OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

20286

DP/ID/SER.B/716
7 July 1993
ORIGINAL: ENGLISH

STRENGTHENING THE CAPABILITY OF THE SYRIAN SCIENTIFIC STUDIES AND RESEARCH CENTRE IN THE FIELD OF OPTICAL TECHNOLOGY

DP/SYR/86/001

SYRIAN ARAB REPUBLIC

Terminal report*

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

Based on the work of Dr. J. Prasad,
chief technical adviser

Backstopping Officer: M. Boutoussov
Institutional Infrastructure Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

V.93 87144

TABLE OF CONTENTS

EXPLANATORY NOTES

A. Currency

The Syrian Pound has the official value of 43 Syrian Pounds to the US Dollar.

B. Acronyms and short terms

AIFS: Angular Image Field Size.

AOFS: Angular Object Field Size.

AR: Anti-Reflection.

BFD: Back Focal Distance.

Bfl: Back focal length.

BIOMEM: Is a medium level model of educational microscope.

BSO: Backstopping officer.

C&F LINES: Red and Blue Lines of Hydrogen Spectrum.

CIOM: Changchun Institute of Optics and FineMechanics; P.R. China.

CLC: Cemented Lens Combination.

COD: Computerized Optical Design.

CSIO: Central Scientific Instruments Organisation, Chandigarh, India.

CTA: Chief Technical Adviser.

CTD: Center for Technology Development.

DER: Draft Evaluation Report.

DOTF: Diffraction Optical Transfer Function.

Efl: Equivalent Focal Length.

ENPD: Entrance Pupil Diameter.

EXPD: Exit Pupil Diameter.

F. Number: Relative Aperture.

40+0.65: Means Magnification is 40 times and numerical aperture is 0.65. Similar meaning applies to other stated expressions (like 4+ 0.1, 10+025, 100+1.25) mentioned in text.

GOTF: Geometrical Optical Transfer Function.

>: Greater than.

HfO_2: Hafanium Oxide.

HIAST: Higher Institute of Applied Sciences and Technology.

IR: Infrared.

ISO: International Standards Organisation.

JD: Job Description.

KCZ: Kombinat Veb Carl Zeiss, Jena.

LABPLAN: Advanced Level Model of Educational Microscope.

LAMBDA: Wave Length of Light.

LILAC: The Medical Center For Equipment and Surgical Instruments, Damascus.

LITMO: Leningrad Institute of precision Mechanics and Optics , Leningrad, USSR.

M(OR X): Magnification.

MgF_2: Magnesium Fluoride.

m/m:: Man-Months.

µm: Micro-Meter.

MTF: Modulation Transfer Function.

NCC: National Center for Calibration.

nm: Nano-Meter.

NPD: National Project Director.

ODA: Overseas Development Agency.

ODDS: Optical Design Data Sheet.

OG: Optical Group.

OTW: Optics Technology Wing:

PRODOC: Project Document.

R&D: Research and Development.

RD&D: Research, Design and Development.

RMS: Root Mean Square.

SIO: Silicon Mono-Oxide.

SIO_2: Silicon Di-Oxide.

SL: Syrian Pound.

SSRC: Scientific Studies and Research Center.

TCDC: Technical Co-operation Amongst Developing Countries.

10 X: Means magnification produced by the particular optical device is 10 times. Similar meaning applies to other stated symbols, like , 5X, 40X, 100X mentioned in text.

TPI: Threads Per Inch.

TPR: Tripartite Review.

UNDP: United Nations Development Programme.

UNIDO: United Nations Industrial Development Organization.

<u>UNV</u>: United Nations Volunteers.

<u>UV</u>: Ultraviolet.

<u>UV-VIS-NIR</u>: Ultraviolet- Visible -Infrared.

<u>ZnS</u>: Zinc Sulphide.

<u>ZrO_2</u>: Zirconium Oxide.

ABSTRACT

The present Project Terminal Report deals in comprehensive manner with its various attributes and brings out cogently the significant technical contributions related to the project performance. The important results obtained are given in subsequent paragraphs.

Within the framework of the project DP/SYR/86/011, an Optics Technology Wing (OTW) of contemporary standard has been set up in a premises which was untill December 1987 only a vacant workshop hall already constructed as basement of HIAST Computer Center building of SSRC. OTW is now reverberating with sophisticated technical activities supported by commitment, confidence and enthusiasm of the National counterpart staff teams.

The activities of the project have resulted in the establishment of fully operational optics technology laboratories and workshops which can justifiably be considered as a National Center of Excellence in this key domain.

The project has been successfully executed in accordance with its set plans. It is worthnoting that all the 14 outputs included in project document are accomplished in full .

OTW is now well equipped for fabrication of miniature to macro size (up to 100 mm working diameter) lenses, prism trains, proof plates , test spheres, and other types of standard precision optical elements.

The prime benifits obtained through the execution of the present project can be cited as:

- Establishment of the required infrastructural facilities and National base for providing technical training and pursuing research , design, and development in the field of instrumental optics and technology.
- Generation of a cadre of National staff well versed in complex technological processes by way of fellowship training abroad , complete interaction with internationally recruited professional project personnel/LITMO experts, and access to advanced technology in developed countries.
- Realisation of the first Syrian made precision optical components, optic kit, and prototypes of three versions of educational microscopes with different levels of sophistication.

- Creation of awareness and capability in the National staff for attempting to undertake in future: (a) design and development of advanced versions of student microscope and other types of optical instruments presently being imported in the country, like, projection, medical, telescopic and surveying instruments; and (b) experimental batch production to cater for refinement in product design and adaptation for mass production.
- The technology developed has immense potential in vocational training, employment women, know-how transfer, import substitution, and regional co-operation.

1. INTRODUCTION

A UNIDO executed UNDP Project entitled "Strengthening the Capability of the Syrian Scientific Studies and Research Center in the Field of optical Technology" has been in operation at SSRC, Damascus since December,1987.

The project received special consideration since it was felt that this can provide a good basis for regional and inter -regional TCDC cooperation and generate employment opportunities for women.

The development objective of the project is to contribute to the scientific and technological development of Syria, through the establishment of the Center for Optical Technology Development.

The immediate objectives of the project are: (i) Establishment of physical facilities i.e workshops and laboratories required for Optical Technology Development; (ii) Development of related scientific techniques for production of microscopes, educational optics kits and assorted optical components; (iii) Development of prototypes of of educational optical instruments and components intended for know-how transfer to the industry; and (iv) Utilization of the established facilities for on-job training of local manpower i.e creation of a cadre of scientists, engineers, technicians and artisans well versed in different optical techniques and reinforcement of the local training through the award of individual and group fellowship training and study tours abroad.

2. PROJECT DETAILS

Project No.	DP/SYR/86/011
Primary Function:	Institution Building
Govt. Implementing Agency:	Syrian Scientific Studies & Research Center, Damascus.
Support Agency:	United Nations Development programme (UNDP).
Executing Agency:	United Nations Industrial Development Organization (UNIDO).
UNDP Input: (including Cost Sharing)	US $ 1,877,284
Govt. Contribution in kind:	Syrian Pounds 4,078,000.

3. BACKGROUND INFORMATION

3.1. Scientific Studies and Research Center, Damascus

Scientific Studies and Research Center (SSRC) is a public autonomous institution established in 1969 at Damascus. A branch of SSRC dealing with "avionics" is established in Aleppo.

SSRC is involved in education and applied scientific research. It has a staff member strength of about 1000 persons. The annual budget is about 120 million Syrian Pounds.

SSRC is sub-divided into:

- Research and development departments covering primarily the fields: applied physics, electronics technology, computer technology, electronic data processing, data automation, remote sensing, applied mathematics, telecommunication, precision mechanics, chemistry, biology, economics, and optical sciences.
- Higher Institute For Applied Sciences and Technology (HIAST). This Institute is running a 5-year regular degree level course in informatics with an annual intake of about 60 students. Upon completion of the common course of 3 years at HIAST, the chosen students are sponsored for advanced training in France.

SSRC is also actively involved in International cooperation programmes, like, seminar sessions of the Arab Schools for Sciences and Technology; scientific and technical cooperation with European Economic Community, Algeria, France and other concerned regional organisations.

3.2. Center for Technology Development

Upon request from the Syrian Government, in 1984, ODA engaged Fulmer Research Laboratories of UK under British Aid Arrangements to advise the Government on the feasibility of establishing Center for Technology Development (CTD) at SSRC, Damascus.

The consultants concluded that there is an imperative need for the establishment of CTD at SSRC. It was suggested that CTD must be involved in long term applied research; product and process development and engineering; organization of training programmes and rendering short-term technical services. Further, within the ambit of CTD, in the long run, facilities should be established in a number of technology areas which can eventually serve as "skill centers". For generation of enough confidence, the beginning can be made with low risk projects possessing high probability of success.

3.3: Technological Study Report of Kombinat Veb Carl Zeiss, Jena (KCZ)

In 1986, under contractual obligations, a technological study report was submitted by KCZ, which covered technical details for the establishment at SSRC of optical and opto-mechanical workshops at laboratory level.

In 1986-87, a Consultant mission was fielded by UNIDO to review and assess KCZ report. As a result of critical scrutiny, the following recommendations were made:

- The study report submitted by KCZ is very comprehensive and contains wealth of information. It can be made use of by the project in planning the layout of the optical workshops for proper work flow, understanding the basis of preparation of optical design data sheets, manufacturing technology, quality assurance and other connected technological aspects.
- KCZ report may however not be suitable directly for implementation at SSRC for the following reasons:
  - (i) It does not provide enough scope for the creation of indigenous research and development base.
  - (ii) The optical elements identified for production would not lead to the creation of the capability of total system development.
  - (iii) It is considered difficult by SSRC to mobilise financial resources to the tune of 4.5 million US dollars.

Keeping into view the above aspects, in cooperation with local authorities, a draft project document for technical assistance was then prepared. The Consultant was later invited to discuss it in-depth with the concerned authorities in the Regional Bureau of Arab States located at UNDP Office in New York. This PRODOC then became the basis of future work after incorporation of necessary modifications as were decided by UNDP, taking into consideration further Government inputs.

PREPARATORY WORK

In 1987-88, a Consultant mission was again fielded by UNIDO to carry out preparatory work for the project. The tasks broadly covered under this mission included: Preparation of the plan of the Optical Technology Wing of SSRC, Damascus; Identification of the National staff for the project ; Description of the duties and required qualifications of UN volunteers in different areas of optics technology; Draft outlines of the terms of reference of the sub-contract; Job Description of short-term consultants; Placement of requisitions for expendable and non-expendable equipment; Fellowship nominations; and recommendations on study tour programmes.

4.1. Plan of Optical Technology Wing (OTW)

A document entitled "Plan of the Optical Technology Wing of SSRC, Damascus" was prepared. It runs into 62 pages and describes in details civil engineering, electrical, utilities and equipment requirements of different laboratories, their intended purpose and graphical representation of the relative locations of different items.

The plan was developed under the boundary condition that it has to be accommodated in the vacant workshop hall (33.45 x14.20 sq. meters floor area) already constructed as basement of HIAST computer center building of SSRC.

OTW has provision for: entrance hall; optical store; mechanical store; change/rest room, common room, glass inspection/blocking and deblocking room; mechanical bureau/drafting and dimensional metrology; mechanical workshop; optical surface generation and grinding room; fining and polishing room; lapping and high speed polishing room; centring/edging and shop floor test room; optical technologists bureau; optical thinfilm coating; cleaning and chemical treatment; characterization and optical assembly; graticulation; optical design and National Project Director bureau.

