or the separation of diffraction orders are attained.
- O₈ - Three-arm free-space module. This module gives a room for splitting or coinciding optical beams. It is attached for example, to the exit ends of O3 or O4 modules thus providing individual channels for both of splitted rays. The angle between the output arms may be changed according to the experimentator's needs.
- O₉ - Pinhole assembly. A set of pinholes ϕ 10 - 50 μ made in magnetized steel plates of 50 μ thickness. Serves for "cleaning" the light intensity distribution field when the laser beam is used for illumination.
- O₁₀- Slit assembly. Same as O9 but with 10 - 50 μ slits in the 50 μ thick plates. Serves to obtain one dimensional optical filtering in pattern recognition, image processing and inreferometric instruments.
- O₁₁- Prism module. 90°-degree glass prism is mounted with possible fine rotation along the right-angle corner axis. Serves to attain the 90° declination of the wide optical beam, and also for surface quality control by prism interferometer.
- O₁₂- Corner angle module. Same as O11 but containing the mirror holder instead of a prism-holder. Serves to attain optical axis right-angle turn.

*)- The adjustable modifications of these modules are concerned under OM-titles.

2. Mechanical Modules

- M1. - Manually driven transverse micropositioner. Serves for fine transition of the attached object in one direction.
- M2. - Manual pivot micropositioner. Serves to attain the pivot motion of the object attached around the in-plane axis.
- M3.- Manual turntable micropositioner. Serves to attain the rotation of the object attached around the normal axis.
- M4.- Manual axial micropositioner. The extra rigidity is provided in order to avoid the transverse misadjustment when axial movement is performed. Serves for final adjustment of optical paths within the device or the part of it.
- M5.- Sample or container holder. The mechanically adjusted frame for housing the specimen under investigation. The frame can be pivoted and transversely moved for thorough sample adjustment. M5-module fits into O3 and O5-modules.
- M6.- Adjustment member for O-modules. Serves for slight inclination of the following module compared to the previous one.

All M-modules are compatible with the family of O-modules and others and within their own family.

3. Opto-mechanical Modules

- OM4 - Beamsplitter or mirror module analog to O4 with the movable beamsplitter housing. The rotation of the beamsplitter around the axis normal to the optical axis is attained.
- OM5 - Sample holder module analog to O5 with an extra degree of freedom. One-or two-dimensional translation unit is included. Final adjustment is made by M5-module.
- OM6 - Holographic plate holder with micropositioning of the hologram. For use in real-time holography, optical information processing.
- OM7 - Free space module with the variable geometric length. Contains M4-module for fine elongation of the optical path within the module.

4. Electromechanical Modules

- EM1 - Electrically driven transverse micropositioner. Piezoceramics or stepper motor used for fine movements. The driving signal from the monitoring system is converted in E7 module.
- EM4 - Same as EM1 but for axial driving. Stepper motor or piezoceramics is used. E7 module is a voltage or pulse generator unit.
- EM5 - Same as M5 module but with final or programmed adjustment made by stepper motor or piezoceramics
E7 module is a voltage or pulse generator unit.

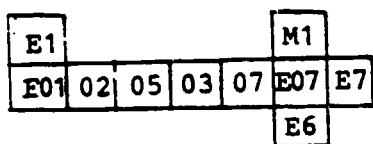
5. Electrooptical Modules

- EO1 - Source module. The housing and adjustment assembly for tungsten, halogen or arc discharge lamp. The voltage is supplied by E1 module.
- EO2 - Laser module. HeNe, Ar, HeCd, CO₂, or dye laser is installed optionally. The module provides the laser ray adjustment for aiming the O1 module.
The voltage is supplied by E2 module.
- EO3 - Laser module. Pulsed illumination provided by this module is obtained from ruby, nitrogen-pumped dye, semiconductor or YACr lasers optionally.
The voltage is supplied by E3 module.
- EO4 - Shutter module. Electrooptical or electromechanical Shutter (optionally or both in line) to obtain pulse or stroboscopic illumination by CW lasers or stroboscopic illumination by CW lasers or incandescent lamps.
Driving signals are supplied by E4 module.
- EO6 - TV camera with the vidicon sensitive to IR radiation (optionally) EO6 module is driven by E5 module.
- EO7 - Detector module. Silicon or germanium "p-i-n" or avalanche diode is used with suitable supply from E6 module and current amplification by E7 module.

