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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

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

METALLURGICAL INDUSTRIES

The technical assistance programmes in the sector of metallurgical industries

MARCH 1992

C O N T E N T S

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For any further information, please contact:

Head
Metallurgical Industries Branch
Industrial Operations Technology Division

Vienna International Centre
P.O. Box 300
A-1400 Vienna
Austria
Phone: (01) 21131-3968
telex: 135612
fax: (01) 232156

INTRODUCTION

The mandate of the Metallurgical Industries Branch is the acceleration of exploitation and processing of local ore and metal resources of developing countries to yield added value metallic and other products for home use and export.

Depending upon the complexity of the technical co-operation projects costs may vary from several thousand to several million dollars. More than 100 technical assistance projects are under implementation at a time; about the same amount of projects are under formulation/preparation. The main subjects covered by the projects are as follows:

- ***Development and strengthening of non-ferrous metals industry;***
- ***Development and strengthening of iron and steel industries;***
- ***Development and strengthening of foundry and other metals forming/ transformation industries and products;***
- ***Establishment and strengthening of centres for metallurgical technology and corrosion protection;***
- ***Industrial processes for utilization of metallurgical wastes, promotion of environmental and pollution control measures and processing of metallurgical scrap to produce added value products;***
- ***Introduction of rationalization and computerized systems in production processes, maintenance and related fields;***
- ***Development of new advanced metals, alloys and composite materials.***

Within these technical areas the Metallurgical Industries Branch is primarily concerned with the following activities:

(a) Elaboration and adaptation of technologies for processing of metallurgical minerals or ores including assessment of data on volume and quality of reserves; sampling, laboratory and pilot test work to identify the optimum way of processing of indigenous raw materials into higher added value products;

(b) Assistance in establishment, management and operation of new plants at all levels, including national planning of metallurgical industry sectors through master plans, techno-economic studies, feasibility studies and marketing studies;

(c) Provision of expertise for rehabilitation, modernization and efficient operation of existing plants covering application of appropriate technologies and equipment, including technological consulting, product development, and introduction of managed and computerized systems; improvement of product-mix, harmonized to the national, regional and

interregional demand, consulting on management and cost accounting of metallurgical and metal transformation plants;

(d) Assistance in restructuring, privatization and conversion of metallurgical industries on company and plant level;

(e) Advisory services in energy management and conservation;

(f) Advisory services in standardization of metal products;

(g) Environmental protection, including recycling/utilization of industrial wastes from metallurgical operations, such as red mud; recycling of lead batteries; recovery of metals from flue dust, etc. Owing to the nature of metallurgical industries, this activity is characterized by an ever important role and environmental considerations are part of most projects undertaken in the metallurgical sector.

(h) Establishment of centres, laboratories or of testing/evaluation units for metallurgical and metal transformation (e.g. foundry) development, thereby increasing research and development and technical consulting capabilities in developing countries with a view to facilitate adaptation of foreign know-how and to decrease dependency on other countries;

(i) Development, organization and implementation of specific training programmes, in-plant group training or study tours and individual fellowship placements, usually in connexion with project activities.

In the implementation of its technical co-operation activities the following services are provided by the Metallurgical Industries Branch:

- Identification and initial evaluation of project opportunities;
- Preparation and evaluation of techno-economic cost-benefit analyses, opportunity studies, pre-feasibility studies and full techno-economic studies;
- Project formulation and design;
- Preparation of the Project Document, detailed implementation plan and project budget;
- Project implementation and follow-up.

The Metallurgical Industries Branch is organized into several units, covering the iron and steel and new materials/processes, foundry, metal transformation and processing and non-ferrous and precious metals extraction. The typical organization of a unit consists of the Unit Head who, apart from carrying out project implementation himself, provides advice and counsel to two or more backstopping officers related to project generation and implementation. The Branch plays an active role in the development of new programmes or new directions and in the identification of problems and opportunities for technical assistance projects. To facilitate project

formulation by UNIDO field personnel, a Portfolio of Project Concepts (Document number IO/46 (SPEC.)) was elaborated and distributed to UNIDO Country Directors in July 1990. The 30 project concepts cover a wide range of opportunities for metallurgical projects, mainly in the area of advanced technologies, environment and energy conservation.