The layout of each section has further been elaborated under the headings: intended use; room condition requirements i.e. loading capacity of ceiling, floor, construction and ambient atmosphere; lighting and electrical connection requirements; connection to media; description of items; their quantity and dimensions; and schematic representation of relative locations of different items.

OTW serve mainly as technical work sections. Allocation of additional built-in rooms in close proximity of OTW is made housing: optical design and systems engineering, opto-mechanical design; optical alignment and testing laboratories; and bureaus for National and International staff assigned to the project.

Construction of the new optics technology laboratories largely in accordance with the above document is completed. Minor variations in placement of machines were affected for smooth work flow. Pending installation of air-conditioning and dust control equipment in accordance with revised detailed plans, as short term measure, window type air-conditioners and double glass windows have been provided in clean areas. Water drainage system has further been improved by providing baffles. Compressed air lines have been laid in the basement with protrudation points at required places in different laboratories. Water chilling plant and other ancilliary equipment has also been housed in the basement for minimising noise level and conservation of free space in laboratories. Sodium vapour lamps have been installed from above in polishing rooms; thus enabling checking of job surface accuracy against proof plate in situ. Electrical connections in different laboratories are provided through over-hung rails.

Conceptually, OTW has been planned around following considerations:

- Entrance hall will meet the requirement of check point and explaining to the visitor the facilities set-up and work output.
- Easy transport of materials to and from optical and mechanical stores.
- Change of apparels/shoes, placement of personal articles, in the change room.
- Group meetings, lectures, technical demonstrations, departmental library and snack in the common room.
- To the extent possible , accomplishment of initial group training of National staff in the right wing of OTW.
- Restricted movement in work areas particularly in clean zone.
- Drafting services of a full time staff member in OTW itself responsible for proper maintenance and cleaning of the premises.

4.2. <u>National Staff</u>

28 full time National staff members comprising of B.E./M.Sc./ Ph.D. - 7; B.Sc. - 5; and technicians - 16 were identified in the PRODOC.

The Government project personnel in position and their field of occupation are given in Table 1.

The availability of a full time senior co-ordinator reporting to National Project Director and exclusively resposible for the diffusion and transfer of developed technologies to the local private and public sector industries, Government departments and academic institutions remains yet to be provided.

4.3. <u>U.N. Volunteers</u>

7 UN Volunteers in different areas of optics technology were identified in the PRODOC. The fields of specialisation covered

are: optics fabrication, thin film coating , optical design, optical testing, optical assembly and repair, optical tooling and mechanical fabrication, and mechanical design.

As a result of special recruitment efforts made by UNV, Geneva, 6 experts (excepting post with specialisation in optical design) joined the project. Expert in assembly, testing and repair could serve the project only for 9 months. Recruitment of the vacant posts had to be abondoned since the tenure of UNV cannot be less than 2 years.

4.4. Sub-contract

For speedy implementation of the project and to tap all sources of expertise available in developed and developing countries which can be profitably utilised for meeting the set goals, provision is made in PRODOC of sub-contract.

Suggestions for realisation of twinning arrangements with established institutions in the world well known for excellent output in the area of instrumental optics and technology; and close technical collaboration between SSPC and Central Scientific Instruments Organization, Chandigarh, India are further incorporated in PRODOC.

The sub-contract No. 89/44 was entered into with Leningrad Institute of Precision Mechanics and Optics (LITMO). The sub-contractor has provided 10 man-months of expert services in different optics technology areas;15 man-months of group fellowship training; and complete know-how packages of 2 models of microscopes.

The sub-contract was run during the period May 1989 to June 1991. The total amount paid is US $ 120,000.

4.5. Consultants

A provision in made for 13 man-months of short-term consultants in PRODOC. The areas of specialisation initially identified were: optics fabrication, thin film coating, optical testing, and technical cooperation.

A consultant in optics fabrication and measurement facilities served the project from 10.12.1988 to 9.2.1989. The expert in optics fabrication served the project during the period May, 1989 to October, 1989. The expert in optical design served the project in October, 1991 for two months.

The details of internationally recruited professional project personnel are given in Table 2.

4.6. Equipment

For procurement of expendable and non-expendable equipment, an expenditure of US $ 980,491 is made.

During the consultant mission in 1987-88, requisitions were placed for:

(i) Non-expendable equipment for total estimated cost of US $ 656,800 against the provision of US $ 680,000 and

(ii) Expendable equipment for total estimated cost of US $ 121,600 against the provision of US $ 140,000.

These requisitions covered: Glass sawing machine; lens rounding machine; lens curve generator; universal milling machine; grinding, smoothing and polishing machines; lens centring machine with laser centring device; precision spherometer; autocollimator; Abbe refractometer; lens collimator; Fizeau interferometer; test targets; UV-VIS-NIR spectrophotometer with absolute specular reflectance attachment and software programme of data handling routines; measuring instruments (outside micrometer, floating carriage micrometer, depth micrometer, vernier callipers, dial indicator with magnetic stand, universal bevel protector, thickness and dial gauges); optical stress analyser; vacuum coating plant; ultrasonic cleaning and drying equipment; laminar flow work stations; spherical turning attachment; flat tools; electric oven; standard optical components (optical flat, cube and square); optical glasses of different refractive index and Abbe value; ophthalmic glass plates; float glass plates; abrasives (carborundum, emery, aluminium oxide, cerium); polishing pads; diamond saw blade and wheels; optical blocking materials; optical cements; and optical coating materials.

During 1989, field requisitions were further prepared for balance expendable and non-expendable equipment for total estimated cost of US $ 104,100. These covered: books, technical digests, video tapes and reference standards; optical polishing pitch; PYREX 7740 OR DURAN 50 DISCS; further supply of ophthalmic glass and optical glass plates; silicon carbide abrasive; lens paper; spare and wear parts of DAMA optical production machines; diamond-tipped hollow drills, hot plate; diamond pencil; pocket size magnifiers; spare parts of Lambda 2 UV-VIS-NIR Perkin Elmer spectrometer; smoothing and polishing machine for processing with loose abrasives micro-lenses; lens centring device for proper alignment of lens elements during cementing; spare and wear parts of LOH optical production machines; centring chucks of Universal WG laser machine for small diameter lenses; optical glasses (FK-5, LaK-25 and SK-4); Iris diaphragms; positive working photo resists; spare parts of Edwards E 306A coater and evaporation sources; photoresist spinner; UV exposure unit; reference graticules for microscopy work; angle block set; and stereomicroscope.

During 1990 and 1991, a few other equipment items found necessary from operational consideration were ordered upon recommendation of National Project Director.

List of equipment already received at project is given in Table 3. These are now fully operational.

Existing equipment and machines available at SSRC relevant to project requirements have further been fully integrated with it. Notable examples are: lathes (Schaublin 125, TOS-SN 40 B); universal milling and boring machine (Deckel FP 4M); drilling machine (Aciera 22 S1), Edwards E 306A vacuum coating plant, computer terminal with plotter; optical design software programmes (general ray tracing, optimisation, analysis: spot diagram, MTF, DOTF, GOTF); focometer cum optical spherometer (Moller-Wedel) etc.

4.7. Fellowships

A provision is made in the PRODOC for fellowship training overseas of 17 SSRC staff members in the areas of optical workshop technology; thin film technology; optical metrology; optical design and system engineering; optical assembly and repair; graticulation; mechanical design; mechanical workshop and tooling; dimensional metrology; foundry and metallography; and technical cooperation. Fellowship training of 17 National staff members for 81.1 man-months is already accomplished. Details are given in Table 4.

4.8. Study tour

A provision of study tour is made in PRODOC for upgradation of the experience of 4 SSRC senior managers in acquainting with modern developments in optics technology.

Study tour of 2 senior scientists of SSRC to USSR, GDR, Austria and India was undertaken during the period 19.2.89 to 15.3.89.

Study tour of the National Project Director to USSR, FRG and Austria was undertaken during the period 5.12.89 to 23.12.89.

Details are given in Table 4.

5. OUTPUTS

For the achievement of the four immediate objectives (stated on page 9 , para 4 , of the present report), a total of 14 outputs are contained in the PRODOC. The activities to be pursued for realization of these set goals are further interwoven in PRODOC.

The progress of different outputs is given below:

Output No. 1

Output details given in PRODOC

Procurement, installation and putting into operation the machines required for setting within SSRC the optical and opto-mechanical workshops, optical design and system engineering, optical assembly and repair, and optical thin film technology laboratories.

Output progress

- Optical and opto-mechanical workshops are fully operational.
- Optical design and system engineering facilities set up. System design of junior level microscope / optics kit completed.
- Edwards 306 and E610 A coating machines are installed and fully operational. Durable reflection and anti-reflection coatings are realised.
- Optical assembly and repair activities started after receiving fabricated optical parts of the microscopes and some optical instruments from National Establishments.

Output No. 2

Output details given in PRODOC

Establishment of the techniques of pattern making in wooden shop; ferrous castings in foundry shop; optical tooling, jigs and fixtures in opto-mechanical workshops, precision optical elements in optical workshops and reflection/anti-reflection coating in thin film technology laboratory.

Output progress

- Pattern making techniques established.
- Ferrous castings for optical tooling and auto-collimator stand realised.
- Optical tooling (spherical and plane), jigs and fixtures fabrication techniques established.
- Optical elements fabrication techniques through single lens working and block polishing realised.
- Samples of reflection, multi-layer AR coatings, Fabry-Perot filter made on E 306 and E 610 A coating plants.

Output No. 3

Ou[illegible]t details given in PRODOC

Establishment of the technique of replication of reticles.

Output progress

- Laboratory premises to the required standards constructed and furnished.
- Laminar flow work station, ultrasonic cleaner, photo resist spinner, and inspection microscope procured and installed.
- Master patterns procured.
- Replication of micrometer graticule and other standard patterns realised, following chromium vacuum deposition photoresist process which combines extreme precision with high mechanical durability.

- Spectroscopic grade standard rectangular slits of height 9.7 mm and width 0.8 mm made by photo-etching process. The slits were needed for coupling with Jobin Yvon H 20 IR monochromator available at project.

- Fellowship training of the concerned national staff in graticulation at CSIO, Chandigarh, India for 3 man-months.

Output No. 4

Output details given in PRODOC

Development of capabilities in optical design through the application of available real time computer and software programme.

Output progress

- Computer terminal installed. Software programmes written for cemented/airgap doublet and three cemented components design.
- Thorough practical on-job training of the concerned National staff towards : full utilisation of the available ray tracing and optimisation programmes; basic understanding of lens design fundamentals; initialisation of the design process; progressive refinement in design ultimately suiting pre-defined performance criteria; and tolerancing.
- Further indepth training of the concerned National staff in total development of the optical design of real systems. The exercises related to the design of microscopic ,telescopic, projection and photographic instruments.

Output No. 5

Output details given in PRODOC

Development of system engineering design capability which shall comprise working out specifications of the various sub-systems against the given functional requirements.

Output progress

- System engineering design of junior model of microscope/optics kit completed.
- Critical study of the system designs of BIOMEM and LABPLAN microscopes provided by LITMO , their adaptation for prototype development, and carrying out necessary modifications suiting fabrication and assembly processes.

Output No. 6

Output details given in PRODOC

Upgradation of the library services in optics technology by way of subscription of international technical journals/bulletins in the subject area, and procurement of reports , patents, and standard treatises in optical engineering.

Output progress

- 25 Books, 15 Technical Digests, 14 Standards, and one Video Tape have been procured.

Output No. 7

Output details given in PRODOC

Development of design data sheets of different optical elements giving constructional parameters together with tolerancing.