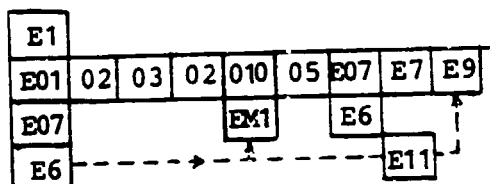
6. Electronic Modules

- E1 - Stabilized voltage and (or) current supply.
- E2 - Stabilized high voltage supply.
- E3 - Stabilized current (or voltage) pulse generator.
- E4 - Stabilized high voltage pulse generator and (or) CW signal generator with variable frequency.
- E5 - TV set with possibility to synchronize the TV camera.
- E6 - Low voltage stabilized unit.
- E7 - Current and voltage amplifier (DC or pulse modes of operation)
- E8 - Digital display for displaying and/or printing the output data.
- E9 - "X-Y" plotter
- E10 - Microprocessor for monitoring the experimental routine.
- E11 - Multifunctional oscilloscope.

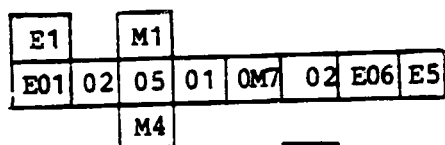
Examples of Modular Design of Wide Range of Optical Scientific Instruments



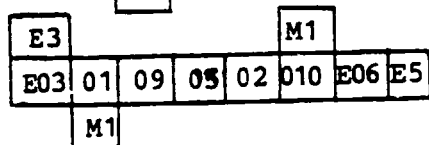
1. Spectrograph



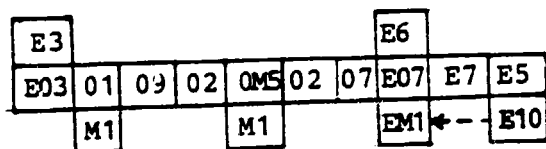
2. Monochromator with automatic data processing and source illuminance stabilization.



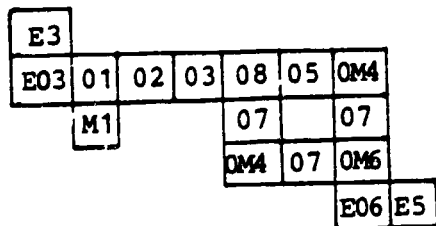
3. Microscope with TV display



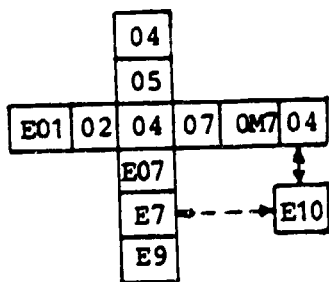
4. Schlieren interferometer for transparent media control



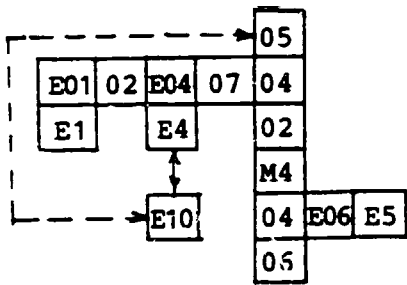
5. Image analyser or optical spectral analyser



6. Holographic testing equipment for nondestructive testing



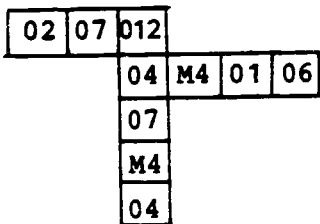
7. Fourier - spectrometer



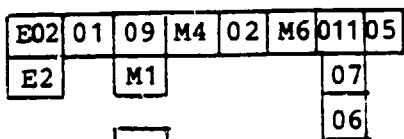
8. Stroboscopic camera for photo and TV registration of High-speed phenomena.



