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United Nations Industrial Development Organization
Department of Industrial Operations
Industrial Operations Technology Division

ENGINEERING INDUSTRIES

**The technical assistance programmes
in the sector of Engineering Industries**

MARCH 1992

G. H. 1992

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Challenges and Opportunities
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Chemical Industries
Metallurgical Industries

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Introduction

The paper highlights the potential contribution of the Engineering Industries Branch to the development of engineering sector and strengthening of engineering capabilities in national development plans and country programmes of the developing countries. In addition the main technical co-operation programmes of the Branch are also summarized.

The Engineering Industries Branch is involved in all phases of technical co-operation projects, i.e.:

- Project identification
- Techno-economic cost-benefit analysis
- Project design
- Project document formulation
- Project execution.

The sub-sectors of the Engineering Industries Branch cover a wide spectrum of activities with different aims. To achieve these aims, projects involve one or more of the following activities:

- Institution building (e.g. technical research and development, training centres and institutes, etc.)
- Strengthening of existing capacities
- Creating pilot plants
- Convening workshops and expert group meetings
- Providing direct technical support to solve immediate problem.

Depending upon the complexity of the technical co-operation projects costs may vary from US\$ 10,000, or less, to several million dollars.

Parameters of engineering industries

(i) The development and strengthening of national engineering capabilities is an area of priority in any national development plan as modern engineering should be the basis for any industrial and economic development, not just for engineering industries but for all industries including sub-sector product maintenance/service. The machinery and equipment, parts and services constitute a major components of all industries and their capacity utilization is an important aspect for industrial development.

(ii) Engineering industries activities range from the supply of equipment to technologically advanced engineering production in small- and medium-scale industries. The following sub-sectors of engineering industries are considered:

- Agricultural machinery and rural equipment
- Electronic equipment and computer applications
- Energy systems engineering and applications

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Machine tools and metalworking
Transport equipment
Packaging technology, and
Industrial installations

(iii) Human resource development, from an engineering point of view, covers artisan and small- to large-scale industries. It encompasses areas of product development, design, production and maintenance and includes technical and training aspects varying from simple fabrication and batch-level production to series manufacture. Engineering industries play an important role in equipment development and production for various economic sub-sectors. The equipment inputs for agricultural development, industrial processing of agricultural outputs, machine tools, transport and communications, conventional and alternative sources of energy, high technology in various fields in hardware and software are just some of the examples.

(iv) The following areas are included with special reference to facilitate technical skills in terms of human resource development:

Engineering design and development;
Production technology;
Capacity utilization;
Material and tool engineering;
High technology, and
Repair and maintenance.

The overall directions and strategies

(i) The programmes of the Engineering Industries Branch are solution-oriented. They have established priority areas and elements of industrial development for the attention of developing countries. The Branch is interested in industrial projects, manufacturing activities and new innovative approaches to technical co-operation problems, and in facilitating technical co-operation among developing countries (TCDC). Application of engineering techniques to rural industrialization, integration of electro-mechanical and electronic aspects to sub-sectoral development, equipment development in the energy sector, advancement of manufacturing value added through process technology and packaging techniques and the introduction and application of advanced technologies are areas of major thrust.

(ii) Activities emphasize the practical aspects of engineering techniques. In addition, a foundation is laid to promote future technical co-operation activities within the framework of country priorities, especially taking into account the UNDP philosophy on "new directions". The changing pattern of industrial development through encouragement of private industry and restructuring of public sector industries promoted by the governments gives an opportunity to the Branch to play an important role in development endeavours.

(iii) Activities aim to harmonize national capabilities in development planning and strategies. Through the application of engineering techniques activities significant elements such as national/sub-regional and

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interregional themes of poverty alleviation and rural economic development are considered; so are capacity building in structural reform and economic recovery; public and parastatal sectors reform; promotion of conditions for a dynamic private sector; technology for development; preservation of the environment and natural resources; technical co-operation among developing countries, (TCDC); integration of women in industrial development and participation in sub-regional complementarity of engineering capabilities with national institutional mechanism. The existing and future industries through the provision of technical and engineering services would thus be assisted with a degree of commercial orientation.

(iv) Main areas of technical co-operation are the application of appropriate techniques to rural industrialization; integration of electro-mechanical and electronic aspects in sub-sectoral development; metalworking and machine tools; development of equipment in the energy sector; advancement of value added manufacturing through process technology and packaging techniques; repair and maintenance; and the introduction and application of advanced technologies. Lately, activities have focused on rural development through agricultural mechanization, technological structures for the metalworking sector, equipment for the energy sector, spare parts, manufacture, and rehabilitation and maintenance of existing equipment. Activities also cover computer and computer-related equipment, measuring and control equipment, and energy-related equipment.

(v) Overall priorities of the UNIDO and the Branch's programme are the development and transfer of technology, promotion of small and medium-scale industries, human resource development and training, promotion of a safe and healthy environment, encouragement of cooperation among developing countries, promotion of integration of women in industrial activities, and promotion and consideration of energy aspects. In this context the Branch promotes measures intended to strengthen common engineering and technical institutional infrastructures. These include engineering design and development, production technology and process engineering, tool engineering and services as well as material banks, repair and maintenance, spare parts production, technical management including quality control, and training. There exist also programmes to promote the insitutional infrastructure. The following are some examples: pilot demonstration and training plants, batch level production techniques, common engineering services (units/centres); specialized technical centres and institutes, rehabilitation centres, repair and maintenance workshops and specialized institutes. From a technical point of view the areas focused upon are: rural development through the incorporation of agricultural implements and equipment in the metal sector, application of electronic high technology to industry; computer-aided manufacture in the machine tool sector, spare parts manufacture for the transport industries, and equipment development for the energy sector.

(vi) During the 1990s the Engineering Industries Branch will continue to co-operate with various organization in the United Nationa system in the implementation of activities: to introduce more advanced manufacturing technology into industrial production in developing countries. This will be through joint technical working groups with the Food and Agriculture Organization of the United Nations, the International Labour Organization, the International Maritime Organization, the United Nations Educational, Scientific and Cultural Organization and some of the Economic Commissions.

Activities in the sub-sectors

(i) *With respect to economy and rural development*, due attention is paid to the programmes of governments in their efforts to develop the rural sector and work-generating activities. Focus is put on opportunities for the employment of women. Agricultural development and industrial processing of agricultural outputs together with manufacturing of agricultural tools and implements is encouraged. This includes manually and animal drawn equipment, storage and post-harvest technology, intermediate power equipment, rural transport equipment, water pumps, wind mill pumping systems. Aspects of manufacture, repair and maintenance and marketing are also covered. The major objectives are to enhance the quality of life in the rural sector, contribute to improved agriculture, maintain equipment service systems and to provide suitable tools and implements which are within the purchasing capacity of small and medium farms.