The detailed presentation by programmes will provide a good overview on the activities that the Metallurgical Industries Branch can offer in the main sub-sectors of the industry. The following examples of technical co-operation projects and activities illustrate the type of assistance requested and provided:

Light non-ferrous metals sector

Ongoing projects cover all aspects of ***bauxite processing, alumina production and aluminium smelting***. Particular emphasis is given to possibilities for the utilization of other raw materials (e.g. alunites) and to energy saving measures.

Production of ***non-ferrous metal semi-fabricates***. This activity assists developing countries which have often only reached the stage of primary metal production to develop downstream industries, to meet the local market demand for semi-fabricated products.

Production of titanium slag, sponge, metal and intermediate products, such as laboratory/pilot testing of ilmenite ore for metallurgical processing to titania slag and ductile grade pig iron.

Heavy non-ferrous metals sector

In the heavy non-ferrous metals sector, bacterial leaching of ***copper*** ores and low-grade ores, ***zinc*** and ***lead*** operations and production of ***rare and precious metals***, e.g. small size ***gold*** winning operations are of significant interest to developing countries. Assistance is also provided to small and medium ***mineral processing*** companies to develop and improve their beneficiation activities.

Iron and steel sector

Traditional activities cover the preparation of master plans, assistance in establishment of steel plants, rehabilitation of steel mills, e.g. modernization of rolling mills, production of ***special steels*** and introduction of energy saving and conservation measures. Recent Projects in this field are characterized by advanced technological processes, e.g. continuous casting, secondary steel making, production of special steels and alloys; emphasis is also placed on projects related to ***direct reduction of iron ores*** for production of sponge iron and various small scale smelting processes.

Foundry and metal forming/transformation sector

This includes ***casting, forging, rolling, extrusion, stamping, heat treatment, welding,*** *etc.* The industry plays an important role in supplying parts which cannot be manufactured by any other process and which are essential to the manufacture and maintenance of industrial, agricultural, transport and household machinery and equipment.

Most projects aim at assisting the developing countries, particularly Africa, in improving foundry operations to enable the manufacturing of essential tools, agricultural implements, etc. and spare parts for machinery to save costly imports. Activities also cover the ***establishment of pilot and demonstration foundry/forge shops with training laboratories*** and modern technologies such as precision casting and electroslag melting. Special emphasis is given to improving the quality of castings and heat treated products.

Metallurgical technology centres

The establishment and operation of ***R and D centres***, laboratories, institutes, pilot and demonstration units in selected fields of industrial development is the main instrument to both transfer and adaptation of existing technologies and also development of new achievements and capabilities. Centres for metallurgical technology are created or supported by UNIDO to effectively promote the adaptation and modification of proven processes and products and later, relying on the accumulated knowledge and experience, to develop new processes and products most suited to prevailing conditions. The upgrading of the scientific and technological capabilities of various metallurgical research and development institutes is of particular concern. The programme also deals with the establishment of technical training and consultancy centres.

Mineral Beneficiation Pilot Plants

Activities cover mineral beneficiation R & D laboratories and centres, pilot plant investigations and setting up of demonstration plants, e.g. establishment of a multipurpose ore beneficiation pilot plant, designed to promote an indigenous technical base and capabilities for the local staff to provide services to the national metallurgical industry.

Utilization of metallurgical wastes
Environmental and pollution control measures
Processing of scrap

Owing to the great magnitude of emissions generated by the metallurgical industry, environmental control measures are an intrinsic and integral component in each stage of metal making technology. Thus, the Branch has been active to promote all activities leading to increased ***"environmental awareness"***.

Apart from utilization of metallurgical wastes e.g. ***utilization of red mud*** from bauxite processing for production of bricks, blocks and tiles, ***recovery of precious metals from tailings*** and battery ***lead recycling***, energy saving projects which also have a direct impact on the environment are promoted. Various projects aim at improvement and rehabilitation of metallurgical plants and scrap collection and processing.

Computerized systems in production processes, maintenance and related fields

Projects aim at introducing ***computerized production and process control*** as well as managing maintenance systems in metallurgical plants. Apart from productivity increase, production and inventory cost savings, a uniform quality and timely deliveries can be achieved. Most innovative production technologies require computer control as an indispensable pre-condition. Considerable savings have already been achieved through the introduction of computerized managed maintenance systems in various metallurgical plants. Workshops and expert group meetings are organized to create better awareness on the benefits that the introduction of such systems brings about. Project examples are:

(a) Introduction of computerized managed maintenance systems (CMMS), in metallurgical plants;

(b) Application of computer based production and maintenance management systems;

(c) Computer application for production process control in the iron and steel industry;

(d) Computerized energy conservation in metallurgical industries;

(e) Process control;

(f) Software development and training centres.