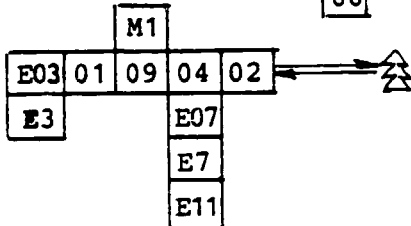
9. Telescope (refractor)



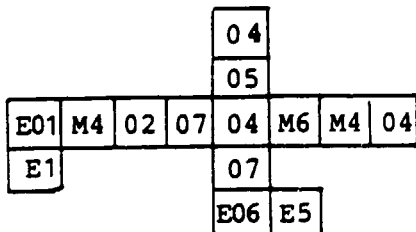
10. Telescope (reflector)



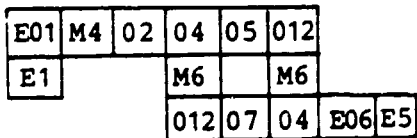
11. Prism interferometer for surface evaluation



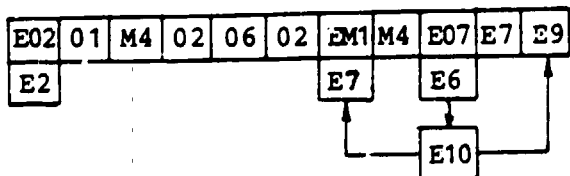
12. Laser rangefinder



13. Michelson interferometer with TV display



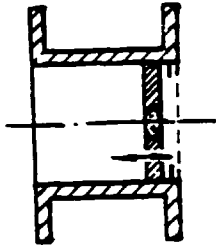
14. Mach-Zender interferometer with TV display