(ii) *In the field of metalworking industries*, the activities cover both plant and institutional aspects with emphasis on capacity building and human resource development. Emphasis is placed on improvement of installed industrial capacity through product mix, improvement of quality, reduction of cost through introduction of numerically controlled machine tools and improved manufacture. This includes the introduction of high quality tools, and preventive maintenance and repair of machinery and equipment. The scope and application of metalworking and machine tools sub-sector with varied degrees of technology is one of the major fields of technical co-operation activities. It covers product, plant and technical institutional levels. Emphasis is placed on improvement in utilization of installed industrial capacity through diversification of product mix, improvement of product quality, and reduction of product cost through progressive introduction of numerically controlled machine tools and improved manufacture, including introduction of high quality tools. The introduction of computer controlled scheduling for maintenance and inventory control systems for spare parts play a role. Reconditioning of worn parts and components through metalspraying technologies receive considerable attention.

(iii) *High technology* cover development, controls, precision technology, environmental control, quality and emphasizes retraining of personnel through the application of computer aided design/computer aided manufacture and computer control techniques. Human and institutional development is an important element to promote development for capacity building, structural reform and economic recovery programmes. Efforts also respond to increasing awareness of environmental problems through the preparation of pollution control guidebooks; application of noise control techniques; remote sensing and/or telemetering of environmental parameters; design, development and manufacturing of low-cost analytical instruments for pollution monitoring.

(iv) *In the area of energy*, activities give emphasis to the harmonization of energy production with environmental protection policies. This includes process planning, modification on equipment, installation and service of installations, repair and maintenance, control and measuring

instrumentation, training programmes and dissemination of technical information. Transfer of technology for the local production of wind turbines for electricity generation, production line for the manufacture of solar water heaters, construction of cold storage plants, and design of mini-hydro power plants are examples. Therefore, one of the areas which provides opportunities to promote practical and innovative concepts and actions is the field of energy. It constitutes equipment for existing non-renewable energy sources, such as oil, hydro and coal as well as renewable sources, such as solar, wind and bio-mass. It also covers instrumentation for control, conservation and environmental engineering. Examples are wind turbine manufacture of solar water heaters, training in techniques of improved quality and reliability of electrical components, laboratory for calorimetric and performance testing of air-conditioners, etc.

(v) The importance of *packaging technology* to assure quality, marketability, shelf-life and to increase value is recognized by the developing countries and the Engineering Industries Branch. Agro industries, precision engineering, component and ancillary industry as well as consumer and domestic products require high standards. Assistance is given to packaging manufacturers and users based on international tendencies and regulations.

(vi) *Repair and maintenance, spare parts production and services* are incorporated together with training of local personnel and is an element in all projects. These two factors have contributed to fuller utilization of installed capacity and introduction of quality and reliability in industrial activities.

Conclusions

After studying this paper, one may wish to develop the engineering programme concepts and project ideas with the aim of transforming overall industrial development scenario into practical reality and operation. Dissemination of technical information, technical staff missions and discussions may pave the way for further actions needed to define the modalities of the start-up and financial sources.



M. Delos
Head of Branch

METALWORKING AND MACHINE TOOLS UNIT

Mr.H.Fritz	Unit Chief	Design, development and production of metal products machine tools and tools. Repair and maintenance of industrial equipment, general engineering. Metalworking and machine tools, co-ordination of Trust Fund projects.
Mr. G. Kopolo	Industrial Development Officer	
Mr. A. Malayeri	Industrial Development Officer	

ENERGY, ENVIRONMENT AND TRANSPORTATION ENGINEERING UNIT

Mr.H.H. Seidel	Unit Chief	Design, development and manufacture of machinery and equipment.
Mr. R. Kaulfersch	Industrial Development Officer	Design, development and manufacture of energy generation equipment.
under recruitment	Industrial Development Officer	Design, development and manufacture of transport equipment.
under recruitment	Industrial Development Officer	Environment equipment and systems

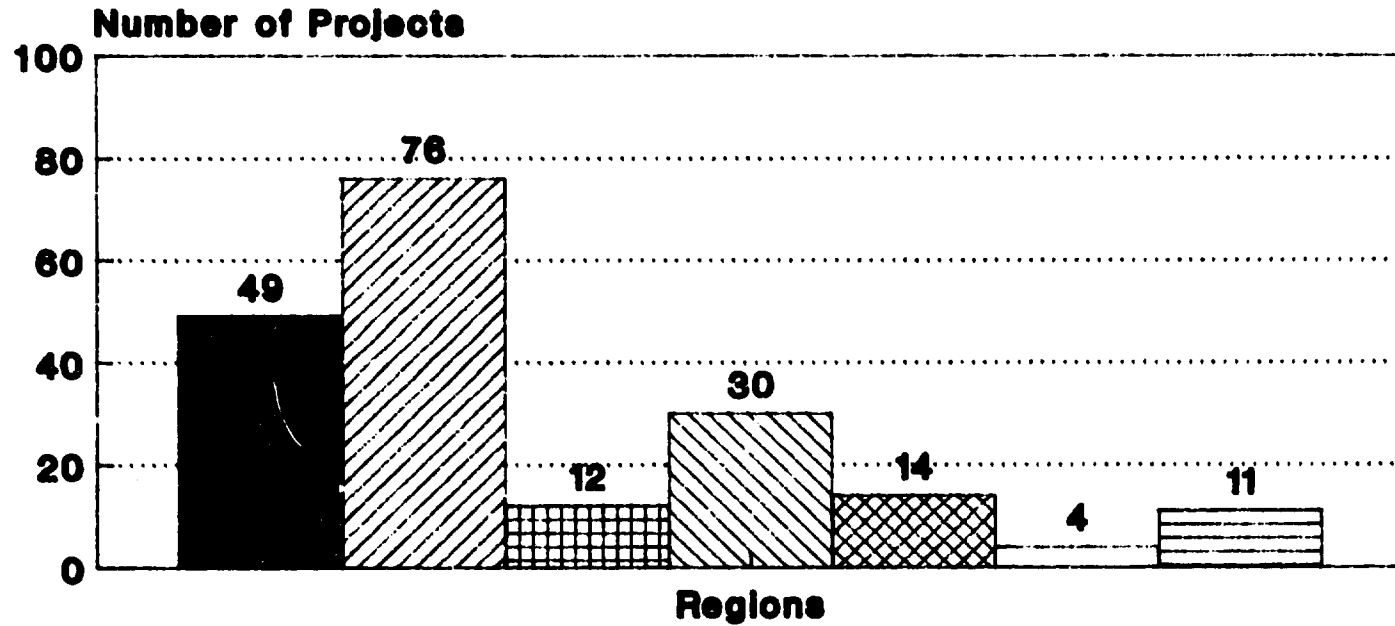
ELECTRONICS AND COMPUTER APPLICATION UNIT

Mr. C. Guerkoek	Unit Chief	Electronics and computer application.
Mr. V. Shatravko	Industrial Development Officer	Electronic equipment, microelectronics, industrial automation.
Mr. E. Kok	Assoc. Ind. Development Officer	Computer-aided techniques and technologies.
Ms. N. Louvat	Assoc. Ind. Development Officer	Computer application to repair and maintenance

AGRICULTURAL- AND PACKAGING MACHINERY UNIT

Mr.Y. Gladilov	Unit Chief	Design, development and manufacture of agricultural machinery/implements.
Mr. J. Belo	Industrial Development Officer	Design and development of packaging machinery and systems.