New advanced metals, materials and technologies

Major technological advances in new metals and materials are characterized by a high degree of R and D content. Therefore UNIDO has spent time and efforts in order to set up proper infrastructure to promote the production of new materials. This aim is achieved, e.g. through computerization, energy saving technologies and technology adaptation, such as for the production of ***superpurity metals*** and processing of ***raw materials for the electronic industry*** (e.g. silicon, gallium arsenide, etc.), special aluminas and ceramic materials, rapid solidification, production of metallic glasses, etc. The programme covers the requirement by the more advanced developing countries for more sophisticated technology.

Conclusion

In the light of the international trends and the requirements of developing countries the Metallurgical Industries Branch concentrates its special efforts to fulfil the mandate of the UNIDO medium term plan and to cope with emerging priorities, i.e.

(a) Environment protection
(b) Energy conservation
(d) Plant rehabilitation
(e) Transfer or technology
(f) Technical co-operation among developing countries
(g) Small and medium scale industries
(h) and considering the nature of metallurgical industries, to a lesser extent, on the integration of women in development.

Particular emphasis is placed on helping developing countries in plant rehabilitation and privatization efforts. Based on the imminent needs in the eastern European countries in the metallurgical industries field efforts concentrate on improving management skills; plant profitability; provision of advice on marketing/sales of products; reduction of air and water pollution and waste utilization; introduction of cleaner technologies and energy conservation measures. Apart from a number of small scale projects already implemented in these countries or under implementation, regional programmes for diminishing transboundary environmental impact and risks connected with metallurgical industrial operations are being promoted. Many of the efforts will call for donor financing to complement the UNIDO funds with their contribution to help metallurgical industries in central and eastern Europe to survive and become "clean" and, with the possibility to participate in profits which may be expected from operations such as processing of solid wastes to extract metals and other marketable products.

To support the technical assistance programme, the Branch is organizing a number of workshops/expert group meetings/symposia on various crucial and timely aspects of metallurgy. It has also issued a large number of documents. Lists of meetings and documents may be obtained free of charge upon request.

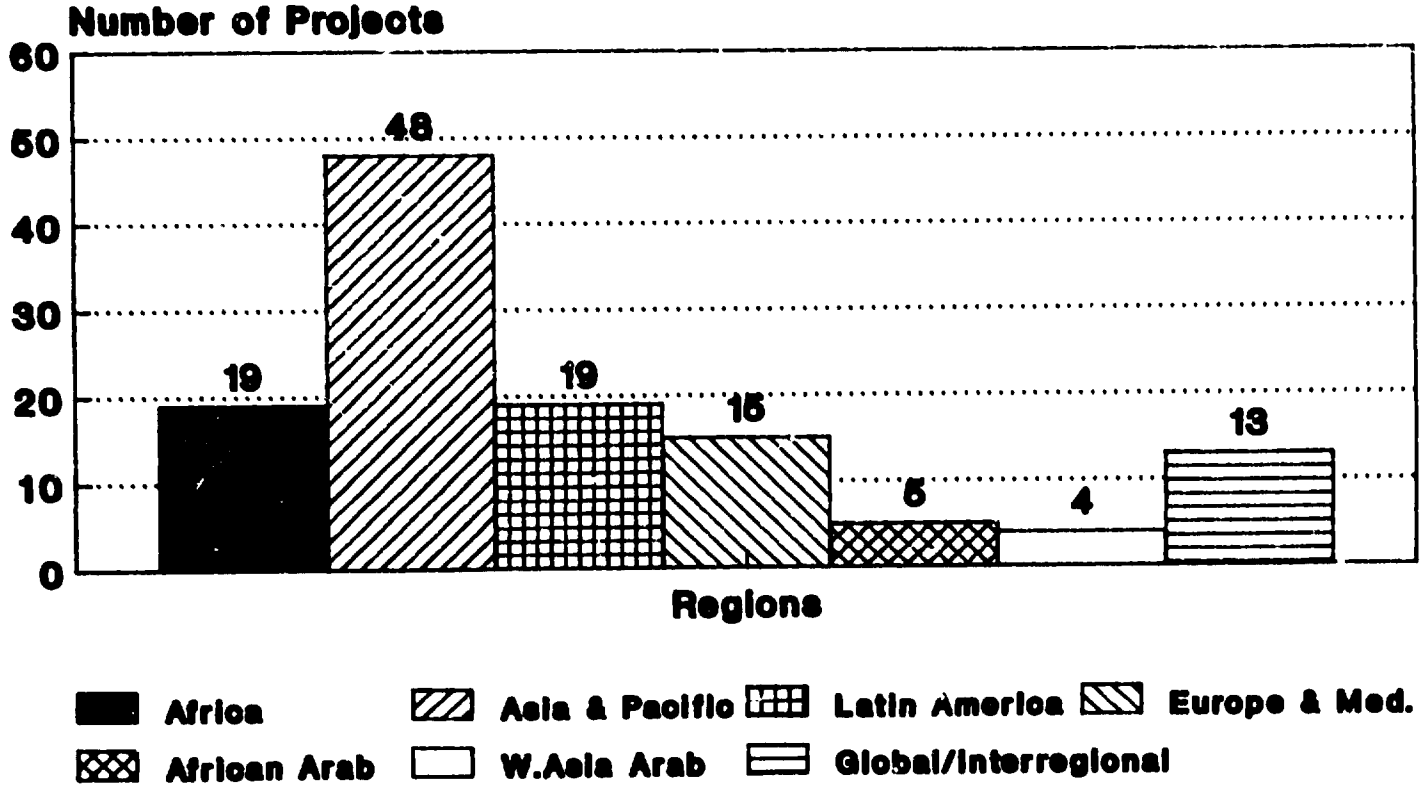
In addition, the Branch is actively co-operating with other Branches/ programmes within UNIDO, e.g. the System of Consultations in the organization/ implementation of the iron and steel and non-ferrous consultation meetings and undertakes preparations and participates in important international meetings, such as in the Conference on Ecologically Sustainable Industrial Development, held at Copenhagen from 14-18 October 1991.