Output Progress

- Optical design data sheets of the following elements have been worked out at project and finalized:
  - Lenses, mirrors, prisms, glass slab, ground glass screen for optics kit .
  - Optical devices, like hand held magnifier, achromatic cemented doublet/triplet, lens combinations.
  - Micro-optics: 10X Huygen's eyepiece; 5,10X objectives; reflecting mirror.
- Optical design data sheets of the different optical elements of BIOMEM and LABPLAN microscopes were provided by LITMO which were critically studied by project personnel for execution.

Output No. 8

Output details given in PRODOC

Developmment of design data sheets of optical tooling, mounts, jigs, fixtures and mechanical hardware together with tolerancing and surface finish requirements.

Output Progress

- Design data sheets of optical toolong required in fabrication of elements of optics kits and microscope optics worked out.

Output No. 9

Output details given in PRODOC

Development of prototypes of optics kit, student microscope, and assorted optical components.

Output Progress

- Fabrication of the following optical elements and system is completed:
  - 20 Nos. Educational Optics Kits comprising of 13 optical elements: 5 lenses, 4 mirrors, 2 prisms, 1 glass slab, and 1 screen.
  - Lenses for microscope objectives and eyepieces:
    10 Nos. - 5X objective.
    7 Nos. - 10X objective.
    20 Nos. - 10X eyepiece.
  - 4 junior microscope prototypes.
  - BIOMEM microscope optics.
  - LABPLAN microscope optics .

Output No. 10

Output details given in PRODOC

Preparation of technical manuals and know-how documents of optics kit and student microscope.

Output Progress

- Optical design data sheets of different elements of optics kit and details of experiments which can be conducted utilizing these components have been worked out.
- Detailed manufacturing drawings for junior level student microscope completed.

- Detailed manufacturing drawings of BIOMEM and LABPLAN microscopes provided by LITMO.
- Preparation of the technical manuals/know-how documents of all the above items.

Output No. 11

Output details given in PRODOC

Preparation of training schedules illustrating methods of fabricating optical and mechanical components to the pre-set specifications and sub-stage inspection, final quality checks and assembly.

Output Progress

- Upgradation of the knowledge of National staff in the different aspects of optics technology through the medium of periodical lectures.
- Distribution of written notes for future reference.
- Periodical objective type tests to monitor understanding level.
- Practical demonstraions and exercises on:
  * Optical design of 5X, 10X, objectives.
  * Optical design of binocular objective.
  * Optical and mechanical designs of shop autocollimator.

Output No. 12

Output details given in PRODOC

Training of 100 scientists, engineers, technicians and artisans from SSRC, industry and academic institutions through special seminars, workshops and short-term training sources.

Output Progress

- On-job specialised training of 46 National staff in complex optics technological processes is completed.
- Training services are being extended to other beneficiary organisations and potential entrepreneurs, both in public and private sectors.

Output No. 13

Output details given in PRODOC

Seventeen SSRC staff members trained overseas in the areas of: optical workshop technology, thin film technology, optical design and system engineering, optical assembly and repair, graticulation, mechanical design, mechanical workshop and tooling, dimensional metrology, foundry and metallography and technical cooperation.

Output Progress

- Fellowship training overseas of 17 National staff members for 81.1 man-months in different optics technology areas is completed.
- Due to exigencies of work, Mr. Domian Abbasi under-went fellowship training on three different occassions to Bulgaria, India, and USSR for a total period of 9.5 man-months.

Output No. 14

Output details given in PRODOC

Upgradation of the experience of four SSRC senior members in acquainting with modern developments in optics technology through undertaking study tour to industrialised countries.

Output Progress

- Study tour of two senior scientists of SSRC to USSR, GDR, Austria and India was undertaken during the period 19.2.89 to 15.3.89.
- Study tour of National Project Director To USSR,FRG and Austria during the period 5 to 23 December, 1989.

6. OPTICS KIT

The optical elements incorporated in the optics kit were chosen on the basis of demand survey and feed back from Physics faculty members of SSRC and Damascus University.

The optics kit presently contains unmounted lenses, mirrors, prisms and miscellaneous components of varied specifications. At a later stage, upon receiving affirmation from the users' departments, it is also planned to include mounted elements so as to be directly amenable for conducting optics experiments.

6.1. Lenses

Five single elements of configuration equi-convex, plano-convex, equi-concave and plano-concave are contained presently in the optics kit. Constructional data (radii of curvature, surface shape, center thickness, edge thickness, diameter, nominal and back focal lengths and glass type), tolerancing parameters (diameter, thickness, radii, surface finish, centring accuracy, coating, focal length, and general requirements) are given upon optical design data sheets (ODDS) in each case.

For proper selection of experiments, as a guide, the following general remarks are further included in the relevant ODDS:

- Equi-convex lenses are best suited in finite conjugate imaging applications up to magnification of ± 5. At or near 1:1 conjugate, coma, distortion and lateral chromatic aberration are almost totally eliminated.
- Plano-convex leses are best suited in finite conjugate imaging applications where magnification ratio exceeds ± 5. Curved surface is always positioned towards longer conjugate.
- Equi-concave and plano-concave lenses are used in combintion with other types of lenses to increase the system focal length. The correct configuration is determined on the basis of residual aberrations of existing system.
- Plano-concave lenses are commonly used to diverge collimated light. Curved surface is always positioned towards the more collimated beam.

6.2. Mirrors

Round flat, rectangular flat, concave and convex spherical mirrors are contained presently in the optics kit. Constructional data (dimensions, center and edge thickness, focal length, radius, material specifications), tolerancing parameters (diameter, thickness, size, focal length, surface accuracy and finish , coating and general requirements) are given upon ODDS in each case.

The general remarks made in relevant ODDS are:

* Flat mirrors are used in folding/bending the light beam. A left-right reversal of image is caused upon each reflection.
* Spherical concave and convex mirrors act like positive and negative lenses respectively regarding their image forming properties. Mirror surface geometry suits better in certain applications compared to equivalent glass lens systems. Besides, since no dispersion effects are involved, reflecting systems remain completely free from chromatic aberration over the desired spectral band width.

6.3. Prisms

Equilateral and right angle prisms are contained presently in the optics kit. Constructional data (size , material specifications), tolerancing parameters (dimensions, angular tolerance, surface flatness and finish, coating and general requirements) are given upon ODDS in each case.

The general remarks made in relevant ODDS are:

* Prism is essentially a non-image forming optical element used for two main purposes, namely to create wavelength dispersion of incident light into its constituent colours and to deviate the light path to any desired direction.
* Equilateral prism is commonly used as dispersion device. Higher the index of refraction of prism material, greater is the deviation of incident light and usually more

separation between dispersed colours.

- Right angle prism, with angles of 45°-90°-45° can be used as total internal reflector and as constant deviation prism. The angular deviation is 90°/180° when light rays are incident normally on prism face/hypotenuse. In constant deviation prism, regardless of incident angle, the entering and emergent beams remain parallel.

6.4. Miscellaneous components

Rectangular glass slab and square ground glass screen are contained presently in the optics kit. Constructional data (size, thickness range, material specifications), tolerancing parameters (dimensions, thickness, surface finish, and general requirements) are given upon ODDS in each case.

The general remarks made in relevant ODDS are:

- Parallel size rectangular glass slab can be used for setting up experiments in refraction, total internal reflection, and light displacement.
- Ground glass screen can be used to study light scattering, visual observation of image, and in proper alignment of component optical elements of given system.

7. OPTICAL DEVICES

Utilising largely the stock optical elements and/or optical tooling, design of some simpler optical devices have further been worked out. These are hand-held magnifier, achromatic cemented doublet, achromatic cemented triplet, and cemented lens combinations.

7.1. Magnifier

The design developed is based on a stock element. Constructional data (radii of curvature, surface shape, center and edge thickness, diameter, focal length, magnification and glass type); tolerancing parameters (diameter, thickness, radii, surface accuracy, centring accuracy, coating, focal length, and general requirements) are given upon ODDS.

The general remarks made are:

- Magnifier is a positive lens whose function is to increase the size of the retinal image over and above that which is formed with the unaided eye. It forms an erect virtual image of the object.
- Hand-held magnifier can thus be used as a convenient reading glass. With its aid, the task of reading small prints become easier.
- Unlike eyepieces, magnifiers do not have fixed exit pupil. Eye position can thus be variable. In other words, the performance of magnifier mostly remains insensitive to pupil shift. An equi-convex form is promising choice for the purpose.
- The present optical device has sufficiently large field of view and provides 5X magnification (small variation in magnification caused due to change in distance between eye to focusing plane from 250mm to infinity is usually ignored). In small diameter versions and with suitable modification of mount design, it can even be used as pocket magnifier or watch-maker's loupe.

7.2. Doublet

The design developed is based on available optical tooling. It is an achromatic cemented doublet, corrected for the red (656.72 nm) and blue (486.13 nm) lines of hydrogen. Relative aperture is 8.5, effective focal length 374.5 mm and back focal length 369.0 mm.

Constructional data (radii of curvature, surface shape, center thickness, clear aperture, diameter, and glass type); tolerancing parameters (diameter, thickness, radii, surface accuracy, surface finish, centring accuracy, optical cement, coating, focal length, and general requirements); and technical specifications (type, relative aperture, effective and back focal lengths) are given upon ODDS.

The general remarks made are:

- Achromatic cemented doublet comprises of two lenses of differing refractive index and Abbe value, paired such that the chromatic aberration produced by front element is compensated by the rear lens. In addition, good spherical aberration and coma correction can be obtained.

- Well-corrected achromatic cemented doublet finds numerous applications e.g. collimating lens at infinite conjugate ratio, microscopic and telescopic systems design, low power laser beam manipulation etc. Again, collimator in itself and in conjunction with other accessory devices, is widely used in optical metrology, alignment, lens testing and as target projector.
- As collimating lens, the achromatic doublet can be used to focus incident parallel radiations to a well corrected point image in the focal plane. Conversely, a collimator can be used in reverse direction to transform a point source of light into parallel bundle.

7.3. Triplet

The design developed is based on available optical tooling. It is an achromatic cemented triplet corrected for C and F lines. A high index symmetric flint element is sandwitched between two identical low index crown elements. The device is conceived basically to serve as a superior quality magnifier. Useable relative aperture is f/10, Efl - 61.9 mm, Bfl - 53.7 mm and magnification - 4X.

Constructional data (radii, surface shape, center and edge thickness, diameter, and glass types); tolerancing parameters (diameter, thickness , radii, surface accuracy, surface finish, centring accuracy, optical cement, coating, focal length, and general requirements); and technical specifications are given upon ODDS.

The general remarks made are:

- The symmetric achromatic cemented triplet provides several inherent advantages, e.g. (1) at or near unit conjugate ratio, coma, distortion and lateral chromatic aberration are almost totally eliminated; (2) performance remains reasonably well from unit conjugate ratio up to a magnification (or demagnification) of approximately 5., (3) lenses are reversible permitting their utilisation either side up., and (4) there is no preferred conjugate plane at any specific conjugate ratio.

- During its usage as a magnifier, the present device provide sufficiently large working distance with wide field of vision. Further, the focus position can be suitably chosen enabling viewing of object with a relaxed eye.
- Because of the specification of single radius of curvature for all lens elements, with consequent minimum expenditure upon required optical tooling, the device shall be amenable to fast production with cheap costs.

7.4. Lens combinations

The design developed is based on stock elements. Two types of cemented lens combinations (CLC) of zero power are conceived. Constructional data (radii, surface shape, center and edge thickness, diameter, efl and material specifications); and tolerancing parameters (diameter, thickness, radii, surface finish, centring accuracy, focal length, and general requirements); are given upon ODDS.