Number of projects within ENG 1991



■ Africa ▨ Asia & Pacific ▩ Latin America ▧ Europe & Med.
▤ African Arab □ W.Asia Arab ▯ Global/Interregional

By Region

AGRICULTURAL MACHINERY

The technical assistance programme focuses on channelling advanced technologies to specific areas of need in order to achieve greater efficiency and increased production of a greater variety of equipment in different geographical areas. A clear integration of machinery with the environment is advocated, thereby reducing the excessive demands of some technologies. It is also essential to establish the extent of mechanization best suited to a country's ability to absorb new applications.

PROJECTS AIM AT:

- Product design, prototyping, reverse engineering
- Pilot production
- Production rationalization and automation
- Repair and maintenance of products and plants
- Environmental monitoring and control

IN THE AREAS OF

- Agricultural machinery and equipment
- Agricultural implements
- Process control and automation equipment and systems
- Mechanical components

USING THE FOLLOWING TECHNOLOGIES:

- ◆ Conventional techniques and/or technologies
- ◆ Computer-numerical controlled machining
- ◆ Computer-aided design and manufacturing
- ◆ Computer-integrated manufacturing
- ◆ Flexible manufacturing systems
- ◆ Artificial intelligence/expert systems

**PROJECT
AREAS**

Examples of the areas covered by the programme's projects are:

o **Agricultural machinery and equipment**

Tractors, trailers, loaders, diesels, hydraulic equipment for tractors and farm machinery

Tillage machinery

Machines for cultivation, harvesting and post-harvesting treatment of basic agricultural crops

Machines and equipment for protected ground

Equipment for small farms

Irrigation equipment

Machines and equipment for production and preparation of feeds

o **Agricultural implements**

Animal-drawn tools

Low-cost agricultural implements

Ploughs

Manual weeders

Rice transplanters

Manually operated pumps

And others

o **Process control and automation equipment and systems**

Automatic control apparatus

Measuring instruments and testing

Equipment for promotion control of agricultural machinery

o **Mechanical components**

Equipment for repairs and maintenance of tractors and agricultural machines

Equipment for reconditioning of worn parts

**TECHNOLOGY
SELECTION**

Production technology depends on the scale of the production programme. In designing, formulating and executing these projects, suitable technologies are selected from a wide range of available options. These include conventional and appropriate technologies on the one hand, and more modern ones such as computer-numerically controlled (CNC) machining, computer-aided design and a manufacturing (CAD/CAM), etc. on the other. Flexible manufacturing systems (FMS) and artificial intelligence and expert systems (AI/ES) are also utilized when the infrastructure and the environment of a specific project permit.

**PROJECT
EXAMPLES**

Some of the projects within the programme are grouped below according to their aims or outputs.

Product design, prototyping, and engineering

The economies of most developing countries are based on agriculture. On an average, more than 50 per cent of the population earn their livelihood directly or indirectly from agriculture and availability of agricultural tools as well. The Governments of developing countries pay particular attention to improving the situation regarding the production of agricultural tools, implements and equipment; industrialization through local fabrication of tools, manually operated equipment, animal-drawn implements and simple power-operated machines; and establishment of a sound relationship between agriculture and industry.

Engineering Development and Service Centre

Problem: The lack of industrial infrastructure to carry out basic design and engineering activities in agricultural machinery and implements is a serious problem for many developing countries.

Project: Establishment of engineering development centres for training national specialists in design and manufacture of agricultural machinery, tools and equipment covering all phases of work from ideas to final products.

Demonstration and training plant for rural artisans and small-scale self-employed workers/groups

Problem: In a large number of developing countries there are many artisans in rural areas who use oil drums (sheet metal) as the primary raw material to make stoves, pots, pans, trunks/suitcases, water troughs, etc. In most cases the level of production techniques is very low and does not meet standards.

Project: Establishment of a demonstration manufacturing and training plant with manually-operated machine tools and simple production equipment and accessories in order to train rural artisans and self-employed workers on design and manufacture of simple rural equipment, rural utensils, maintenance and repair; in providing specialized knowledge on material selection, simple technical calculations, marketing, etc. Such plants could be transformed into commercially-oriented unit, when necessary..

PILOT PRODUCTION

Problem: In many developing countries especially in Africa and Asia, production capabilities of agricultural tools are not adequate. The present level of production of such equipment is not sufficient. Therefore the main emphasis should be focused on how to produce this equipment utilizing the existing possibilities and creation of new production facilities.

Project: Establishment of new or reconstruction of existing production facilities and

technological skills to be developed progressively; upgrading the agricultural machinery sector and according to it the priority it deserves; upgrading the production capabilities of existing production at the enterprise level through modest expansion, diversification into a high category of product involving related basic technologies and new development. Existing facilities and skills and further developing them with additional inputs in terms of product know-how, equipment and manpower with investments can result in quicker outputs. Of course, all projects must consider the environmental problems at the level of production.

▣ Maintenance and repair and spare parts production

Problem: Maintenance and repair and spare parts production for agricultural equipment was and still is an acute problem for many developing countries. The absence of adequate spare part manufacturing facilities necessitates imports resulting in extended delivery dates and long down time because of delays in delivery of spare parts from abroad.

Project: Establishment of a workshop on maintenance and repair and spare parts production with the necessary machine tools and other equipment in order to provide systematic preventive maintenance and also repair of agricultural tools so as to avoid any product losses during cultivation and harvesting seasons. Such a project could be supplied by a mobile maintenance and repair unit for servicing agricultural machinery on the spot.

▣ Solution of the specific technical problems

Upon request UNIDO can provide consultancy assistance in solving different technical problems regarding designing, manufacturing, training, organization of production, maintenance and repair of agricultural machinery and equipment, etc.

ELECTRONIC EQUIPMENT AND COMPUTER APPLICATIONS

The technical assistance programme focuses on channelling advanced technologies to specific areas of need in order to achieve self-reliance and independence. Electronic equipment and computer applications should be developed by each country that desires to advance its industrial development at a higher rate, to improve the local base and increase the quality of products intended for export. Their development require relatively a modest financial base while a great portion of the intellectual input can be mobilized locally.

PROJECTS AIM AT:

- Product design, prototyping, reverse engineering
- Pilot production
- Production rationalization and automation
- Repair and maintenance of products and plants
- Environmental monitoring and control

IN THE AREAS OF:

- Electronic components and equipment
- Medical equipment
- Environmental monitoring and control equipment
- Telecommunications equipment
- Industrial process control and automation systems
- Precision mechanical components

USING THE FOLLOWING TECHNOLOGIES:

- Conventional techniques and/or technologies
- Computer-numerical controlled machining
- Computer-aided design and manufacturing
- Computer integrated manufacturing
- Flexible manufacturing systems
- Artificial intelligence/expert systems

**PROJECT
AREAS**

Examples of the areas covered by the programmes's projects are:

O Electronic components and equipment

- * Active microelectronic circuit components (semiconductor devices such as integrated circuits, transistors, diodes, etc.)
- * Passive components (resistors, capacitors, etc.)
- * Microprocessor-based equipment and systems
- * Low-cost electronic equipment, including microcomputers
- * Opto-electronic components and equipment (fibre-optic cables, lasers, terminal equipment, etc.)