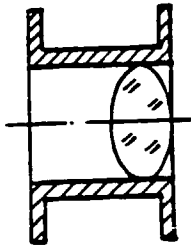
15. Automatic microdensitometer

7. Sketches of Different O - Modules

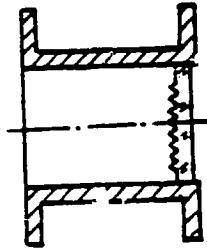
O₁



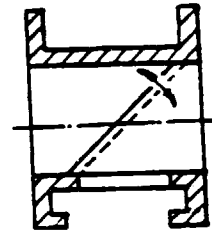
O₂



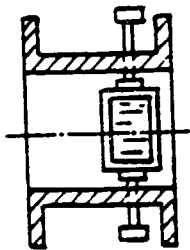
O₃



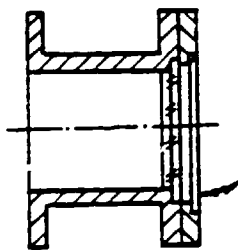
O₄



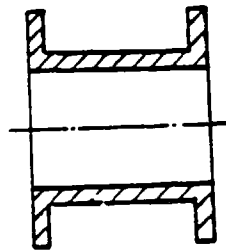
O₅



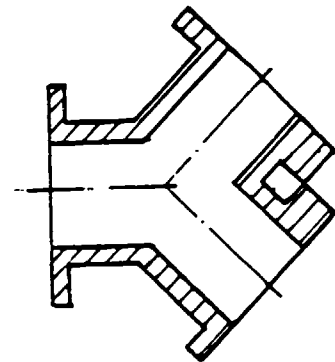
O₆



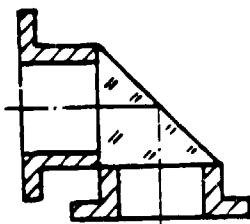
O₇



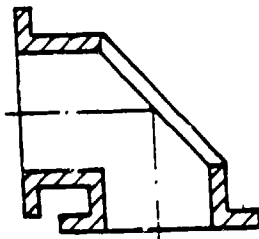
O₈



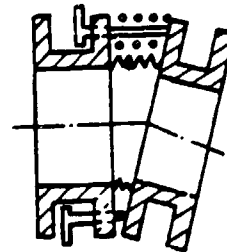
O₁₁



O₁₂



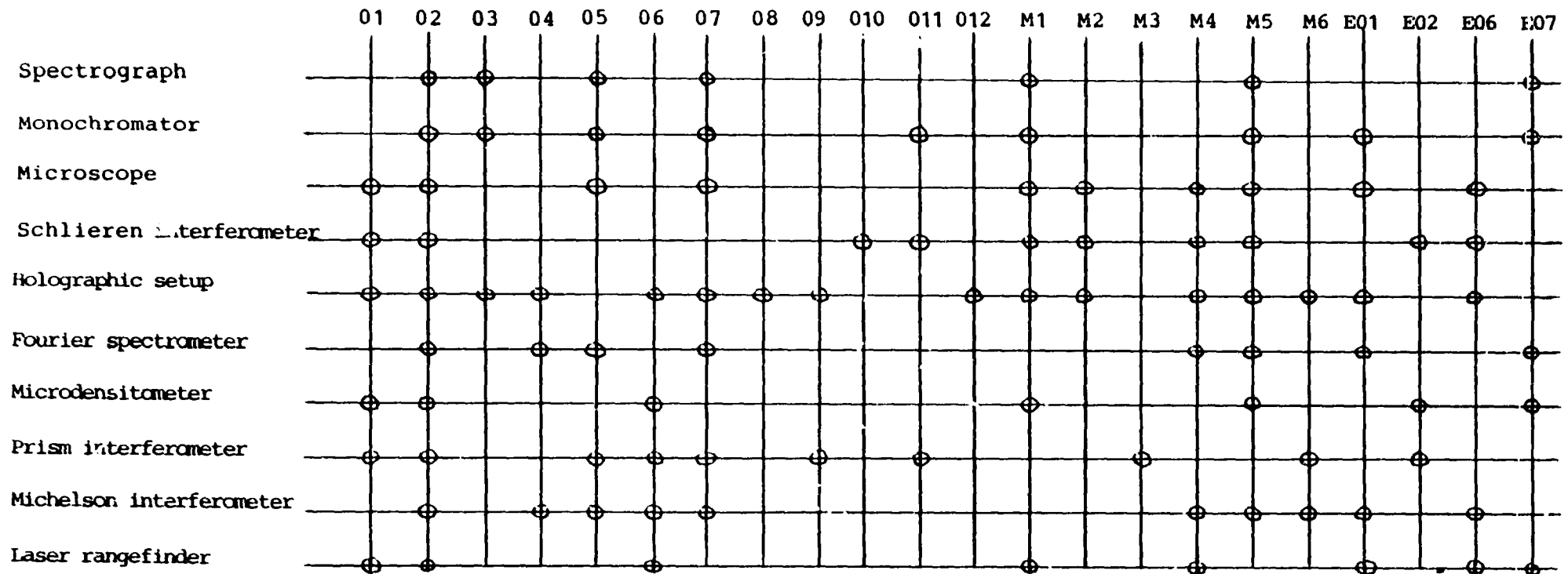
O₁₃



The cross section may be chosen circular or rectangular in accordance with production abilities.

MODULAR CHART OF OPTICAL DEVICES FAMILY

(without electronic sub-equipment)



ANNEX II

ON THE APPLICATION OF MD CONCEPT FOR THE DESIGN
OF ANALYTICAL INSTRUMENTS

1. Sensors Modules

S1 - (H₂O-trace)

An electrochemical sensor for determination of moisture content in gases based on the principle of continuous absorption of water vapor by a hygroscopic substance and its electrochemical decomposition.

S2 - (H₂O - high concentration)

Basically the same type of sensor with much lower sensitivity to moisture content.

S3 - (O₂ - traces)

An electrochemical sensor based on the principle of continuous reduction of oxygen to a gas diffusion oxygen electrode which is cathodically polarized by means of a cadmium electrode.

S4 - (O₂ - high concentration)

A three electrode electrochemical cell with basically the same type of oxygen sensitive electrode.