Jan V. Krouzek
Head of Branch

METALLURGICAL INDUSTRIES BRANCH
ORGANIZATION CHART
Head: Jan V. Krouzek

Iron and steel and new materials/processes		
Mr. Y. Grebtsov	Unit Chief	Technology and production of iron and steel, special steels and new materials, computer applications
Mr. M. Sato	Industrial Development Officer	Environmental protection, steel manufacturing (rolling, forming) technology, welding
under recruitment	Industrial Development Officer	Mini steel mills (operation and maintenance)
under recruitment	Industrial Development Officer	Energy conservation and efficient energy processes
Foundry, metal transformation and processing		
Mr. A. Buckle	Unit Chief	Foundry, metal processing, heat treatment, materials processing
Mr. V. Iliev	Industrial Development Officer	Metallurgical centres, forming and transformation of metals
Mr. M. Nogueira	Industrial Development Officer	Rehabilitation, energy systems, specialized fields, ore beneficiation
Non-ferrous metallurgy and precious metals extraction		
Mr. Ch. Beinhoff	Unit Chief	Heavy non-ferrous metals, precious metals, ore beneficiation, non-waste technologies,anti-pollution systems
Mr. T. Grof	Industrial Development Officer	Light non-ferrous metals, aluminium, alumina industry, copper and aluminium semi finished products

Number of projects within MET
1991



By Region

FOUNDRY, METAL TRANSFORMATION AND PROCESSING

The technical assistance programme in the **Foundry, Metal Transformation and Processing** industries provides knowledge, expertise and applications in traditional and advanced technologies related to the production of quality spare and metal parts.

PROJECTS AIM AT:

- The manufacture of quality cast and forged spare parts, and parts for the construction of machinery and equipment;
- Complete specification and design, prototyping and reverse engineering of metal parts, preparation of metallurgical specifications, process specifications and control;
- Profitable technical and production practices for foundry, forge, heat treatment and other processing routes, such as hot and cold rolling of steel, tube manufacture, wire drawing, extrusion and others;
- Quality assurance and verification;
- Self supporting Demonstration Production plants for training and technology transfer, and Institutions for techno-industrial support;
- Energy economy in metallurgical processes;
- Environmentally friendly processes and associated control systems.

IN THE AREAS OF:

- Foundry
- Forge
- Heat treatment
- Steel rolling
- Welding
- Surface treatment
- Electroplating
- Hard facing
- Coatings
- Metal forming
- Powder metallurgy

USING THE FOLLOWING TECHNOLOGIES:

- Conventional, appropriate technologies;
- Near net shape manufacturing processes;
- CAD and CAM for castings, foundry patterns and dies;
- Computer aided systems for process control, and energy conservation.