O Medical equipment

- * Biomedical and hospital equipment
- * X-ray equipment particularly the basic radiological system (a joint effort with WHO)
- * Orthopaedic prostheses and invalid chairs

O Environmental monitoring and control equipment

- * Electronic test and measurement equipment
- * Controllers
- * Data logging, transmission and analysis equipment

O Telecommunications equipment

- * Rural telecommunication equipment
- * Environmental testing and tropicalization of telecommunications equipment
- * Telecommunication equipment and spare parts for subscriber use (telephone sets, party line equipment, private branch exchanges)
- * Low-cost micro-earth stations for satellite communications

O Industrial process control and automation equipment and systems

- * Design and development of computer - and microprocessor-based industrial automation
- * Low-cost appropriate automation
- * Industrial robotics
- * Artificial intelligence and expert systems applied to machine diagnosis and process control
- * Image processing for industrial automation

O Precision mechanical components

- * Dies and moulds for precision plastic and metal parts
- * Reverse engineering of dies and moulds

**TECHNOLOGY
SELECTION**

In designing, formulating and executing these projects, suitable technologies are selected from a wide range of available options. These include conventional and appropriate technologies on the one hand, and

more modern ones such as computer-numerically controlled (CNC) machining, computer-aided design and manufacturing (CAD/CAM) etc. on the other. High technologies such as computer-integrated manufacturing (CIM), flexible manufacturing systems (FMS) and artificial intelligence and expert systems (AI/ES) are also utilized when the infrastructure and the environment of a specific project permit.

PROJECT EXAMPLES

Some of the projects within the programme are grouped below according to their aims or outputs.

Product design, prototyping and reverse engineering

A key feature of product development projects is integration of the market requirements such as use, functionality and safety of the products with the possibilities and limitations of production. Development of product design capabilities leads to quicker response to changing market demands, and improves product functionality, better prototyping facilitates efficient production and adds to the quality of the final product.

Computer-aided design (CAD) centre

Problem: The lack of efficient industrial design capability prevents a higher rate of productivity in many developing countries. Although CAD is not a substitute for an experienced designer, it can improve quality

and productivity in the design process. Furthermore, a large amount of standard design know-how can be provided to the designer by the CAD system.

Project: Creation of a CAD centre for demonstration purposes, training (both at the centre and in the industry using mobile training units) and as a service centre. The project can be implemented in a series of modules, the smallest being a single-microcomputer CAD set up to be used as a demonstration unit to increase CAD awareness in domestic industry. At the other extreme, large systems compose of multi-workstation local-area networks served by minicomputers. Each module is self-contained and can be designed, executed and upgraded as required.

Electronic packaging and ergonomic design

Problem: The local electronic equipment manufacturers are unable to compete in export and import substitution markets due to the low quality of electronic products, caused mainly by poor packaging (casing) and related thermal, electromagnetic and other problems.

Project: Establishment of a centre for Electronic Packaging Technology and Ergonomic Design. The centre acts as a focal point in the country and co-operates with research laboratories, electronic equipment and system manufacturers, end-users and educational institutions. UNIDO provides expert services and equipment, trains its staff both abroad and on-the-job.

Environmental testing and tropicalization of telecommunication equipment

Problem: Climatic conditions prevailing in the countries of the tropical belt pose stringent operating requirements for telecommunication equipment. If such equipment is not tropicalized, then lower reliability, longer down times and a shorter life span could result.

Project: Establishment of a Regional Environmental Testing and Tropicalization Centre (ETTC) for telecommunication equipment to help minimize losses due to lack or inadequate tropicalization in testing the performance of equipment under simulated environmental conditions and developing and applying appropriate tropicalization techniques and materials. The Centre complete with buildings, facilities, laboratories, workshops, equipment, technical library and database, trained personnel and the management system is capable of: (i) carrying out environmental tests to verify if the telecommunication equipment is tropicproof; (ii) developing and/or applying tropicalization techniques and materials to the already installed equipment and locally designed and/or manufactured equipment; and (iii) providing advisory services on the subjects within its area of competence.

Mould and die design and manufacturing

Problem: Local manufacturers of metal and plastics products are unable to manufacture products of sufficient quality, mainly because of the low quality of the mould and dies used.

Project: Technology transfer in the area of design, development and prototyping of dies and moulds for metal and plastics products. Creation of a facility as the focal point of modern die and mould engineering in the country will enable: (i) design (using CAD), development and prototyping (using CAM) of dies for production of metal products and moulds for plastic products; (ii) provision of services to co-operating institutions and clients, such as testing and checking their dies and moulds in design stage, precision machining (including computer numerically-controlled (CNC) machining) of die and mould components, and training of their staff in design, development and manufacturing techniques and technologies of dies and moulds.

Very large scale integrated circuit (VLSI) design

Problem: Local development and production of electronic equipment needs to be promoted through a national capacity to design, prototype and manufacture of application-specific VLSI circuits (ASICs). Such capability may also create export possibilities.

Project: Establishment of a centre for the design and prototyping of very large scale integrated (VLSI) circuits. This Centre is expected to act as a focal point for the VLSI design and to co-operate with research laboratories, microelectronic component manufacturers and educational establishments. UNIDO will assist in the creation of the Centre through provision of high-level expert services, training of staff, and installing and operating of a computer system, peripheral equipment and related computer-aided engineering (CAE)

software tools.

Reverse engineering

Reverse engineering refers to the combination of activities to analyze and document the design of an existing product. It covers a number of techniques and technologies which can be transferred or developed in a series of interconnected modules.

Problem: The lack of product design technologies is one of the major impediments to increasing the output of manufacturing industries in developing countries.

Project: Overcoming design and manufacturing limitations by means of a reverse engineering technology package containing: (i) scanning hardware and software; (ii) software tools for the conversion of scanned data; (iii) hardware and software for CAD and other analyses; and (iv) CAM of product or mould or die.

Low cost instrumentation

Problem: The trend in instrument design is towards more expensive and complex equipment, which is mostly beyond the reach of developing countries. Such complex equipment is fully adapted to local manufacturing and operating conditions.

Project: Technology transfer in the field of design, development and pilot manufacture of low-cost electronic instruments such as temperature and humidity instruments for agriculture, weighing and analytical instruments for health services, and basic electronic test and measuring instruments for technician training. The transfer is made possible through strengthening or

creation of an institute.

Pilot production

Pilot production plants are established to test the suitability of manufacturing processes and technologies to conditions of a developing country. This group of projects generally include a technology transfer package covering several aspects of the production such as product design, process know-how and quality control procedures as well as all necessary plant machinery and equipment.

Production rationalization and automation

Industrial automation is the key to efficient use of existing production capacities. Automation is a key element in new investments. Gains to be achieved through industrial automation include reduced product costs and shorter delivery dates.

Industrial automation and robotics

Problem: Engineering industries in developing countries lack competitiveness in import substitution and export markets, owing to inefficient production capacity utilization, as well as low product quality and limited product features.