The general remarks made are:

- It is well known that insertion of a glass plate with plane parallel faces placed orthogonal to the axis in an optical system causes only longitudinal displacement of the image. However, when the plate is tilted in non-collimated light beam, aberrations are introduced. It has further been suggested that astigmatism and coma so introduced could be minimised by the use of a plate having between its faces, a little lack of parallelism wisely chosen.

- In the above context, for better clarity and understanding, it is considered interesting to study under identical conditions, the aberrational characteristics of the above two types of CLC vis-a-vis equivalent thickness plane parallel crown glass plate and compare results. Neglecting manufacturing defects, and assuming the intermediate cemented surface to form continuous homogeneous medium of same refractive index, CLC 1 essentially can be visualised as equivalent to thick glass plate with plane parallel end faces; and CLC 2 a meniscus lens having front surface concave and rear surface convex.

8. EDUCATIONAL MICROSCOPES

8.1. Junior level model

For utilisation in schools, the optical system design of a portable junior level microscope was developed. It incorporates 5, and 10 X objectives, and 10 X Huygenian eyepiece. A spherical concave mirror is provided enabling proper illumination of the semi-transparent object placed on the microscope stage. Constructional data, tolerancing parameters, technical specifications and design details are given in relevant ODDS.

Huygenian eyepiece is composed of two air-separated plano-convex lenses with plane faces of both field and eye lenses facing towards human eye. Focal plane remains located between the elements. Ratio of the powers of two lenses is appropriately chosen to minimise coma and spherical aberration. Spacing between the elements is adjusted to eliminate lateral colour. Magnification is 10 X, apparent field diamater - 10.5 mm and barrel diameter - 23.2 mm.

Microscope objective 5X is cemented achromatic doublet corrected for C and F lines. Numerical aperture is 0.1, working distance - 29.3 mm and focal length - 25.5 mm.

Microscope objective 10X is of Lister type. It is composed of two widely spaced achromatic doublets. Numerical aperture is 0.25, working distance - 7.5 mm and focal length - 16.0 mm.

The objectives are corrected for a mechanical tube length (distance from the rear shoulder of the microscope objective flange to the microscope tube end) of 160 mm. Mounting thread form is standard RMS (Whitworth 36 TPI).

8.2. Advanced models

Design and development of another two advanced versions of microscopes (coded as LABPLAN and BIOMEM) has been pursued in collaboration with LITMO. The newly designed achromatic series of objectives for LABPLAN provide sharp and well-defined images over all objectives i.e. 4* 0.1, 10*0.25, 4*0.65 and 100*1.25. The objectives are of CF class i.e. fully corrected for chromatic aberration. Spherochromatism and secondary chromatic aberrations are nearly zero without using optical glasses or crystals. Root mean square wave front aberration of all objectives is 0.07 Lambda on-axis and 0.17 Lambda off-axis. Well corrected wide field eyepiece10X with large exit pupil distance (25 mm) is provided.

For cost reduction, in BIOMEM model alternate set of objectives viz. 4* 0.1,10*0.25 and 40*0.65; and eyepiece 10X is provided. In contrast to LABPLAN, no optical corrections for lateral chromatic aberration, secondary chromatic aberration and image curvature is made in this case. The illumination system of LABPLAN is of Koehler type i.e. it comprises of a collector lens, auxiliary lens system, plane mirror, and swing-out condenser. Condenser makes it possible to provide optimum illumination for observation with the objectives of low power (4, 10X) to high power (40,100X) by simply engaging or disengaging the top lens. In BIOMEM, the illuminating system comprise only of a plano-concave mirror and swing-out condenser.

The basic technical parameters of the two models of microscopes are given in Table 5. The salient points to be noted are:

- Modular design concept permitting incorporation of additional attachements in future.
- Sturdiness of instrument achieved through fixed observation tube and focusing by stage movement.
- Graduated drive control knobs provided co-axially facilitating easy operation.

From interchangeability and standardization considerations, mechanical tube length for all objectives is kept 160 mm; and parfocality (distance between object plane and objective collar plane) - 45 mm.

9. LECTURES

For upgradation of theoretical and practical knowledge of the National staff in optics technology , a scheme of periodical lectures delivered by the International team was introduced. The topics covered are given in Table 6. These can broadly be classified into the categories: fundamental optics, geometrical optics, typical optical systems, optical test instruments, optical metrology, and quality assessment; optical workshop technology; opto-mechanical workshop technology; cleaning, and care of optical components; and optical systems assembly.

Objective type tests were further conducted for receiving the feedback. In some cases, even written notes in English and Arabic were distributed to the participants for better comprehension .

10. OTHER SIGNIFICANT TECHNICAL CONTRIBUTIONS

In this section, elaboration is made of other significant technical contributions not covered elsewhere in the present report.

10.1 Microscopes: Design and Manufacturing Technology

Draft Final Report submitted by LITMO to the Project can be treated as exhausted Technical Documentation in Microscopes Design and Manufacturing Technology. It can serve as a model in future for effective transmission of technology and preparation of know-how packages. This Report comprises a title page, a table of contents and twenty nine (29) pages of text and (7) Annexes (1 through 7).

The following salient points of the above Technical Documentation are worth noting:

- Documentation is fulfilled in accordance with the ISO specifications.
- Documentation is suitable for the microscope optical and mechanical fabrication on the machines and equipment available at the SSRC.
- There are no die-cast, plastic or pressed parts suggested during prototypes fabrication stage.
- During the fabrication some modifications or corrections of the microscope parts may be possible to suit SSRC workshop facilities, if necessary.

The Optical know-how package contains:

1. Optical tool drawings for fabrication of the set of objectives.
2. Test plates drawings for all optical elements, standard control and working test plates in pairs.
3. Technological process to manufacture objectives, eyepiece, condenser and illumination system.
4. Technological process to manufacture prism and mirrors.
5. Technological process of lens cementing and coating.

The Mechnical know-how package contains:

1. Manufacturing technology of all mechanical parts and workpieces of microscope prototypes.

2. Technological process of assembly of focusing mechanism, stages, nosepiece , stands , condensers, bases with controller.

The Opto-mechanical know-how package contains:

1. Route charts of technological process of fixing and centring objective lenses in mounts for each lens separately.
2. Route charts of technological process of assembly and adjusting objectives , eyepiece , condenser.
3. Adjusting tables for objectives 40 X 0.65, 100 X 1.25.
4. Detailed technical documentation of additional equipment for micro-optics, centring and adjusting is as follows: centring chucks (two types); autocollimation tube ; inspection microscope for checking objectives parfocal distance and centring.
5. Drawings of tools and accessories for micro-objectives assembly such as set of holders for centring chucks, mounting jig , thread bushing , wrenches.

Technical documentation for final testing and performance evaluation of micro-objectives, eyepiece and BIOMEM -S,L prototypes contains:

- Technical requirements, testing regulations, test methods, list of equipment for microscope testing required for microscope performance evaluation.

The developed know-how packages offers the following advantages:

1. Advanced method of fixing objective lenses in mounts by cementing using hermetic cement.
2. New effective process of centring lenses in mounts based on autocollimation which provides high precision independent centring and efficiency requiring no special worker's qualifications.
3. High quality, reliability and efficiency of the objective assembly and adjustment are achieved through the use of adjusting tables and detailed typical micro-objective instruction.

4. A simple and reliable method of final testing and performance evaluation of BIOMEM - S,L prototypes
5. The know-how packages contain a detailed and clear presentation of document covering the assembly and manufacturing technology of all parts and units of the microscope prototypes.

The following technical features of the two models of microscopes developed are finally recalled:

- High quality optical image provided by incorporating achromatic series objectives and wide-field eyepiece - 10 X. The objectives have a very small image curvature with lateral chromatism being fully corrected , and spherochromatic and secondary chromatic aberration approximating zero. All objectives and the eyepiece contain only ordinary types of optical glass without using special glasses or crystals.
- The illuminating system is in line with the best models available; it is capable to provide uniform illumination of transparent micro-objectives in bright field of transmitted light. This system has a simple design and permits continuous observation from low to high magnifications with comfortable operation. The light source uses 6V - 20W long-life bulb, considerably simplifying time consuming bulb replacement.
- The high eyepoint design, drive control knobs and indication facilities are in agreement with ergonomic standards and engineering physiology, providing comfort for long period of observation.
- Sturdiness of the microscope design and its individual mechanical components allows reliable long-time observation.
- The modular design concept underlying the available BIOMEM models permits to further develop certain other models of microscopes, like , polarising, phase-contrast etc.

10.2. Computerized Optical Design (COD)

The activities in the area of Computerized Optical Design were further strengthened during the consultancy mission of Prof. Serguei Rodionov to the project from 2 October to 3 December 1991.

The following computer facilities are available to the project:

* Leanord - 386, IBM compatible, personal computer, main processor i386, no mathematical co-processor, 1 MB RAM, Monochrom monitor , 10 MB HD, 1.11 MB FD.

* Zenith - 386/387, IBM compatible, personal computer main processor i386 SX, 20 MH, mathematical co-processor 1387 SX 20 MH, colour monitor VGA, 1 MB RAM, 10 MB MD, 1.11 MB FD.

* There is also mini Vax computer in the SSRC (not in the optical design section), and Leanord computer may be used as Vax terminal.

Software Packages available for COD are:

* Imperial college (England) optical package, including programme for optical systems tolerancing and lens library for selection of initial construction of optical system. This package is installed at Leanord and Zenith personal computers.

* Reading University (England) package "OPAL" for solving various problems of optical design. This package is installed at PC computers as well as Mini-Vax computer. PC versions now provided solving only simple problems such as rays tracing and synthesisof thin component optical systems. Total capacity of this package can be utilized at Mini-Vax computer.

* LITMO package "OPAL" is installed at Zenith 386/387 computer. The main advantages of the package are friendly interface with designer , powerful methods of optimization , useful practical methods for beam's size determination, and new conception of aberration's evaluation.

Practice in COD included development of real systems. Typical examples are given below:

Telescope system design

Telescope tube with prism erecting system was designed in several variants.

The main specifications: Magnification M=8, ENPD-10 , EXPD-5 , AIFS = 10 , AOFS = 5 , F- number-5.

Four variants of objective were designed: two cemented doublets, one separated doublet and one cemented doublet plus singlet. Two variants of eyepieces were designed - Kellner and symmetrical type. Final design - cemented doublet with Kellner eyepiece has good near diffraction limited quality..

Microscope system design

For microscope, two variants of micro-objective 10 X magnification were designed.

Also illuminating system (Kohler) was designed, including collector and condenser.

And binocular attachment for "BIOMEM" microscope was designed including relay lens and binocular prism system.

Also micro-objective 2.5 X magnification with parfocal distances 45mm was designed for microscope "BIOMEM".

Photographic objectives design

Detailed investigation and design of photographic objectives were fulfilled, from simple "triplet" to very complicated "Inverted telephoto".

Using powerful computer programmes, we can obtain more simple design , for example , it was possible to exchange expensive optical glass (lanthanum glass) with ordinary glass without loss of system quality.

The first design was "Triplet" type. Using optimization, it was possible to obtain two variants with different glasses of normal quality for F=4.

The second was "Tessar". Several designs of "Tessar", with good quality for F=2.8 were developed.

The third was high speed objective "Planar" or "double-Gauss" type with F=1.4 ; several variants of this type were designed, using various kinds of glasses with good image quality.