PROJECT AREAS

Activities related to foundry, metal transformation and processing involve all phases of technical co-operation projects in the areas indicated above, for new investment and for the expansion and rehabilitation of existing plants. By supplying technical and administrative assistance and expertise to the sub-sectors which provide the basic industrial support activities of foundry, forge, heat treatment, electroplating, other surface treatments, and other associated activities, the responsible officers direct efforts principally to promoting the supply of proper quality spare and original metal parts for the support of metal consuming industries, industrial and other maintenance, and to the building and repair of machinery and transport equipment. Particular attention is addressed to the following activities.

♦ TRAINING

The success of any project, industrial or institutional depends upon the availability of **trained, experienced personnel** and upon the implementation of **carefully designed and programmed training programmes**. Great emphasis is placed upon the:

- Evaluation of personnel requirements, and of available personnel;
- Preparation and implementation of training programmes for projects, industry and institutions.

With the co-operation of the Human Resources Development Branch, close operational contacts with training establishments and institutes are established and industries identified with which coordinated, long and medium term (i.e., up to 18 months) individual training programmes may be implemented, as necessary for the introduction of new and existing technologies, processes and for management training at different levels for all the activities described above.

Whilst the requirement for technical and production level training is always clear, there are critical areas which project managers frequently do not consider in sufficient detail, such as:

a. Financial analyses and activities e.g. accounting, production and product costing, cost analysis and estimates;
b. Production planning and projection;
c. Maintenance planning and control and budgeting.

UNIDO considers that training in these activities is of the greatest importance.

♦ INSTITUTION BUILDING

Assistance is given for the establishment, upgrading or expansion of technical, research and development institutes and training centres, ensuring that they be involved in projects clearly offering technical assistance to industry. Institute projects take into account the necessity for industry to make a "profit" in order to survive, and that the technical assistance is ultimately directed to this end. Thus institutional projects emphasize this point and are oriented to ensure that the projects are clearly directed to supporting industry, bearing in mind the "financial" aspects of industry programmes and that the

institute staff be able to discuss these matters with their industrial counterparts.

♦ **RE[illegible]BILITATION**

The rehabilitation of plants must be approached methodically, taking into account those factors which determine the feasibility of the rehabilitation such as:

(a) Real market (as distinct from estimates and projections);

(b) Availability of trained personnel or of personnel apt for training;

(c) The possibility of modifying the organisational, and the operational and financial systems and management, and the wage and salary structure to conform to proper usage, in order to ensure the continued successful operation of the rehabilitated plant at the end of the project;

(d) The availability of foreign exchange for indispensable imported material inputs, spares and maintenance services.

If adequate conditions are met, then techno-economic feasibility studies can be commissioned, which will contemplate rehabilitation of existing plant, and its complete or part replacement with new technology.

Studies comprising (a) through (d) must be organized and implemented using experienced specialists from the relevant technical fields.

♦ **ESTABLISHMENT OF NEW PLANTS, DEMONSTRATION PRODUCTION UNITS**

The promotion of the establishment of new plants, whether industrial scale, or Demonstration Production Units (DPUs which are economically self-supporting training and technology-transfer units) will be done in order to introduce technological excellence, and will be implemented in accordance with market requirements. The concept of small-medium-large scale is not relevant where the application of technology, significant to the industrial economy is concerned. The artesanal skills required for example for decorative castings are properly left for the attention of the relevant UNIDO branch involved with small and medium-scale industry whilst the Metallurgical Industries Branch handles the advanced technology directed at the production of parts with strict requirements, irrespective of the size of the production units.

Demonstration Production Units - DPUs- (as distinct from Pilot Plants) are expected to operate at a high level of excellence, and to introduce technologies, with the necessary training into the industry over a long period. In order to generate the income necessary for self-sustaining operation and not to represent a drain upon the finances of either industry or the State, the DPUs manufacture cast parts and spares which are required by local industry, but which are technologically so far above local production abilities and capacities that the DPUs will not compete with local plants. The DPU will thus make a significant contribution to the operation of local industry by supplying parts and spares whilst offering advanced training and consultancy services, and an effective, on-the-job operational technology transfer facility.

Where possible, the establishment of specialized, advanced production lines and DPUs, will be promoted within existing successful plants in order to minimize investment in infrastructure and administration, and ensure the efficient training of the operative and technical personnel.