Project: An institution building project and aims at the establishment of a centre for industrial automation technology and robotics. The centre is expected to provide services to the small and medium scale engineering industry to improve its product

quality, cost effectiveness, product features and shorten reaction time in adopting new products. Its services include: (i) product and tool design; (ii) robot applications; (iii) consultancy on advanced production techniques; (iv) human resources development, and (v) infrastructure building for CIM development.

Development of computer numerical control (CNC) unit for machine tools

Problem: A rapid growth of utilization of CNC machine tools in developing countries is expected. In countries with a sufficiently large domestic market and an already established machine tools industry, imports of CNC units would require large foreign currency allocations and dependency on expertise abroad for maintenance and repair.

Project: Creation of a centre with CNC system development capabilities in the form of human resources and physical facilities. The project also encompasses transfer, assimilation and development of technologies for design, development and prototyping of CNC systems.

Pilot flexible manufacturing system (FMS) for tractor production

Problem: Although mechanization of agriculture has top priority in many developing countries, proliferation of tractors is restricted by the relatively high costs and shortage of appropriate types for different crops and soil.

Project: Introduction of a pilot flexible manufacturing system (FMS) and an expert fault diagnosis system at a tractor manufacturing plant, in order to analyze and

determine the parameters that lead to successful implementation of FMS in different factories. The ultimate goal is to support production of different types of tractors for diverse types of soil, and at the same time reduce production costs and make tractors available to a larger group of farmers, thus improving the agricultural output.

Low-cost automation for small- and medium-scale industry (SMI)

Problem: Small- and medium-scale industries (SMI) suffer from high production cost and varying (or low) quality of products. Although automation is an appropriate route to remedy these shortcomings, the cost is often beyond the means of SMI.

Project: Strengthening or creating an institute to develop low-cost automation packages such as loading and unloading systems for lathes, presses and grinders; special-purpose machinery; and assembly-line machinery. The institute is also expected to provide extension services and training to SMI, as well as to assist them in modernizing their organizational and operational structure through automation.

Failure analysis laboratory for microelectronic components

Problem: Electronic equipment producers as well as microelectronic component manufacturers from developing countries suffer from reliability problems due to low production yields and/or later failure of components, sub-assemblies and assemblies.

Project: Establishment of a centre for failure analysis of

microelectronic components. The facility is expected to provide testing services (including the analysis of test results) in particular to small and medium-scale manufacturers who cannot afford a similar service within their plants. The centre acts as a focal point for the failure analysis studies and co-operates with component manufacturers, equipment designers and producers, and research laboratories. UNIDO provides expert services, technical staff training, and all necessary equipment.

□ Repair and maintenance of products and plants

Computer-based electronic integrated information system for plant operation and maintenance.

Problem: Large process-based industries such as iron and steel, cement, sugar, fertilizers etc. suffer from lack of information needed to maintain high-level plant performance including repair and maintenance of production apparatus.

Project: Improvement of industrial productivity in the cement sector through utilization of an electronic integrated information system. The system will optimize the transfer of know-how and information at the man-machine interface: appropriate interventions will secure plant efficiency in increasing the availability of plant and machinery.

Instrumentation Services Centre (ISC)

Problem: Development of instrumentation techniques in a

country, one of the main pillars of the overall technical and technological development, depends on efficient use of national instrumentation resources. A frequent problem is the absence of adequate repair and maintenance services, with the result that many instruments are out of order.

Project: Creation of an instrumentation services centre (ISC) with a modular structure that permits the establishment of some or all of the following modules at a time: (i) national register of instruments; (ii) maintenance and repair services, including after sales services; (iii) instrument rental service; (iv) consultancy services (v) measurement techniques service-designing specific measurement set-ups and making available expert staff and instruments; (vi) development of new special purpose instruments, and (vii) training.

□ Environmental monitoring and control

Environmental monitoring and control is gaining ever increasing attention in developing countries. The possible negative economic, social and health impacts of environmental degradation on the people of developing countries is of paramount importance. However, proposed activities related to stabilizing and/or bettering the environment in developing countries are hampered by lack of know-how and/or lack of measuring, testing, analyzing and controlling equipment.

Noise engineering

Problem: Industrial noise pollution decreases productivity

and can damage workers' health.

Project: Creation of a noise engineering centre complete with special purpose facilities (anechoic chambers etc.) to utilize multi-purpose noise engineering techniques can be utilized in industrial pollution monitoring and control as well as other industrial activities such as investigating and reducing operating noise levels of domestic appliances-particularly important for export items-and/or industrial equipment, and analyzing the noise signatures of industrial equipment and systems for diagnosis and repair.

Study and expert group meeting on pollutants and their control in electronics industry

Problem: The electronics industry contributes to environmental pollution in the form of dangerous waste solvents and gases.

Project: A study will identify the pollutants and polluting processes of the electronics industry and lead to guidelines on pollution monitoring and control in this sector. An associated expert group meeting increases awareness of industrial pollutants and their control in the electronics industries of developing countries.

ENERGY SYSTEMS ENGINEERING AND APPLICATIONS

The technical assistance programme focuses on technological knowledge, expertise and applications in conventional and advanced technologies related to conventional as well as new and renewable sources of energy. A country's development is dependent on an economic source of energy. Careful planning and an inventory of resources can lead to a faster rate of economic growth. Conventional sources can, in their exploitation, cause environmental damage. An easing of the pressure of demand through the use of new technologies can give time to establishment of control mechanisms. Design and employment of appropriate systems and equipment are therefore essential.

PROJECTS AIM AT:

- ▣ product design, prototyping, reverse engineering
- ▣ pilot production
- ▣ production rationalization and automation
- ▣ repair and maintenance of products and plants
- ▣ components and spare parts production and assembly
- ▣ environmental monitoring and control
- ▣ testing and certification

IN THE AREAS OF

Conventional Sources of Energy

- energy generation equipment design and manufacture
- thermal power plants
- diesel generator sets
- repair, maintenance and optimization of operation to upgrade plant thermal efficiency

New and Renewable Sources of Energy (NRSE)

- wind energy (water pumping and electricity generation)
- hydropower (small, mini, micro)
- solar energy (low temperature process heating, crop drying, desalination, refrigeration, cooking, selective surface technologies, photovoltaics)
- biomass and biogas engine systems

Energy auditing and conservation

- in industry
- in distribution systems

USING THE FOLLOWING TECHNOLOGIES:

- ◆ conventional techniques and/or technologies
- ◆ computer-numerically controlled testing equipment
- ◆ computer-aided design and manufacturing
- ◆ artificial intelligence/expert systems

ACTIVITIES

The energy sector covers a vast area, therefore, the activities of the programme can only be highlighted on a limited scale. Areas cover all phases of technical co-operation projects, i.e.:

- needs assessment in particular for rural electrification;
- identification and formulation of energy options;
- transfer of appropriate technologies;
- local manufacture of energy-related equipment;
- energy pricing and taxation;
- assessment of energy conservation potential;
- identification and formulation of measures aimed at environmental protection;
- training of national personnel

PROJECT AREAS

Examples of the areas covered by the programme's projects are:

Conventional sources of energy

- Assistance to electric household appliances research institute
- Upgrading of the economy and reliability of locomotive diesel engines