The next was "Telephoto" objective with specification: EFL=500, F=5.6, TOTAL LENGTH /EFL=0.75. Four designs without special glasses were developed.

The last was "Inverted Telephoto" with specification: EFL-21, BFD=12, F=2.

10.3 Miscellaneous

- For monitoring the thickness of optical thin films during evaporation , an ingenious method has since been developed which involves coupling the output from EdwardsOptical Film Monitor (Model OFM-3) externally with Jobin Yvon H 20 IR Monochromator and side-on photo-multilpier. The present technique allows better spectral control compared to the insertion of discrete array of interference filters in light beam path.

- Engineer Khalid Maya is pursuig since September 1992 Ph.D. work under supervision of Prof. E. Putilin (of LITMO). The problem relates to the design and development of rugate filters suppressing sidelobes over broad spectral regions with maintenance of the stop band reflectance. Co-deposition of two materials, e.g. ZnS - MgF_2, SiO_2 - SiO, is being attempted for the purpose.

- Mr. Ahmad Kamal Jalal has been sponsored by Aleppo University for carrying out experimental work since January 1992 for M.Sc degree under supervision of Dr. Khalid Maya. The work relates to the development of suitable AR coating for solar cell. ZrO_2/HfO_2, single layer AR film has been deposited for the purpose. HfO_2 coating has been subjected to the required environmental conditions and found durable.

- Mr. Domian Abbasi is undergoing advanced training since ~~ August 1992 for one year at Changchun Institute of Optics ..

Fine Mechanics (CIOM), Changchun, China. His work relates to the design and development of the mechanical system of an interferometer for testing aspheric surfaces during production.

- The Junior Level Microscope designed and developed earlier at the project has been further refined by effecting improvement in focussing mechanism and utilising moulded mechanical parts. Prototypes based on this modified design have also been made. It is now amenable for series production.

- The Project has collaborated with Dr. Ahmad Hydar (of SSRC) in providing durable nickel coating by thermal evaporation process upon the exterior surface of solid ceramic cylinders required in development of temperature sensor.

- The Project participated in the XXXII Science Week Exhibition held between 7-13 November, 1992 at Damascus University. It generated lot of interest amongst visitors; became an efficient source of inquiry for developing specific products and for establishing in future meaningful co-operation with private and public sector organizations.

- The Project has established closed technical collaboration on bilateral basis with CSIO, LITMO, and CIOM. This can in the long run lead towards setting up active twinning arrangements in specific areas with these established institutions in the world well known for excellent output in the area of instrumental optics and technology.

- Upon invitation, Professor Xue Mingqiu of Xian Institute of Optics and Precision Mechanics, Xian, China, delivered a series of 3 lectures at SSRC between 26-28.4.93 on the following topics:
  - (i) On Development of Applied Optics.
  - (ii) On Application of Optical System in Space.
  - (iii) Engineering Optics in China.

  The lectures were followed with stimulating discussion with faculty members.

11. DEVELOPMENT SUPPORT COMMUNICATION

As a follow up of the statements made under Sections J, page 19 of ProDoc and the recommendations made in Tripartite Reviews, the NPD and senior faculty members of the Project in association with other concerned staff members at SSRC have made continuous strenuous efforts to establish active linkages with private and public sector organizations. The results of these efforts, which in essence can be called as "Development Support Communication" are summarized below:

11.1 Linkages with Public Sector Institutions

I-1- Health Ministry: Dr. Nijmeh the Director of Ophthalmic Hospital.

- Maintenance and repair of optical instruments.
- Development of retinoscope (currently under development).

I-2- Ministry of Irrigation: Dr. Malakani

- Requirement of stereoscope and magnifiers (>100).

I-3- General Company for Technical Studies and Consultation: Eng. Serih Al- Buni

- Development of surveying instruments(level).
- Establishment of center for maintenance, repair and calibration of optical instruments with the collaboration of National Center of Calibration, (NCC). A ministerial subcommittee is formed (Dr. Bizri is a member). Currently a survey is undergoing (Eng. Al-Buni) to determine the requirement from NCC.

I-4- Damascus University: Dr. A. Bosary
- Repair of microscope (mechanical and broken optical components).
- Purchase of optical components (single lenses, prism , reticles and micrometer for microscopes). Currently we have an order for 110 singlets

I-5- Allepo University:

The coating facility is used for the practical work of MSc. degree in the application of solar energy (anti-reflection coating for photo-voltaic cells).

I-6- Ministry of Education: (School Technology Center,STC)

Prof. Talo

- Joint production of the student microscope. Purchase of optical components. Feasibility study for the establishment of optical workshop in the STC.

I-7- General establishment of Geology and Mineral Resources:

- Purchase of pocket stereoscope. Development of mirror stereoscope.
- Maintenance and repair of microscope.

I-8- Atomic Energy Commission:

- The use of coating facility to develop superconductor.
- Manufacturing of glass cube for spectral analysis (9000 SL).
- Development and manufacturing of objective and mechanical holder for Photo/Gamma camera (20.000 SL). (under production).
- Manufacturing of 6 protein analysis devices (under production).
- Development and manufacturing of laser Beam Expanders. (under designing).
- Development and Manufacturing of laser mirrors.

I-8- Salhab Sugar Factory, Homs

- Fine lapping and polishing of glass window for furnace (18 pcs 500 SL each)

11.2 Linkages with Private Sector

As a result of our participation in the Exhibition of Scientific Instrument held during the Science Week organized by Damascus University , we were contacted by several private industry and trading centers. The current outcome of this contact was;

II-1- Company for Metallic Production (Aleppo):

The production of lenses for projection system in machines used for metal cutting. These machines are out of production and the company can not obtain the replacement for brocken lenses in the projection instrument. This order is 4X8 singlets at 90.000 SL.

II-2- Badawi (LILAC) Company for Importing and Manufacturing medical instruments:

The development and production of condensers and concave mirrors for locally manufactured instrument for general ear examination (10pcs 2000 SL each). (under production).

II-3- Laboratory and Teaching Instruments Trading Center:

Negotiating the possibility of co-operation in the production of : Slide projector - overhead projector and other optical instruments.

II-4- Al Attar New Establishment for Educational Aids:

- 10X Linen and Product Tester with 100 μm glass scale (under production).
- Technical assistance in microscope production.

12. TRIPARTITE REVIEWS (TPR)

12.1 First TPR

The first Tripartite Review of the project was held at State Planning Commission in Damascus on 6.1.90. This was attended by the experts from the Government, UNDP, UNIDO and SSRC. The overall assessment of the progress uptill 31.12.89 was rated to be "more than planned". It has been considered as one of the successful projects.

UNDP, Damascus had further identified only the project DP/SYR/86/001 from Syria which had obtained clear and quantifiable visible results in 1989. This information was required by the Administrator's Office in New York for the presentation of 1989 annual report containing ten years perspective of UNDP.

The following decisions and management actions to be taken were identified:

1. Follow-up mission of the CTA either through converting the remaining 7 m/m into split missions or offering him a one year contract, as found expedient for the project.
2. Arrange for training courses for maintenance and repair of the equipment purchased for this project.
3. Discontinue the efforts for recruitment to UNV posts SYR/V/132 and 137 (balance period).
4. Change in JD and field of specialization of short-term consultant from Optical Testing to Optical Design.
5. Strengthen twinning arrangements with Leningrad Institute and consider TCDC co-operation with other institutes/centers dealing with optics and optical technology in developing countries.
6. Ensure the establishment of production of optical components which will save foreign currency. In addition SSRC should give more emphasis for prototype equipment and strengthen its capabilities in small batch manufacturing (limited scale production).
7. Optics kits produced at SSRC should be exhibited in Kuwait Fair in order to determine degree of acceptability and competitiveness in the regional market.

12.2 Second TPR

The second TPR of the project was held at the State Planning Commission in Damascus on 15.9.91. The list of participants is given below:

STATE PLANNING COMMISSION

- Dr. R. Yasmineh ,	Director, Economic, Scientific and Tech. Coop. Dep./International Relations .
- Mr. B. Sibai ,	Deputy Director, Economic, Scientific and Technical Relations.
- Mr. N. Shakbazof ,	Assistant, Deputy Director.

SSRC

- Dr. F. Mousselly ,	NPD
- Ms. M. Kailas ,	Scientific Tech. Cop. Dep. , SSRC

UNIDO

- Ms. K. Liebl ,	Area programme Officer
- Mr. M. Boutoussov ,	BSO
- Dr. J. Prasad ,	CTA

UNDP

- Mr. B. Eagona ,	Resident Representative a.i.
- Mr. K. Alloush ,	National programme Officer
- Ms. N. Kozak ,	Senior Programme Assistant

The following decisions, recommendations and management actions to be taken were identified:

The TPR members expressed appreciation for the impressive achievements of the project in terms of R&D optical technology capabilities established in the SSRC and for the production of prototypes of educational optics kit, junior level microscope and biomem microscope (advanced version). The TPR reached the following decisions, conclusions and recommendations:

1- Having established the required infrastructure and technical facilities, the project should make concrete efforts for: Identification of other optical instrument(s) which are required to be developed in Syria and initiation of RD&D activities thereupon, integration with potential end-users; and commercial adaptation of the technology developed.

2- Establish a unit within the SSRC which would in the future be responsible for the required promotion/commercial adaptation, know-how transfer and development.

3- Develop a comprehensive strategy on how to identify potential end-users, demand and supply interlinkage, etc. which should take into account not only survey aspects but developmental aspects as well.

The TPR recommended that an in-depth evaluation of the technical assistance rendered by the UNDP to this on-going project be carried out. UNDP was requested to draft the Terms of Reference and clear it with the other concerned parties.

13. In-Depth Evaluation

During the second TPR of the project, it was recommended that an in-depth evaluation of the technical assistance rendered by UNDP to this on-going project shall be carried out.

The terms of reference of the joint evaluation mission of the Government of Syria/UNIDO/UNDP of the project were formulated by UNDP and cleared with the concerned parties.

The Evaluation Team comprised of:

- Mr. Carl Erik Wegener, Development Management Consultant, and Team Leader, Representating UNDP.
- Dr. J.L. Nidetzky, Managing Director of Laser-Consulting and Engineering Technologie, and representing UNIDO.
- Dr. T. Tarbadar, Professor in Optics, University of Damascus, and representing the Government of Syrian Arab Republic.

The work of the mission was carried out in Damascus during the period 17.4.93 to 6.5.93. CTA, NPD, Dr.N. Bizri and other concerned National counterpart staff provided substansive back up assistance to the Evaluation Team in its activities concerning all aspects of the Project implementation.

The leader of the mission prepared Executive Summary of the Draft Evaluation Report (DER). This was discussed with UNDP, Damascus on 5.5.93.

The relevant extracts from DER are listed below for reference purposes:

Quote. " Within the frame work of immediate objectives, the project has been a success.

The laboratories and workshops of the Optical Group at the SSRC are now established in modern, well designed and well equipped building on the SSRC premises. The equipment foreseen in the project document has been purchased and installed, with a few minor modifications. Additional equipment has been supplied by SSRC. With assistance of the international experts the choice of the equipment has been based on sound criteria delivered by international suppliers of good reputation. All equipment are in operation.

A prototype of a high standard microscope has been developed in collaboration with a well known Russian Optical Institute. The prototype has been produced by SSRC. During this collaboration technological capabilities and skills have been transferred to SSRC which is now fully capable of modifying the design of the prototype and to develop complete new prototype of instruments at the same or inferior standard.

The Optical Group has a qualified staff as foreseen in the project document; in some fields at international level. The qualifications have been obtained through on-the-job training in workshops and laboratories under the guidance of international experts and through fellowships to internationally well known institutes and manufacturers. The staff appears highly motivated.