S5 - (Temperature)

According to the application all common thermal sensors may be used, namely thermocouples, resistive or semiconductor types.

S6 - (Pressure)

An inductive type of pressure transducers with different sensitivity and range.

2. Electronic Modules

E1 - Analogue electronic devices

The analogue instrumentation follows the same idea of modular design and includes several basic sub-modules accepting different types of input converters in accordance with the sensors used. Such an approach leads to the opportunity of versatile instrument configuration.

E1.1 - Basic modules

- Power supply unit
- Reference source
- Digital voltmeter

- Digital output converter (digital output)
- Voltage to voltage converter (voltage output)
- Voltage to current converter (current output)
- Controller (relay output)

E1.2 - Input converters

- Current to voltage converters (for electrochemical sensors)
- Voltage to voltage or resistance to voltage converters (for thermal sensors)
- Phase sensitive amplifiers (for pressure sensors)

E2 - Microprocessor

According to the aim pursued a specific microprocessor system should be configured using the common building blocks (processor, memory, I/O modules, steering logic, A/D and D/A converters, etc)

E3 - Controller

Using several of the above mentioned analogue modules the controller includes a special function and actuator modules.

E4 - Low power

For maximal energy conservation a low power electrochemical sensor should be matched with the appropriate electronics and display.

3. Equipment

By means of combination of ready-made modules and/or instruments a special purpose equipment may always be built without much effort allotted to basic research. Some of the equipment may find its own market which may justify production line output.

- Q1 - Gas purifier - reaction and/or absorption columns full of catalyst and molecular sieve, and/or getters.
- Q2 - Glove box - any standard glove box.
- Q3 - Custom made units - according to the application.

The judical choice of appropriate modules may lead to the creation of different instruments and systems finding a wide range of applications. For the sake of illustration some examples follow, shown also at the Modular Chart of this Annex:

- Hygrometer for trace moisture measurements applicable for laboratory experiments, environmental chambers, lamp manufacturing, petroleum refining, fiber optics manufacture, nuclear reactor feed gas control, semiconductor production and development, metal

processing, chemical manufacture, high purity gasmanufacturing, glove box operation, control of welding atmospheres, etc.