- Establishment of a regional environmental testing and tropicalization centre for telecommunications equipment

- Computer-aided electricity demand management and supply planning

- Emergency rehabilitation programme for diesel driven pump sets

- Testing of components used in electrical power distribution systems

- Modernization of transformer production

- Workshop for semi-knocked down (SKD) assembly and repair of electrical storage batteries

- Technology transfer for the design, test and pilot manufacture of high voltage power capacitors for electrical power distribution systems

New and Renewable Sources of Energy

- Research and development programme for NRSE

- Manufacture of wind turbines for electricity generation

- Technical assistance in laboratory tests for adopting a wind generator type for pilot production

- Assessment of wind energy

- Improved technologies procedures for construction of hydropower plants

- Development of small hydropower plants

- Advisory services to the

development of small hydropower plants

○ Support for the regional network on small hydropower plants

○ Regional programme for the establishment of small hydropower plants

○ Regional research and development and training centre for mini and small hydropower generation

○ Production of solar panels

○ Development and establishment of solar-photovoltaic water pumping systems

○ Practical workshop for technicians and engineers in the field of design and manufacturing of solar water heaters

○ Manufacturing of solar water heaters for industrial applications

○ Demonstration of industrial low temperature application of solar energy

○ Application of alternative fuels for internal combustion engines

○ Centre for technology options for utilization of alcohol in engines for agriculture, industry and transport sectors in developing countries

○ Assistance in applying solar wood drying techniques

Energy saving and conservation

○ Energy conservation in industry

○ Techno-economic study on the establishment of an electric energy centre

○ Energy conservation in power generation and industry

○ Strengthening of electrical inspection department, electrical testing laboratory, training and technical service facilities

○ Assistance in energy management in small and medium scale industries

TECHNOLOGY SELECTION

In designing, formulating and executing these projects, suitable technologies are selected from a wide range of available options. These include conventional and modern technologies.

PROJECT EXAMPLES

Projects being handled are grouped below according to their aims or outputs.

Product design and prototyping

A key feature of product development projects is integration of the market requirements such as use, functionality and safety of the products with the possibilities and limitations of production. Development of product design capabilities leads to quicker response to changing market demands, and improves product functionality. Better prototyping facilitates efficient production and adds to the quality of the final product.

Pilot production

Pilot production plants are established to test the suitability of manufacturing processes and technologies to conditions of a developing country. This group of projects generally includes a technology transfer package covering several aspects of the production such as product design, process know-how and quality control procedures as well as all necessary plant machinery and equipment.

Production rationalization and automation

Industrial automation is the key to efficient use of existing production capacities. Automation is a key element in new investments. Gains to be achieved through industrial automation include reduced product costs and shortened delivery times.

Repair and maintenance of products and plants

A frequent problem in development of industry and infrastructure is the absence of adequate repair and maintenance services with the result that production machinery and other equipment is out of order leading to low productivity and complete breakdowns. In this context non-availability of spare parts imposes a strategy for the local production of these.

Environmental monitoring and control

Environmental monitoring and control is gaining ever-increasing attention in developing countries. The possible negative economic, social and health impacts of environmental degradation on the people of developing countries is of paramount importance. However, planning activities related to stabilizing and/or protecting the environment in developing countries are hampered by lack of know-how and/or lack of measuring, testing, analyzing and controlling equipment.

METALWORKING AND MACHINE TOOLS

The technical assistance programmes focus on channelling technologies for the process of manufacturing machine tools, equipment and industrial installations, setting up maintenance facilities for equipment, and increasing self-reliance in the design and manufacture of spare parts. Because of the expansive nature of this area of activity the projects can only concentrate on specific areas, however, related activities are found in every phase.

As it is an industry which may have a negative impact, safe disposal of metal turnings, lubricants or cooling liquids require projects advocating care to avoid pollution. Application of appropriate technologies and hardware are strongly encouraged. Recycling of wastes and their integration into new products are recommended. Promoting local design more closely aligned with regional needs are a serious consideration allowing for better use of raw materials.

PROJECTS AIM AT:

- ▣ Design and prototype manufacture
- ▣ Machine tool manufacturing complex
- ▣ Engineering design and tool centre
- ▣ Machine tool R&D Centre
- ▣ Modernization of machine and machine building industry

IN THE AREAS OF:

- Metalworking industry
- Machine tool industry
- Tool, die design and manufacture
- Repair and maintenance

OVERVIEW ACTIVITIES

The following activities are within the programme:

O Metalworking industry

Conventional machining methods in most of the developing countries prevail, however, modern manufacturing methods using computer controlled machine tools, machining centres and robotics and/or combinations of flexible manufacturing systems are being introduced progressively in the metalworking and capital goods industry. The advantages of this trend are obvious and should be introduced or applied if the industry in developing countries wishes to be competitive. Therefore, technical assistance projects are increasingly needed to develop capabilities in advanced and computer aided manufacturing techniques through the establishment of relevant engineering service centres, which are capable of advising industry and of assisting in the modernization process of established manufacturing industry.

Another possibility of progressively changing from the traditional manufacturing methods to advanced methods at the plant level is the establishment of an Autonomous Manufacturing Island (AMI) for a selected number of parts. For this selected number of parts conventional machines and CNC (computer numerical controlled) machines can be combined to undertake the various machining operations, while production planning and control, flow of material and sequences of operations are optimized with the

aid of computers. Included in this concept is also tool management and maintenance of machinery and fixtures. The immediate investment for the establishment of an AMI is comparatively low and the AMI concept can easily be used for other numbers of parts within the same and/or other factories. Simultaneously, any changes from conventional machine tools to CNC machine tools can be effected as funds for investment and skilled labour and engineering forces became available.

Simultaneous with the modernization process of metalworking industries and their manufacturing technologies, it is also logical that product diversification, design and up-dating should be undertaken. Relevant design capabilities have also to be established.

O Machine tool industry

Some countries which have a machine tool industry need assistance in design adaptation and modernization of their machine tools, in order to bring them into line with present and future demands. Assistance in a number of very specific areas is essential, such as development and design and adaptation of machine tools, their production planning and control of manufacture, tests and after-sales service, including repair and maintenance. Also required is assistance to countries which presently do not have a machine tool manufacturing industry but which have decided to enter into such manufacture in the future.

**O Tool, the design and
 manufacture**

There will always be a need for tools and dies as they are the basis for a great number of products and spare parts in metal and plastics products. Modern technologies in design and manufacture have been introduced latterly in industrialized countries and held to be introduced in developing countries. Through the recent introduction of electro-discharge machining technologies, refined tool design and development, such as fineblanking techniques, could be developed. Fineblanking tools which lead to the manufacture of very precision parts and components, not requiring any machining after blanking, are highly sophisticated. Such tools need specialized knowledge in the selection of appropriate materials, their heat treatment and their final machining. The fineblanking technique has been developed over the last 10 years and there will be an increasing demand for it in the future, not only in industrialized but also in developing countries.