An imporatant contribution to the successhas been the high scientific and technological qualifications of the project management and the CTA as well as their efficient mutual collaboration and their collaboration with the Syrian authorities and UNDP/UNIDO.

The OG has started its commercial activities as a consultant to users of optical equipment in the public and private sectors. But there is still a way to go before the expected break-through in technology transfer to the Syrian industry is realised. What is needed is reliable information of the demand for optical equipment and of potential manufacturers of this equipment.

The mission recommends that the successful completion of the project is followed up immediately by a market survey which can provide a background for the decision of the direction(s) in which the Optical Group shall now move.

The microscope prototype has served its purpose as the instrument of the transfer of the technology to SSRC, but it is not necessarily the most "marketable" product.

It is a question of finding not only "marketable" products, but also to define OG's future role in a much broader, international perspective. Unquote.

Detailed report of the Evaluation Mission shall be written by the leader Mr. C.E. Wegener from the home base and directly submitted in its final form to UNDP and UNIDO who, by agreement, will then submit it to the Government.

14. REPORTS / PUBLICATIONS

During implementation of the project activities, several technical/ semi-technical reports were prepared. Upon completion of their assignments, the international experts also prepared exhaustive reports. UNV'S submitted to the Project Authorities Periodic Reports summarizing their work and identifying their specific contribution/accomplishment. National staff submitted their Final Fellowship Report.

Listing of important Reports/Publications is made below:

1. Prasad, J., and Mousselly, F., " Plan of the Optical Technology Wing of SSRC, Damascus," 62 pages, February (1988).
2. Prasad, J., " Technical Report containing Findings of the Mission and Recommendations", 112 pages, March (1988).
3. Singh, J., " Technical Report containing Findings of the Mission and Recommendations", 18 pages, February (1989).
4. Mousselly, F., Bizri, N., and Prasad, J., " Final Report of Study Tour undertaken during the period 19.2.89 to 15.3.89", 14 pages, April (1989).
5. Abell, R., " Technical Report : Fabrication of Precision Optical Components", 34 pages, October (1989).
6. Mousselly, F., and Prasad, J., "Project Performance Evaluation Report", 62 pages, November (1989).

7. Mousselly, F., and Prasad, J., " Final Report of Study Tour undertaken during the period 5.12.89 to 24.12.89", 20 pages, December (1989).

8. Prasad, J., " Technical Report containing Findings of the Mission and Recommendations", 140 pages, January (1990).

9. Mousselly, F., " Project Performance Evaluation Report", 60 pages, November (1990).

10. "Draft Final Report together with Annexes 1 to 7;1: Optical Design Documentation of Micro-objectives and Eyepieces; 2.1 and 2.2 - Design Documentation of Microscopes - BIOMEM:S,L ; 3- Bill of Materials; 4- Fasteners; 5- Optical Cements; 6- Optical Toolings; 7- Protocols of Technical Conferences,Experts Reports and Report on training", Contract 89/44, Leningrad Institute of Precision Mechanics and Optics, Leningrad (1991).

11. Dzuverovic, V., " The First Syrian-made Microscope", UNV News, Cairo, Egypt.

12. Shumei, Y., et al., " Research on ZnS non-linear thin films and bistable thin filters", Materials Science and Engineering , 39, 501-4 (1991).

13. Prasad, J., and Mousselly, F., " Interim Technical Report related to Project Performance", 44 pages, November (1991).

14. Prasad, J., " Technical Report containing Findings of the Mission and Recommendations", 97 pages, November (1991).

15. Rodionov, S., " Technical Report: Introduction of Computerized Design of Optical Systems in the Center of Optical Technology Development", 21 pages, November (1991).

16. Prasad, J., and Mousselly, F., " Project Terminal Report", 63 pages, May (1993).

17. Prasad, J., " Technical Report containing Findings of the Mission and Recommendations", 32 pages, May (1993).

15. ACKNOWLEDGEMENTS

The authors wishes to express their sincere thanks to all the National staff members, group leaders, international experts, UN volunteers, members of evaluation team, and other concerned persons assigned to the project, for their whole hearted co-operation and excellent contributions.

Particular mention is made to Dr. A.W. Chahid, President; Dr. M. Mrayati, Director of HIAST; Dr. A. Armanazi, Mrs. M. Kallas, Mr. Abdul Kader Naial, and Dr. N. Bizri.

We are also grateful to Dr. M. Boutoussov, Mr. C. Winkelmann and all other officers and staff connected with the Project at UNIDO, Vienna; UNV, Geneva; Mr. Kyaw Lwin Hla, Resident Representative, Mr. El Balla Hagona, Deputy Resident Representative, and Ms. Nadia Kozak for their continuous support and advice. Further, we express our sincere thanks to all other officers and staff of UNDP, Damascus, for providing desired assistance.

One of the author (CTA) expresses his gratitude to Dr. K.R. Sarma, Director, CSIO, for his valuable support and guidance.

TABLE 1

Government project personnel

Post No.	Post title	Name and sex of incumbent	Full or part time	Entry on duty (date) Sched.	Actual (est.)	Departure (date) if applicable
1	National Project Director & Head, Optical System Testing Section.	Dr. M.F. Mousselly, Docteur - Ing., Male.	Full	12/87	12/87	
2	Head, Optical Design Section.	Mr. Nidal Bizri .	Full	1/90	11/90	
3	Head, Thin Film Technology Section	Mr. Khaled Maya, Diplome d'Ingenieur, Male.	Full	12/87	12/87	
4.	Head, Mechanical Section.	Mr. Domian Abbasi, B.E. Male.	Full	2/88	2/88	
5.	Head, Optical Work-shop.	Mr. Ayman Obeid, B.Sc., Male.	Full	12/87	12/87	
6	Mechanical Work-shop Engineer.	Mr. Mohamad Natour, B.E., Male.	Full	5/90	5/90	
7	Optical Thin Film Design Engineer.	Mr. Massoun Atfeh B.E. Male.	Part time			
8	Technical Assistant Optical Testing	Ms. Nada Rajab, B.Sc., Female.	Full	5/88	1/89	
9	Technical Assit. Optical Design.	Mr. Ibrahim Shalesh, B.Sc., Male.	Full	5/88	2/89	
10	Technician-Optical Testing.	Mr. Nazir Krenbeh, Diploma Asst. Engineer Male.	Full	5/88	5/88	
11	Head, Mechanical Workshops.	Mr. Mahmoud Al-Hamad, B.E., Male.	Full	2/88	2/88	5/90
12	Technician, Optical Workshops.	Mr. Arabi Haddad, Diploma Asst. Engineer Male.	Full	2/88	2/88	6/92
13	Technician, Optical Workshops.	Mr. Ziad Safieh, Diploma Asst. Engineer Male.	Full	2/88	2/88	
14	Technician, Optical	Mr. Mourhaf Soui, First Diploma, Male.	Full	2/88	2/88	
15	Technician, Optical Workshops	Mr. Ahmad Al-Abdullah, Diploma Asst. Engineer	Full	5/88	5/88	

Government project personnel

Post No.	Post title	Name and sex of incumbent	Full or part time	Entry on duty (date) Sched.	Actual (est.)	Departure (date) if applicable
16	Technician, Shop Floor Testing/ Optics Fabrication /Assembly.	Ms. Banady Shams Al-Deen, Diploma Asst. Engineer, Female.	Full	5/88	5/88	6/92
17	Technician, Optical Workshop .	Mr. Ahmad Kredi, Technical Bach ., Male.	Full		4/90	
18	Technician, Optical Workshop.	Mr. Maged Kassab, D. Asst. Tech. , Male.	Full		3/90	
19	Technician, Optical Workshop.	Mr. Ahmad Al-Solk, D. Asst. Tech., Male.	Full		8/90	6/91.
20	Technician, Optical Workshop.	Mr. Bassan Al-Azrouni, Asst. Tech. , Male.	Full		10/90	
21	Technician- Thin Film Technology.	Mr. Ahmad Al-Halabi , Diploma Asst. Engineer, Male.	Full	12/87	12/87	
22	Technician-Thin Film Technology.	Ms. Mona Sara, Diploma Asst. Engineer, Female.	Full	12/87	12/87	
23	Technician- Graticulation.	Mr. M.K. Abo-Dhahab, Diploma Asst. Eng, Male	Full	2/88	2/88	
24	Technician.	Mr. Khalid Tarazi, Diploma Asst, Eng, Male	Full	2/88	2/88	
25	Technician- Mechanical Design.	Mr. Fady Kaston, Diploma Asst. Eng, Male.	Full	2/88	2/88	
26	Technician- Mechanical Workshops.	Mr. Khalid Aiouby, Diploma Asst. Eng. Male	Full	2/88	2/88.	
27	Technician- Mechanical Workshops.	Mr. Moussa Souidan, Diploma Asst. Eng. Male	Full	2/88	2/88	
28	Technician- Mechanical Workshops.	Mr. Nazir Reslan, Diploma Asst. Eng. Male	Full	5/88	4/88	
29	Project Secretary.	Ms. Salam Shams, B.A. in English Literature, Female.	Full	5/88	1/89	
30	Project Driver	Mr. Mohamed Dib-Zlatah, Male.	Full	5/88	4/89	
31	Helper / Cleaner	Mr. Riad Azarah, Male	Full	5/88	11/89	
32	Mechanical Design Engineer	Mr. George AL-Hanoon B.E. Male	Full	-	11/91	
33	Technician Optical Workshop	Mr. Ghasan Al-Katib Diploma Asst.Eng. Male	Full	-	1/92	
34	Technician Optical Workshop	Mr. Mohamed Baker Technical Baccalaureate, Male.	Full	-	9/92	

TABLE 2

Post No.	Post title	Name, sex and nationality of incumbent	Entry on duty (date)		Departure (date)	
			Sched.	Actual (est.)	Sched.	Actual (est.)