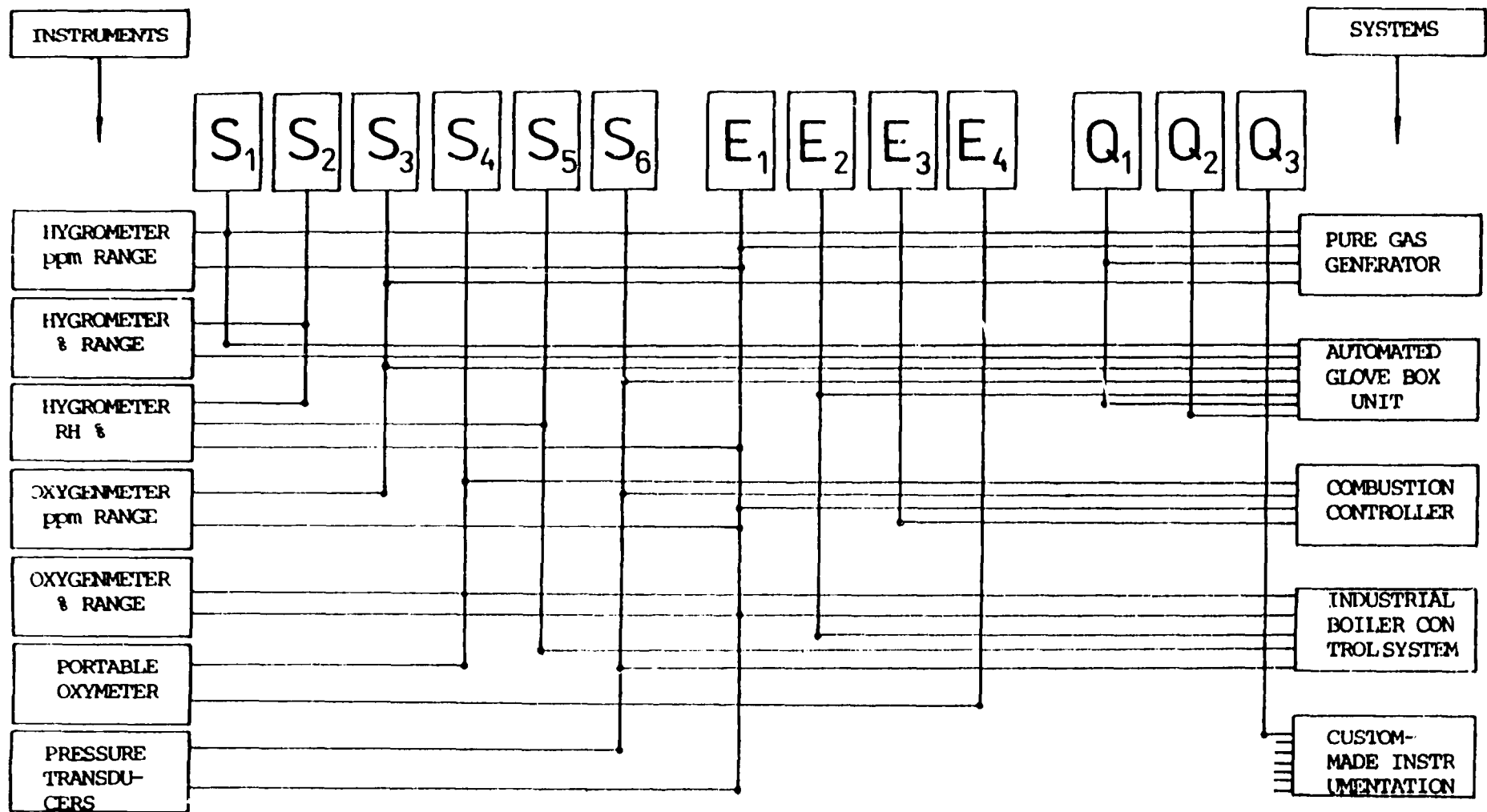
- Hygrometer for high moisture content measurement and control applicable for instrumental air production and control, natural gas transmission, wind tunnels, metallurgical processing, analytical experiments, etc.

- Hygrometer for relative humidity measurement and control applicable in numerous areas such as environmental control, agriculture, air conditioning, aircraft, computers, cleanrooms, confection industry, food processing, greenhouses, leather industry, meteorology, pharmaceuticals, textile industry, etc.

- Oxygenmeter for traces of oxygen measurement applicable for pure substances' production and development, electronic processing, refinery processing, high purity gas manufacture, steel production, diffusivity analyses, cristal growth, inert gas welding, plastics manufacture, high and low temperature synthesis, etc.

- Oxigenmeter for high oxygen concentration measurement applicable to flue gas monitoring, air monitoring in mines, tunnels, sewers, underground cable installations, ships' holds, fuel tanks or reactors, chemical manufacturing, food and bevarages packaging, controlled environments, rubber polymerixation, auto emission systems, etc.