O Repair and maintenance

Repair and maintenance will remain an area of high priority in the future. It is an area of particular importance since manufacturing techniques and associated machinery and equipment are becoming more and more sophisticated and costly. Capital intensive equipment must be maintained adequately and possibly breakdowns could be avoided. Highly skilled maintenance and service engineers and technicians are needed. To develop such skills and services relevant technical assistance projects at the

institutional and factory level are required.

Local manufacture of spare parts and components is also required to support repair services. In this connection rehabilitation of worn parts and components inter-alia through metalspraying techniques is required.

**PROJECT
 AREAS**

Examples of the areas covered by the programmes's projects are:

- Establishment of pilot demonstration plants for on-the-job training and production of locally needed parts and components
- Repair and maintenance projects at plant level, national level and regional level, including rehabilitation of machinery parts and components
- Reconditioning of parts and components through metalspraying techniques
- Design and manufacturing activities for tools, dies, jigs and fixtures
- Establishment of testing centres for automotive ancillary industries with a view to augment local manufacturing content
- Establishment of metal industries research and development centres, which provide extension services to industries in various engineering disciplines, such as design, industrial engineering, quality control, etc.
- Machine tool design and manufacturing projects at all levels, including computer

numerical controlled machine tools.

- Low-cost equipment development projects for LDCs, such as hand- and wind-pumps, cooking stoves, etc.

- Establishment of specialized laboratories for fluid control and testing, fatigue testing and fatigue life prediction of parts and components, automotive emission control, etc.

LINKAGES

There are linkages with the Metallurgical Industries Branch, in particular in the areas of foundry and forging technology since castings and forgings form an important part for optimal machining processes.

TECHNOLOGY SELECTION

The selection of technology to be applied in the technical assistance projects is dependent on the technical level of the environment to which the technical assistance is to be addressed.

PROJECT EXAMPLES

Some of the projects within the programme are grouped below according to their aims or outputs:

□ Design and prototype manufacture

Design and prototype manufacture of many different types of machine tools requires research and

development work which leads to the establishment of machine tool institutes.

Establishment of the Central Machine Tool Institute

Problem: Machine Tools Manufacturers decided that there was a requirement for research and development work, design and prototype manufacture to be carried out by an independent institute.

Project: Since the Central Machine Tools Institute was established co-operation with UNIDO has been ongoing for 15 years. During the Institute's establishment and implementation, UNIDO assistance was furnished in areas such as applied, metalcutting research, analysis of mechanical structures of machine tools, utilization of CNC machining techniques, and CNC training for users from industry. Because introduction of CAD/CAM techniques and their application in industry is crucial, further UNIDO assistance will be required in the future.

□ Machine tool manufacturing complex

Machine tool manufacturing complexes are established to enable developing countries to create a basis for the capital goods manufacturing sector and thus progressively produce high value added machinery for the local and export market. As a first step techno-economic studies for the manufacture of machine tools are required.

Problem: UNIDO was requested to undertake a detailed techno-economic study for the manufacture of conventional machine tools.

Project: The study under UNIDO contract was positive and led to a decision to establish a machine tool manufacturing complex. Under a bilateral collaboration agreement with another developing country the machine tool complex was created whereby an institute from the collaborating country provided the design and manufacturing know-how and undertook training of national experts.

□ Engineering design and tool centre

Engineering design tool centres are established to diversify metal products improvements in quality and design and manufacture with appropriate tools, moulds and dies. Assistance in the establishment of engineering design and tool centres is successfully given to certain countries.

Problem: Capabilities in design and manufacture of tools such as moulds, dies, jigs and fixtures were lacking in a number of countries. In the absence of these capabilities product quality is poor and inconsistent.

Project: UNIDO provided extensive assistance in building up tool centres by training staff in design and manufactures of different types of tools and by providing specialized precision machinery and equipment including heat treatment and testing/measuring equipment. In the above field of specialization training abroad and thorough provision of expertise at project sites are essential. To build up efficient services to be provided for smaller and medium size industries in the recipient countries by the centres is the major objective of these centres.

□ Machine tool R&D centre

A machine tool and R&D centre is the key to efficient use of advanced machine tools including the design, development and manufacture.

Establishment of a Machine Tool Research and Development Centre

Problem: Small manufacturing enterprises produce simple, mainly conventional, machine tools. The quality and design of these machine tools are likely to be quickly out of date and the market for such machines is progressively shrinking.

Project: UNIDO provides design and manufacturing services with a view to strengthening the capability and capacity of the surrounding machine tool builders, and to increasing the market share of their products. UNIDO also hired a local consultant to assess the needs of the machine tools industry of the region and to design the technical assistance project for the establishment of the Machine Tool R&D Centre.

□ Modernization of machine tool industry

Modernization of the machine tool industry is the key to efficient use of existing production capacities through demonstration and development schemes within selected plants and institutions.

Problem: At the plant level machine tool manufacturing and design capacities are often outdated and therefore specific assistance is required.

Project: UNIDO assisted in the formulation of a large scale

programme of technical assistance. Such a programme consists of number of specific demonstration projects which after completion are intended to be repeated. These projects use the design and development of a 16 bit CNC control unit for machine tools; the improvement of selected

foundry machines; the introduction of autonomous manufacturing island; design and manufacture of a machinery centre using a computer assisted modular design concept; and the design and manufacture of two types of turrets for NC lathes.

TRANSPORT SYSTEMS ENGINEERING AND APPLICATIONS

The technical assistance programme in the Transport Systems Engineering and Applications focuses knowledge, expertise and applications on conventional and advanced technologies related to land- and water-borne transport equipment.

PROJECT AIMING AT:

- Product design, prototyping, reverse engineering
- Pilot production
- Production rationalization and automation
- Repair and maintenance of products and plants
- Spare parts production
- Environmental monitoring and control
- Testing and certification

IN THE FIELDS OF:

- Land-transport equipment (railway and road)
 - * Locomotives
 - * Diesel locomotive engines
 - * Track construction and maintenance equipment
 - * Passenger cars
 - * Freight cars
 - * Mining waggons
 - * Automobiles
 - * Trucks
 - * Tractors
 - * Buses
 - * Earth moving machinery for road construction,
 - * Petrol engines
 - * Diesel engines
 - * Turbines
 - * Engine components
 - * Alternative fuels
 - * Emission and fuel standards
- Water-borne transport equipment (sea and river)
 - * Sea and river transport
 - * Cargo and fishing vessels
 - * Coal transport barges
 - * Crude oil, CNG, LPG transport vessels
 - * Shipyards and portuary equipment
 - * Off-shore equipment
 - * Fishing boats

USING THE FOLLOWING TECHNOLOGIES:

- Conventional techniques and/or technologies
- Computer-numerical controlled testing equipment
- Computer-aided design and manufacturing within automotive industry
- Flexible manufacturing systems
- Artificial intelligence/expert systems

**PROJECT
AREAS**

Examples of the areas covered by the programme's projects are:

**• Land transport equipment
(railway and road)**

*** Locomotives**

- . High speed trains
- . Chassis and bogeys
- . Dynamic test stands
- . Automated roller and traction measurement
- . Diesel/electric locomotives

*** Diesel locomotive engines**

- . High performance engine development
- . Low specific fuel consumption
- . Cavitation of cylinder liner
- . Acceptance testing and procedures according to international standards