Internationally recruited professional project personnel

Post No.	Post title	Name, sex and nationality of incumbent	Entry on duty Sched.	Entry on duty Actual (est.)	Departure Sched.	Departure Actual (est.)
11-01	CTA	Dr. Jagdish Prasad, Male, Indian.	4/88 11/88	12.12.87 1.1.89	7/88 9/90	11.3.88 (31.12.89)
11-50	Consultant-Optics Fabrication.	Mr. Rymill Abell, Male, Australian.	4/89	30.4.89	10/89	29.10.89
11-54	Consultant-Optics Fabrication & Measurement Facilities	Dr. Jagpal Singh, Male, Indian.	11/89	10.12.88	1/89	9.2.89
14-01 (SYR/V/131)	UNV- Optics Fabrication.	Mr. Jing Jiang Xie, Male, Chinese (P.R.)	12/88	11.1.89	9/90	10.1.91
14-04 (SYR/V/137)	UNV- Optics Assembly, Testing, repair.	Mr. Li Jun, Male, Chinese (P.R.)	12/88	11.1.89	9/90	10.10.89
14-05 (SYR/V/134)	UNV- Optical testing.	Mr. Jing Chi Yu, Male, Chinese (P.R.)	12/88	11.1.89	9/90	10.1.91
14-07	UNV- Optical Tooling, Mechanical Fabrication.	Mr. Xuan Ming, Male, Chinese (P.R.)	12/88	11.1.89	9/90	10.1.91
14-02	UNV- Thin Film Coating.	Ms. Shu Mei Yang, Female, Chinese (P.R.)	12/89	20.12.89	12/91	19.12.91
14-06	UNV- Mechnical Design.	Mr. Zhenggui Yao, Male, Chinese (P.R.)	12/89	11.11.89	12/91	10.12.91
11-01	CTA	Dr. Jagdish Prasad, Male, Indian	-	31.8.91	11/91	11.11.91
11-50	Consultant - Optics Design	Dr. Serguei Rodionov, Male, Russian	-	2.10.91	11/91	1.12.91
11-01	CTA	Dr. Jagdish Prasad, Male, Indian	-	15.4.93	-	24.5.93

TABLE 3

Equipment

Equipment item* (Give country of origin, if already known)	Cost		Delivery date		Remarks (include order date)
	Budget	Actual	Sched.	Actual (est.)	
1. Lambda 2 UV/VIS spectrometer with accessories and absolute reflectance attachment, 1 set, FRG.	21,000.	31,493.	10/88	11/88	P.O.No.15-8-80742 dtd 30.6.88.
2. Moller precision spectrometer "spheromatic" serial No.121, #237 303, 1 set, FRG.	4,200.	17,722.	9/88	11/88	P.O.No.15-8-80744 dtd 30.6.88.
3. Accessory for Schaublin 125 lathe: spherical turning attach-ment # 125-53.000, 2 sets, Switzerland.	2,000.	6,253.	8/88	11/88	P.O.No.15-8-80763 dtd 7.7.88.
4. Lens rounding machine type RMD 150, serial No. 88/028310 with set of clamp plates, coolant tank type KT 120F, suction device and diamond tool INO., FRG.	3,000.	41,797	12/88	11/88	P.O.No.15-8-80867 dtd 10.8.88.
5. Smoothing and polishing machine type SPP 200-4-D spindles with double eccenter, serial No.88/028400, complete with accessories, INO., FRG.	14,270.	25,966.	12/88	11/88	P.O.No.15-8-80867 dtd 10.8.88.
6. Double eccenter smoothing and polishing machine, type SPP 300-3, serial No. 88/027930, complete with accessories, INO., FRG.	17,775.	23,528.	12/88	11/88	P.O.No.15-8-80867 dtd 10.8.88.
7. Double eccenter smoothing and polishing machine, type SPP 500-2, serial No. 88/027810, complete with accessories, INO., FRG.	13,100.	22,125.	12/88	11/88	P.O.No.15-8-80867 dtd 10.8.88.
8. Sonorex Super RK 1028 BW ultrasonic cleaner with stainless steel inset basket and lid, 1 set, FRG.	4,500.	3,068.	11/88	1/89	P.O.No.15-8-81094 dtd 7.10.88.
11. Abbe refractometer; lens collim-ator; optical stress analyzer; 1 set each, GDR.	16,000.	12,972.	3/89	5/89	P.O.No.15-8-80758 dtd 6.7.88.
12. Electrical oven, max. temp.150° C, control ± 2°C, 1 set, GDR.	500.	1,600.	3/89	5/89	P.O.No.15-8-80764 dtd 6.7.88.
13. Job trays, 40 PCS, GDR.	-	743.	3/89	5/89	P.O.No.15-8-80761 dtd.6.7.88.
14. Optical blocking, cementing and coating materials, 1 lot, GDR.	7,500.	19,793.	3/89	5/89	P.O.No.15-8-80762 dtd 6.7.88.
17. Optical glasses, types K3, PSK 3, BaF4, BaF5, BaF7, Qty 300 Kg; ophthalmic glass plates K13, 30x30x20mm thick, 30 Nos; float glass plates 30x30x12,19,25mm thick, 50 Nos each . 1 lot. GDR.	25,000.	21,598.	3/89	5/89	P.O.No.15-8-80760 dtd 5.7.88.

Equipment

Equipment item* (Give country of origin, if already known)	Cost Budget	Actual	Delivery date Sched.	Actual (est.)	Remarks (include order date)
18. Optical Glasses, Types BC;DF, EDF, BSC. Qty 550Kg, India.	25,000.	28,360.	3/89	3/89	P.O.NO.15-8-B0752 dtd 7.7.89.
19. Optical glass, Type CB2359, 100Kg, France.	1,000.	1,225.	10/88	10/88	P.O.NO.15-8-B0751 Amendment A,dtd 23.9.88.
20. Optical Glasses, Types BK7, SF5, SF13 and SF 14;QTY 250 Kg, GDR.	6,000.	9,942.	3/89	3/89	P.O.NO.15-8-B0750 dtd 1.7.88.
22. Flat tools; Optical Plat, Cube and Square; 1 lot. India.	5,500.	7,807.	10/88	3/89	P.O.NO.15-8-B07[illegible] dtd 7.7.88.
23. Edwards E610 A Vacuum Coating Plant. Complete with accessories, 1 set, U.K.	75,000.	189,007.	3/89	7/89	P.O.NO.15-8-B0796 dtd 20.7.88.
24. Water Chiller, Flowcool Model IC 50 with water pump, 1 set, UK.	5,000.	8,727	3/89	5/89	P.O.NO.15-9- 0289 Y dtd 8.2.89.
25. Polishing Pads - 7000 PCS, Pad Dispenser- 2PCS, Job Trays- 36 PCS. Denmark.	2,000.	1,400.	4/89	6/89	P.O.NO.15-9-0420 Y dtd 14.3.89.
32. Glass working Machines, all fm FRG. a. Sawing Machine TR4-700M complete with accessories. b. Lens Curve Generator RF-1 complete with accessories. c. Universal Milling Machine UFM with 2 angle milling units. d. Smoothing and Polishing Machine VLP 600 with accessories. e. Double Pedal Machine VLP 1[illegible]0 with accessories. f. Smoothing and Polishing Machine VLP 300 with accessories. g. Universal Centring Machine WC Laser with accessories.	123,665.	213,682.	12/88	5/89	P.O.NO.15-8-B0866 dtd 10.8.88.
33. Smoothing and Polishing Tools, 1 lot,FRG.	5,000.	38,251.	4/89	5/89	P.O.NO.15-9-0280Y dtd [illegible].2.89.
34. Microgrit, 400Kg , USA	7,000.	2,336.	8/88	6/89	P.O.NO.15-8-B0745 dtd 30.6.88.
37. Autocollimator Telescopes LC 160C(2units) Cat. No. 401115010 1 set. Plane Surface Interferometer Cat.NO.191002000, 1 set. Measuring Unit for Focal length and Resolving Power Determination , 1 set.All from FRG.	53,000.	38,190.	9/88	4/89	P.O.NO.15-8-B0790 dtd 14.7.88.

Equipment

	Equipment item* (Give country of origin, if already known)	Cost		Delivery date		Remarks (include order date)
		Budget	Actual	Sched.	Actual (ex.)	
38.	Laminar Flow Work Station, 1 set FRG.	8,000.	10,259.	11/88	2/89	P.O.No.15-8-B100. dtd 19.9.88.
39.	Fibre Optical Demonstration Kit, 1 set, USSR	-	20,923.	1/89	11/89	P.O.No.15-8-B150: dtd 15.12.88.
40.	Dimensional Measuring instruments 1 lot, U.K.	5,000.	9,198.	10/88	3/89	P.O.No.15-8-B074: dtd 30.6.88.
41.	Spareparts for Lambda 2 UV/VIS Spectrophotometer and an Epson PC, 1 lot, FRG.	-	DM 15,899	1/90	8/90	P.O.No.15-9-1634: dtd 9.11.89.
42.	Spareparts for Existing DAMA M/Cs 1 lot, FRG.	-	DM 4996	1/90	2/90	P.O.No.15-9-1689. dtd 13.11.89.
43.	11995 Lens paper 6x8 in book 12BK/PK013, 5 Pks, USA.	-	350	2/90	2/90	P.O.No.15-9-1719. dtd 15.11.90.
44.	11 501 12H Hotplate 12x12 Ceramic TP 240V014., Qty 1. Diamond for writing on glass 016. Qty 10.	-	650	1/90	2/90	P.O.No.15-9-1644. dtd 9.11.90.
45.	Silicon Carbide Abrasive, 160 Kg USA.	-	1,987.00	12/89	2/90	P.O.No.15-9-1718 dtd 15.11.89.
46.	Cut Disk of Duran 50. 1 lot, FRG.	-	DM 5436	2/89	5/90	P.O.No.15-9-1782 dtd 24.11.89.
47.	White Ophthalmic Crown Glass in unworked, unpolished strip form Approx 900mmx900mmx24-26mm thick-ness, 3 Plates. Float Glass in 300mmx300mm Plates thickness 12 mm, 19mm, 25mm, 50 Plates each, U.K.	-	STG 5,975.	1/90	4/90	P.O.No.15-9-1783 dtd 27.11.89.
48.	Microscope Stereomaster II Dual ILL 15xEP014, Qty 1. Step Down Transformer 150 Watt015, Qty 1., USA.	-	8161	6/90	8/90	P.O.No.15-0-0506 dtd 10.4.90.
49.	Iris Diaphragm 1 MM 25 MM 40MMOD Qty. 50, U.K.	-	STG 1055.	6/90	8/90	P.O.No.15-0-0509. dtd 10.4.90.
50.	Optical Glass in Random Slabs, FK5, LAK9, SK4, 20 Kg each., FRG.	-	DM 9137.	6/90	10/90	P.O.No.15-0-0508. dtd 23.4.90.
51.	Spareparts for E 306A Coater, 1,125 Kg, U.K.	-	STG834.30	6/90	10/90	P.O.No.15-0-0511 dtd 24.4.90.
52.	Graticules Asstd Microscope Accessories., 72 g, U.K.	-	STG224.00	5/90	7/90	P.O.No.15-0-0572 dtd 26.4.90.
53.	Angle Block Set 10-5505. 1 set, UK.	-	STG221.00	5/90	8/90	P.O.No.15-0-0505 dtd 10.4.90.
54.	012-980 PRS14E Photo Resist Spinner, 1 set, UK.	-	STG 4335	6/90	12/90	P.O.No.15-0-0507 dtd 10.4.90.
55.	Grinding & Polishing M/C PMI & Accessories. Plastic Chucks, 1 lot, FRG.	-	DM 105,463	7/90		P.O.No.15-0-525Y dtd 19.4.90.

Equipment

Equipment item* (Give country of origin, if already known)	Cost Budget	Cost Actual	Delivery date Sched.	Delivery date Actual (est.)	Remarks (include order date)
56. Coating Materials, 1 lot, FRG	-	DM 10,798.	-	8/91	P.O. No. 15-1-0561Y dtd 12.4.91.
57. Container for Liquid Nitrogen, 2 Nos., France.	-	FFR 11,083	-	8/91	P.O. No. 15-1-0333Y dtd 13.2.91.
58. Bearings, 1 lot, U.K.	-	STG 419	-	4/91	P.O. No. 15-1-0296Y dtd 4.2.91.
59. Optical Filters, 1 lot, U.K.	-	STG 1275	-	5/91	P.O. No. 15-1-0445Y dtd 8.3.91.
60. Boring Tools, 1 lot, FRG.	-	DM 1990.	-	3/91	P.O. No. 15-0-1752Y dtd 20.12.90.
61. Optical Glasses, 1 lot, India.	-	INR 124,360	-	9/91	P.O. No. 15-8-30752 dtd 7.7.88.
62. Optical Equipment, 1 lot, USSR.	-	7,100	-	6/91	P.O. No. 15-1-0884Y dtd 11.7.91.
63. Vacuum Equipment, 1 lot, U.K.	-	STG 835	-	7/90	P.O. No. 15-0-0511Y dtd 24.5.90.
64. Quartz Crystal Controller, 1 lot, U.K.	-	STG 5573	-	12/92	P.O. NO. 15-2_0218Y
65. Six Position Test Glass Changer, 1 lot, U.K.	-	STG 5270	-	1/93	P.O. NO. 15-2-0414Y dtd 16.3.92.
66. Specular Reflectance Accessory, 1 lot, F.R.G.	-	DM 3752	-	1/92	P.O. NO. 15-1-1509Y dtd 6.12.91.
67. Fiber Optic Cable, 1 lot, F.R.G.	-	DM 373	-	5/92	P.O. NO. 15-1-1460Y dtd 29.11.91
68. Spare Parts Temescal STIH-270-1 EB Gun, 1 lot, U.K.	-	STG1136.78	-	1/90	P.O. NO. 15-1-1459Y dtd 29.11.91.
69. Coloured Glass Blocks, 1 lot, F.R.G.	-	DM2871.42	-	1/92	P.O. NO. 15-1-1474Y dtd 3.12.91.
70. Microposit S-1400-27 Etc., 1 lot, U.K.	-	STG1115.79	-	3/92	P.O. NO. 15-1-1512Y dtd 6.12.91.