TECHNOLOGY SELECTION

In implementing projects the programme takes due account of the various technological options available and their impact on developing countries. The following areas are of particular relevance:

o FOUNDRY, FORGE

The foundry and forging processes supply a very large proportion of the spare parts used by industry, agriculture and construction whilst foundry products form the basis for the construction of machinery and equipment. These processes are the basis for the operation and growth of industry.

o NEW CASTING PROCESSES, NEAR NET SHAPE CASTING, FORGING AND OTHER

The programme places special emphasis upon the **Near Net Shape** and **Precision Manufacturing Technologies**, because these are now standard paths towards lower operational and production costs. The efficient use of metal, reducing scrap and machining tolerances to the absolute minimum, results in:

(a) very important energy savings - the energy uselessly invested in the metal which is reduced to scrap because of excessive machining allowances is minimized;

(b) the reduction of the metal used per unit of production (UOP), resulting in a reduction of the pollution per unit;

(c) reduction of downstream capital investment required per UOP; i.e., lower machining allowances - less machine time - less machines per UOP;

(d) reduction of working capital and working space per UOP.

Where industries rely upon imported steel inputs, the use of near net shape manufacturing processes can significantly reduce the volume of raw steel imports and thus the foreign exchange input per unit. Inventory and finance costs are also correspondingly reduced where local manufacture is to be promoted.

The use of precision casting processes for the manufacture of dies and moulds for plastics, rubber, and glass and for large dies for metal forming, as well as for foundry patterns can result in considerable savings and in much shorter delivery times, when compared to the conventional machining processes. High accuracy may be obtained, thus reducing the requirement for finish machining to a minimal level. For non-critical plastic parts such as containers, final polishing and facing may be the only finishing operation required for the mould.

The introduction of precision casting processes into existing foundries, where the necessary technical capability exists requires a relatively low investment, and the payback period can be very low. The market should be investigated by a qualified technical consultant.

o HEAT, AND SURFACE TREATMENTS

The use of modern heat treatment processes results in:

(a) Great improvements in service life of parts, tools and components. This reduces the demand for the parts, and thus for the raw material inputs, and this is reflected in the upstream processes as described earlier;

(b) Lower maintenance costs for the consumer of the parts, due to the longer service life;
(c) Energy saving and pollution reduction due to the improvement in material properties so that less material is used per production unit - the reduction in material input represents a net energy/ pollution reduction per unit;
(d) Reduction or elimination of the use of the traditional heat treatment processes using salts such as cyanide and other, which are dumped into the waste water systems in many developing countries.

♦ **Surface treatments:**

Surface treatments are applied to prolong the life of the part, and allow the use of cheaper base materials.

These may be effected by means of heat treatment, i.e. nitriding, ion implantation, or through electro-metallurgical process such as chrome plating, or by immersion in molten metal i.e. galvanizing. This modifies the surface characteristics of the metal in order to produce specific properties required by the service conditions. The above arguments also apply.

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o WELDING

Welding is a complex metallurgical process which demands strict specifications, control and monitoring. This is most vital when the process is applied to alloy steels and critical parts and structures. The programme assists in establishing the necessary procedures, the technical support systems, and the training required for the correct selection and monitoring of these processes.

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o ALLOY SELECTION FOR METAL PARTS, PROMOTION OF SPARE PARTS PRODUCTION

Assistance is also provided to institutes and industry to establish working groups or departments which follow the procedures for the metallurgical analysis and design of metal parts and processes.

The proper selection of materials for specific applications is a critical first step in the local manufacture of metal parts. Errors in this procedure can be very costly indeed, because the failure of a low cost part can be the cause of the stoppage of a complete manufacturing process.

The materials and the manufacturing processes for a casting or forging can be inter-dependent, and their selection will very frequently depend upon the local availability of specific process technology and equipment. Restrictions of this availability may require modification to material specifications which, if not properly effected could result in the production of an inadequate part which will in turn endanger the equipment for which the part is required.

Individual industries, groups of industries with similar equipment and institutions with good operational relationships with industry are encouraged and assisted by this Unit to set up their own laboratories and consulting groups to:
(a) Prepare full chemical/ metallurgical and process specifications for the manufacture of individual spare parts;
(b) Prepare engineering drawings with complete details;
(c) Evaluate possibilities for local manufacture;
(d) Give technical assistance to local manufacturing.