*** Track construction and maintenance equipment**

- . Heavy tonnage tracks
- . Wear and fatigue research
- . Rails, fasteners, tieplates, ties, ballast
- . Track and structures

*** Passenger cars**

- . Chassis and bogeys
- . Sheet metal body shop
- . Suspension and brakes

*** Freight train cars**

- . Double-stack container cars
- . Tank cars
- . LPG, CNG cars

*** Mining waggons**

- . Heavy haul
- . Loading/unloading

*** Automobiles**

- . Assembly of imported components
- . Sheet metal body shop
- . Paint shop

- . CAD/CAM production line
- . Safety and test

*** Trucks**

- . Chassis works
- . Hydraulic/pneumatic systems
- . Refrigeration trucks

*** Tractors**

- . Agricultural tractors and implements
- . Low-cost tractors
- . Multi-fuel tractors
- . Two- and three-wheeled vehicles

*** Buses**

- . City transport
- . Long-range travel
- . Airconditioned vehicle

*** Road construction, earth moving machinery**

- . Graders
- . Levelers
- . Excavators

*** Petrol engines**

- . Carburettor engines
- . Injection engines
- . Spark ignition

*** Diesel engines**

- . Compression ignition
- . Fuel injection systems
- . Power generator systems

*** Turbines**

- . Turbo charger
- . Compressor

*** Engine components**

- . Engine block
- . Head
- . Valve
- . Pump
- . Shaft
- . Gear
- . Springs

*** Alternative fuels**

- . Methanol
- . Ethanol
- . CNG
- . LPG
- . Biogaz

* **Emission and fuel standards**

- . Control and regulatory measures
- . Motor vehicle emissions
- . Exhaust gas catalyzer
- . Lead-free petrol
- . Low sulfur diesel fuel
- . Trap oxidizer
- . Gas analyzer

* **Water-borne transport equipment (sea and river):**
-----* **Cargo and fishing vessels**

- . Ocean transport
- . Deep sea fishing
- . Passenger and goods transport
- . On-boat processing equipment
- . Refrigeration systems

* **Coal transport barges**

- . River and sea transport
- . Loading/unloading equipment
- . Modular construction

* **Crude oil, CNG, LPG transport vessels**

- . Safety and environmental aspects
- . Pressurized vessels
- . Pumping stations

* **Shipyards and portuary equipment**

- . Dry docks
- . Harbour cranes
- . Loading/unloading equipment
- . Naval construction workshops

* **Off-shore equipment**

- . Floating platforms
- . Fixed platforms
- . Floating cranes
- . Pumping stations
- . Oil drills
- . Pipeline systems

* **Fishing boats**

- . River and coastal fishing boats
- . Low-cost construction
- . Deep sea fishing boats
- . Fishing equipment
- . Processing equipment

**TECHNOLOGY
SELECTION**

In designing, formulating and executing these projects, suitable technologies are selected from a wide range of available options. These include conventional (and so-called appropriate) technologies on one hand, and more modern ones, such as computer-numerically controlled testing equipment, computer-aided design and manufacturing (CAD/CAM) etc. on the other. High technologies, such as computer-integrated manufacturing (CIM), flexible manufacturing systems (FMS) and artificial intelligence and expert systems (AI/ES) are also utilized when the infrastructure and the environment of a specific project permit.

**PROJECTS
REFERENCE
LIST**

Some of the projects within the programme are grouped below according to their aims or outputs.

O **Product design, prototyping and reverse engineering**

A key feature of product development projects is integration of the market requirements such as use, functionality and safety of the products with the possibilities and limitations of production. Development of product design capabilities leads to quicker response to changing market demands, and improves product functionality. Better prototyping facilitates efficient production and adds to the quality of the final product.

Upgrading the economy and reliability of locomotive diesel engine:

A prototype 1800 hp locomotive diesel engine has been developed and the high performance, very low specific fuel consumption and low emission rates demonstrated during acceptance testing, thus meeting international standards.

Technical development centre for gears:

A centre for gear development was created to assist a number of industries to upgrade gear quality and product reliability and train technical personnel for gear systems being widely used in the transport sector.

Automotive parts quality and development centre:

Through this centre a multitude of automotive parts manufacturers, mostly small-scale enterprises, has been trained in introducing a statistical quality assurance scheme in order to enable identification of problems associated with the manufacturing process and automotive parts product quality.

Upgrading the manufacture of automotive leafsprings:

This project has led to the improvement of the quality and production output of leafsprings for the transport sector through introducing upgraded manufacturing processes, inspection and quality control.

Upgrading of the diesel engine production line:

Through this project new assembly lines for two-, three- and four-cylinder engines were put into operation using a modular type

concept.

Assistance to the boat manufacturing industry for the production of fibre glass boats:

The project transmitted technology in the manufacturing of various types of boats including design and fabrication of moulds and the process of fibre glass curing.

Technical assistance for a laboratory to test ship structures:

The project has enabled a laboratory to carry out strength and vibration investigations on ships to come up with more efficient structures and fabrication methods affecting both shipbuilding and ship operation.

O Pilot production:

Pilot production plants are established to test the suitability of manufacturing processes and technologies to conditions of a developing country. This group of projects generally include a technology transfer package covering several aspects of the production such as product design, process know-how and quality control procedures as well as all necessary plant machinery and equipment.

O Production rationalization and automation:

Industrial automation is the key to efficient use of existing production capacities. Automation is a key element in new investments. Gains to be achieved through industrial automation include reduced product costs and shortened delivery times.

Locomotive test stand:

Under this project a computer- and processor-controlled diesel locomotive roller test stand being one of the most technologically advanced testing equipment has been designed and installed and is now serving for performance, qualification and acceptance testing of all kinds of diesel locomotives, including high-speed applications.

O Repair and maintenance of products and plants:

A frequent problem in development of industry and infrastructure is the absence of adequate repair and maintenance services with the result that production machinery and other equipment is out of order leading to low productivity and complete break downs. In this context non-availability of spare parts imposes a strategy for the local production of these.

Industrial maintenance centre:

This project aimed at strengthening the maintenance and overhauling operation with emphasis on spare parts production in the transport sector.

Rehabilitation of spare parts:

Specific spare parts were reconditioned for diesel engines

and turbines by applying modern technologies in metal spraying on worn-out mechanical parts.

Rehabilitation of dockyards and ports:

Studies and proposals were worked out to improve the efficiency, capacity and economy of shipyards and dockyards facilities through the provision of adequate maintenance and repair services.

Environmental monitoring and control:

Environmental monitoring and control is gaining ever increasing attention in developing countries. The possible negative economic, social and health impacts of environmental degradation on the people of developing countries is of paramount importance. However, activities related to stabilizing and/or protecting the environment in developing countries are hampered by lack of know-how and/or lack of measuring, testing, analyzing and controlling equipment.

Control and regulatory measures concerning motor vehicle emissions:

The aim of this project is to promote regional cooperation for a concerted approach for introducing emission and fuel quality standards for gasoline and diesel engine vehicles, as well as establishing a number of vehicle emission control centres.