TABLE 4

Training

Fellowship, training course, study tour or in-service training	Duration (months)	Name and sex of fellow(s). If training undertaken abroad indicate country and institution of study	Started (date) Sched.	Started (date) Actual (est.)	Completed (date) Sched.	Completed (date) Actual (est.)
Fellowship , Mechanical Workshop.	2.5	Mr. Mahmoud AL-HAMAD, Male, Bulgaria, RDIA Scientific Instrumentation, Sofia.	6/88	31.08.88	10/88	17.11.88
Fellowship, Mechanical Design.	2.5	Mr. Domian ABBASI, Male, Bulgaria, Scientific Instrumentation, Sofia	3/89	31.08.88	6/89	17.11.88
Fellowship, Optical Workshop Technology.	6	Mr. Ayman OBEID, Male, GDR/FRG, VEB Carl Zeiss Jena/Wilhelm Loh Wetzlar; Dama Optikmaschinen Darmstadt.	6/88	29.09.88	12/88	01.04.89
Fellowship, Optical Workshop Technology.	6	Mr. Arabi HADDAD, Male, GDR/FRG, VEB Carl Zeiss Jena/Wilhelm Loh Wetzlar; Dama Optikmaschinen , Darmstadt.	6/88	29.09.88	12/88	01.04.89
Fellowship, Optical Workshop technology.	6	Mr. Ziad SAPTEH, Male, GDR/FRG, VEB CarlZeiss Jena/Wilhelm Loh Wetzlar; Dama Optikmaschinen, Darmstadt.	6/88	29.09.88	12/88	01.04.89
Fellowship, Optical Workshop Technology.	6	Mr. Mourhaf Soui, Male, GDR/FRG; VEB Carl Zeiss Jena/Wilhelm Loh Wetzlar; Dama, Darmstadt.	6/88	29.09.88	12/88	01.04.89
Fellowship , Thin Film Technology.	6.3	Mr. Khalid MAYA, Male, GDR/UK, VEB Carl Zeiss Jena/Edwards High Vacuum International.	6/88	29.09.88	12/88	08.04.89
Fellowship, Thin Film Technology.	6.3	Mr. Ahmed AL-HALABI, Male, GDR/UK, VEB Carl Zeiss Jena/Edwards High Vacuum International.	6/88	29.09.88	12/88	08.04.89
Fellowship, Mechanical Design.	4	Mr. Domain ABBASI, Male India, CSIO-Chandigarh.	-	30.07.89	-	02.12.89
Study Tour of two SSRC Senior Managers.	1.7 (for both)	Dr. M.P. MOUSSELLY, National Project Director + Dr. N. BIZRI Senior Scientist SSRC on deputation at Reading University. USSR/	12/88	19.02.89	12/88	15.03.89

Training

Fellowship, training course, study tour or in-service training	Duration (months)	Name and sex of fellow(s). If training undertaken abroad indicate country and institution of study	Started (date) Sched.	Started (date) Actual (est.)	Completed (date) Sched.	Completed (date) Actual (est).
Study Tour	0.6	GDR/Austria/India. Litmo, Leci at Liningrad/ VEB Carl Zeiss Jena/ UNIDO/ IIT & NPL at New Delhi;Osaw/ Labo/PO & IDDC at Ambala Cantt. Dr. M.F. Mousselly, National Project Director. USSR/FRG/ Austria. Litmo/Wilhelm Loh Wetzlar; Spindler Hoyer Gottingen/UNIDO.	-	(05.12.89)	-	(23.12.89)
Fellowship, Optical Workshop Technology.	4.5	Ahmad Abdulah, Male, Litmo.				
Fellowship, Optical Workshop Technology.	4.5	Eanadi Shams Al-Deen, Female, Litmo.	-	(6.3.90)	-	(21.7.90)
Fellowship, Optical Testing & Assembly.	4.5	Nada Rajab, Female, Litmo.	-	(6.3.90)	-	(21.7.90)
Fellowship, Optical Testing & Assembly.	4.5	Nazir Krenbeh, Male, Litmo.	-	(6.3.90)	-	(21.7.90)
Fellowship, Optical Design.	4.5	[illegible] Shalesh, Male, Litmo.	-	(6.3.90)	-	(21.7.90)
Fellowship, Mechanical Production.	3	Domain Abbasi, Male, Litmo.	-	(13.12.90)	-	(22.1.91)
Fellowship, Graticulation techniques.	3	M.K. Abo-Al Dhahab, Male, CSIO.	-	(29.7.90)	-	(29.10.90)
Fellowship, Micro lens Fabrication Technology	1	Ayman Obeid, Male, LITMO.	-	(28.5.91)	-	(29[illegible])
Fellowship, Opto-Mechanical Workshop Technology.	2	Khaled Al-Ayoubi Male, CSIO.	-	(1.3.93)	-	(30.4.93)
Fellowship, Opto-Mechanical workshop Technology.	2	Nazir Reslan, Male CSIO.	-	(1.3.93)	-	(30.4.93)
Fellowship, Thin Film Technology.	2	Mona Sara, Female,	-	(1.3.93)	-	(30.4.93)

TABLE 5: Basic technical Parameters of LABPLAN and BIOMEM

Attribute	LABPLAN	BIOMEM
Magnification range	40-1000	40-400
Mechanical tube length, mm	160	160
Parfocal distance, mm	45	45
Location of image plane from tube end,mm	13	13
Set of objectives	4x0.&,10x0.25,40x0.25 100x1.25 (oil immersion)	4x0.1,10x0.25,40x0.0.65
Objective image field size, mm	18	18
Eyepiece	10X	10X
Condenser swing-out type with iris		
aperture diaphragm	yes	yes
Condenser NA for 4x0.1,10x0.25	0.3	0.3
Condenser NA for 40x0.65, 100x1.25	0.9	0.9
Coarse focusing adjustment	yes	yes
Total movement range, mm	20	20
Movement range for one rotation, mm	6.0	6.0
Fine focusing adjustment	yes	no
Focal movement range, mm xx	2.5	-
Graduated increments, mm	0.002	-
Monocular eyepiece tube inclination	30 degrees	30 degrees
Mechanical stage	Cross slide motion of 25*75mm with right hand controls; vernier reading to 0.1mm provided.	Square plane stage with spring clamps
Rotation angle of stage	30 degrees	-
Illumination system	In-base illuminator, 6V,20W halogen lamp, built-in transformer collector lens (4 elements), auxiliary lens, reflecting mirror, iris field diaphragm.	Plane concave mirror, natural light
Revolving nosepiece	Quadruple revolving mechanism with roller bearings.	
Overall dimensions, mm	390*400*220	356*240*200
xx Movement range for one rotation, mm	0.25	-

TABLE 6: Topics of Lectures

I. FUNDAMENTAL OPTICS

Fermat's principle; reflection law; refraction law; refractive index and Abbe value (Dispersion).

II. GEOMETRICAL OPTICS

Single refraction surface; thin lens; two thin lens system ;
Aperture diaphragm; field stop (entrance and exit pupil, entrance and exit window).

III. TYPICAL OPTICAL SYSTEMS

Human eye; magnifying lens; microscope; telescope.

IV. OPTICAL TOOLS FOR TESTING

Collimator (Autocollimator); measuring microscop; prism.

V. OPTICAL TESTING

Dimensional parameters (central and edge thickness, chamfer length, diameter); homogenity (stress, strain, Birefringence, bubbles, straie); refractive index; dispersion; Abbe value; focal length (front, back, equivalent); radii of curvature; magnification; numerical aperture; surface contour; cardinal points (principal, focal and nodal points); field size; depth of focus; centring error; prism angles.

VI. QUALITY ASSESSMENT

Spherical aberration; chromatic aberration; coma; astigmatism; distortion; resolving power; star test; knife-edge test.

VII. OPTICAL WORKSHOP TECHNOLOGY

Background information

Optical workshop layout; optical materials (sheet glass, float glass, ophthalmic glass, filter glass, optical glass and optical crystals); properties and varieties of optical glasses; shop testing of optical glasses.

Auxiliary materials for precision optics fabrication

Optical tools and fixtures (specifications, usage; maintenance and storage); cutting materials (abrasives, diamond tools, polishing powders and pastes); blocking, cementing and cleaning materials (pitch, plaster of pairs, adhesives polishing pads).

Technical requirements of optical components

Classification of optical components and their graphical representation; fabrication errors (surface contour, angular, surface defect and roughness, centring, and cementing errors); understanding of optical design data sheets.

Optics fabrication

Detailed study of all available machines and attachments; plane blank production (slitting, plane surfacing, blocking and cleaning); circular blank production (rounding, curve generating and bevelling); prism and flat production (blocking, smoothing, polishing and deblocking); lens production (blocking, smoothing, polishing ;-deblocking, centring and edging); cementing.

VIII. OPTO-MECHANICAL WORKSHOPS

Background information

Workshop organization ; common raw materials; common cutting tools; materials for optical tools; detailed study of all available workshops machines and attachments.

Mechanical drawings

Introductory remarks regarding mechanical engineering drawings; what is mechanical engineering drawing?; reading of mechanical engineering drawings; exercises on simple mechanical drawings.

Tolerance concept

General ideas; how to specify tolerances?; surface finish specification; tolerance calculation.

Calculation methods

Common calculation methods;special patterns calculation; spatial co-ordinates.

Dimensional metrology

General ideas; measurement instruments; introduce typical measurements; (longitudinal, outside/inside, cylindrical, grooves measurements); threads measurements; measurements and calculations (axial distance between two hole's centers,spherical workpieces concave/convex; angular measurement).

Mechanical fabrication:

Introduction of basic technology processes; how to make workpieces?; production examples; how to make special workpieces?

IX. CLEANING AND CARE OF OPTICAL COMPONENTS

Common cleaning agents and tools; precautions in handling of optical components; how to clean optical components? (manual, ultrasonic cleaning, drying); tests of cleanliness; packing and storage of optical components.

X. ASSEMBLY OF OPTICAL COMPONENTS

Dimensional checking of optical and mechanical parts; cleaning and drying of optical and mechanical parts; assembly of singlets (magnifier); assembly of doublets (cemented, airspaced); assembly of triplets lens combination (enlarger); assembly of prism; assembly of graticule.

XI. ALIGNMENT AND CHECKING

Condenser lens; Huygen's eyepiece (10,15X); Ramsden eyepiece (10X); Kellner's eyepiece; micro-objectives (10,40 and 100X)

XII. SYSTEM ASSEMBLY

Viewing magnifiers; student microscope.