Careful training of metallurgical personnel, and an extensive library is required in order to ensure that correct decisions may be taken.

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o CAD/CAM FOR CASTING DESIGN AND FOUNDRY PATTERNS

Much effort has been expended in the development of computer software which models the solidification patterns for castings. This is now used for the design of castings with the resultant improvement in quality and efficiency. The design process can be extended to assist in solving one of the most critical bottlenecks in the production of casting which is the prolonged production period required for the manufacture of foundry patterns. Additionally, one of the major causes of scrap castings is the use of inadequate foundry patterns. These problems can be reduced to manageable levels, if not largely eliminated by the use of CAD for foundry pattern design, and where pattern production volume permits, CAD/CAM is used.

Special attention is given today to the use of CAD for the establishment of the systems for the entry of the molten metal into the casting mould cavity, and for the feeding of the metal shrinkage during solidification in order to eliminate internal voids and porosities - and thus rejects, (gateing and risering).

Attention to such details is of great importance; where rejects of castings can be reduced from 30% to 5%, this is equivalent to an increase of installed productive capacity of 35%, without additional capital investment and with total fixed operating costs little changed and direct unit operating costs much reduced.

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o ENERGY CONSERVATION AND REDUCTION OF POLLUTION

This should be an integrated and concerted effort and simultaneously with the indispensable **energy audits** which should be carried out at all plants which consume significant quantities of energy, the efficient use of material resources can have an important effect upon the total energy consumption. The inefficient use of steel, for example in the forging plants and other downstream industries is reflected in a false, high demand for steel at the mill. Extra capacity, and investment is thus required in order to manufacture a considerable quantity of steel which will be turned into scrap by the downstream processors. The energy and other inputs invested in this material is thus lost, and must be charged to the cost of the useful products. The consumer thus pays for the inefficient use of resources which is reflected in the cost of the end product.

It is clear that a similar argument can be applied to pollution; modifications to existing processes should be adopted whilst more efficient, environmentally friendly processes are introduced. A more efficient use of resources such as energy, results in lower total pollution, and also allows the cost of anti-pollution measures to be charged over a greater effective production volume.

Insofar as energy conservation within plant operation is concerned, the introduction and monitoring of "good housekeeping practices" will generally produce energy savings to a value above that envisaged by management, and at minimum investment cost.

IRON AND STEEL AND NEW MATERIALS/PROCESSES

The programme for Iron and Steel and New Materials/Processes, provides knowledge and expertise on development and planning of iron and steel industries, the selection and adaptation of improved and new technologies and introduces advanced materials production. Special emphasis is attached to environmental aspects, energy conservation and increase in productivity through introduction of preventive maintenance systems.

PROJECTS AIM AT:

- Choice and selection of technologies; and processes, including testing of raw materials;
- Pilot scale production;
- Introduction of maintenance systems;
- Environmental monitoring and control;
- Energy auditing, and conservation;
- Rationalization of production, including computer application;
- Quality control, increase in performance.

IN THE AREAS OF:

- Development and application of new technologies and advanced steel products in metallurgical industries;
- Energy conservation, environmental monitoring, provision of environmentally sound steel technologies and utilization of industrial wastes;
- Introduction of rational computerized systems in production processes, maintenance and related fields of metallurgical industry.

USING THE FOLLOWING TECHNOLOGIES:

- Conventional, appropriate technologies;
- Computer aided systems for process control and energy conservation;
- Direct reduction of iron ores and sponge iron production;
- Modern production processes, e.g. ladle-refining, vacuum treatment, rolling in controlled atmosphere, and advanced heat treatment techniques;
- Production of high strength low alloy steels, microalloyed steels, other special steels like ultraclean steels; metal matrix composites and ferrites;
- Low-waste/non-waste technologies, e.g. near net shape casting.

ACTIVITIES

To achieve these aims, projects involve one or more of the following activities:

♦ Preparation of master plans and techno-economic studies for establishment of new production facilities, e.g. mini-mills, based on local raw materials and scrap or direct reduction of iron ores;

♦ Institution building, i.e. establishment of nuclei of iron and steel technology, or local or regional R & D centres;

♦ Strengthening of existing capacities, modernization of plants, and rehabilitation;

♦ Establishment of pilot plants and demonstration units;

♦ Convening workshops and expert group meetings;

♦ Direct technical support (trouble shooting) to solve an immediate problem;

♦ Development of human resources through training courses/study tours;.