MODULAR CHART OF ANALYTICAL AND CONTROL INSTRUMENTATION



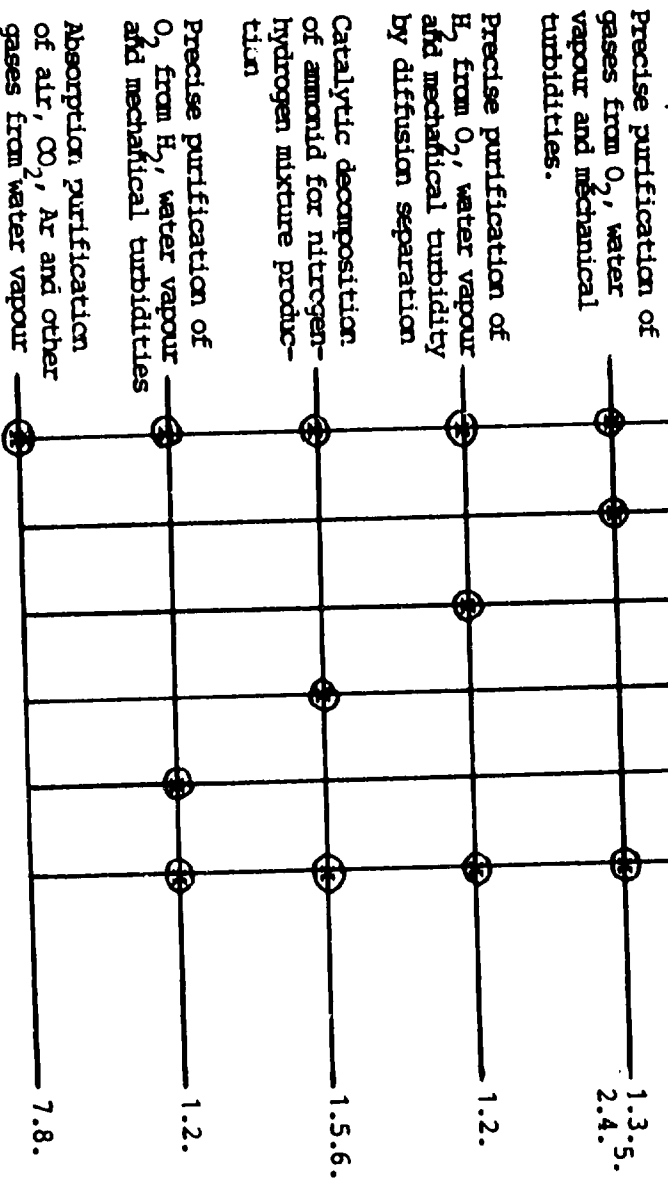
ANNEX III

MODULAR CHART FOR CHEMICAL SYSTEMS

MODULES:

- Module for adsorption purification of gases from water vapour
- Module for catalytic purification of gases from O_2
- Module for diffusion purification of H_2 from O_2
- Module for catalytic decomposition of NH_3
- Module of catalytic purification of O_2 from H_2
- Module of fine filtration of gases

SYSTEMS FOR:



1. - Semiconductor technology
2. - MCVI process for fiber optics
3. - Pharmaceutical technology
4. - Metallurgy
5. - Physico-chemical surface treatment
6. - Power metallurgy
7. - Machine building technology
8. - Welding techniques

ANNEX IV

THE LIST OF SI PRODUCED BY THE PLANT AND EXHIBITED
AT THE AUTUMN PLOVDIV TRADE FAIR'1983.

1. Microprocessor system BK 1300
2. Digital oxygenmeter "Betatest OM 200"
3. Digital hygrometer "Betatest HM 2000"
4. Catalytic column "Oxel M"
5. Setup for extraction of fluid products from emulsions or solutions
"Aromex"
6. Emulsion separator "Phaset"
7. Distillation column for extraction of metals from low concentration solutions.
8. MP-04 Millivolt transducer "Chopper"
9. Set of Harmonic drivers
10. "EEG Analyser" microprocessor system for brain's activities analysis.

ANNEX V

PROGRAMME OF THE EXPERT'S MISSION

	14	15	16	17	x	19	20	21	22	23	24	x	26	27	28	29	30	1	x	3	4	5	6	7	8	x	10	11	12		
1. Arrival to Sofia.					x																										
2. Meetings with the NPP					x				x																						
3. Studying project documents					x																										
4. Meetings with NPC						x																									
5. Visit to CLOZOI, BAS																															
6. Visit to IPSS, BAS																															
7. Visit to Plovdiv Subsidiary Division																															
8. Visit to Plovdiv Trade Fair																															
9. Visit to the Instrumentation Plant - Petrich																															
10. Visit to the Plant of Fine Mechanical Engineering - Blagoevgrad																															
11. Discussion on contacts with foreign companies																															
12. Studying project activities																															
13. Visit to Optical Fiber Facilities-Sliven																															
14. Preparation of Terminal Report																															
15. Contacts with UNIDO, UNDP																															
16. Final discussions																															
17. Departure from Sofia																															