♦ Close co-operation with associations of private industries (e.g. Associacao de Metais in Brazil) willing to provide trust funds covering different problem areas in the iron and steel sector common to a number of member plants.

PROJECT AREAS

Examples of the areas covered by the sub-sector are:

o Development and application of new technologies and advanced steel products in metallurgical industries

* Direct reduction of iron ores for the production of sponge iron (including the use of non-coking coal as a solid reductant);

* Application of modern production processes like ladle-refining, treatment under vacuum, atmospheric pressure, powder injections, temperature/chemical adjustment, etc. and casting techniques for long/flat products, direct steel rolling, continuous casting and thin slab casting and other processes such as electroslag re-melting (ESR), vacuum arc re-melting (VAR);

* High strength low alloy (HSLA) steels and controlled rolling which includes improvement in purity and chemical control, e.g. reduction in oxide/sulphide contents;

* Microalloyed steels and rolling in controlled atmosphere with relatively stable carbide- and nitride-forming elements such as Nb, Va, Ti; production of corrosion resistant steels; heat treatment and thermo-mechanical treatment of steels;

* Production of special steels and advanced heat treatment techniques;

- steels with reduced carbon content and improved weldability, toughness and ductibility, i.e.

interstitial steels, ultra-low carbon steels, micro-alloy steels
- high grade stainless steels, i.e. clad steels, duplex stainless steels
- ultraclean steels
- lining refractories
- simulation models
- near net shape continuous casting
- production of ductile iron.

* Metal matrix composites which are made by powder processes by mixing particulate materials into molten metals;

* Soft and hard ferrite production;

* Production of advanced steel products and alloys mainly covering the rapid solidification process (RSP), composites and metals (silicon, gallium, etc.) for the electronic industry;

* Introduction of dynamic models for Basic Oxygen Furnace (BOF);

* Introduction of modern materials testing methods to improve the quality and match required international standards.

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o Energy conservation, environmental monitoring, promotion of environmentally sound steel technologies and utilization of industrial wastes

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* Introduction of energy conservation policy;

* Introduction of energy management;

* Energy auditing;

* Establishment of energy training centres;

* Temperature estimation system for soaking pits for energy optimization;

* Material and energy balance to improve productivity, particularly in blast furnace operations; powder injection in blast furnaces to decrease coke consumption;

* Power factor improvement;

* Improved local capabilities and capacities in identifying and evaluating the consequences of environmental degradation and in developing adequate industrial planning and coherent environment industrial policies. This can be achieved through:

- Acquaintance with the techno-economic aspects of the introduction of preventive environment pollution measures in metallurgical plants;

- Acquaintance and application of newly developed cleaner technologies in the metallurgical branch, i.e. non-waste and low-waste (NW/LW) technologies, sludge, dust and slag reduction, recycling technologies, waste water reduction and treatment, energy conservation measures;

- Assistance in adopting and developing environment protection technologies/measures through UNIDO and UNDP.

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o Rational computerized systems in production processes, maintenance and related fields of the iron and steel industry

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* State of the art of computer application in the iron and steel industry;

* Introduction of industrial automation in iron and steel plants as a precondition for advanced technologies; automation of rolling mills;

* Production planning and control systems;

* Process optimization;

* Computerized maintenance management systems;

TECHNOLOGY SELECTION

In the sub-sector of the iron and steel industry a wide range of technologies is available. These are not necessarily, new, innovative technologies, but reflect, to a large extent, improvements made to existing processes. Most of these technologies need to be adapted to the conditions prevailing in developing countries, considering the availability and composition of local ores, scrap and reductants. The technological development efforts for new steelmaking technologies and advanced steel production in most developing countries have been very limited. Their R&D efforts have not resulted in the development and industrial application of new technologies, adjusted to their needs. Many developing countries still lack the critical elements of a technological system essential to industrial development.

When planning the establishment of new production facilities, the option of mini steel plants (with a production range of about 500,000 tons per year or more) may be an economic choice for a modest market.

The iron and steel industry programme therefore attaches great attention to

- Help developing countries to prepare master plans for iron and steel industry development;

- Prepare techno-economic, opportunity or pre-feasibility studies for the establishment of new production facilities, e.g. mini steel plants, based on scrap, applying the direct reduction or other processes which may be economic on a small scale;

- Improve capabilities of developing countries in identifying, developing and adapting new steelmaking technologies and in introducing advanced steel production;

- Promoting new technologies such as latest developments in electroslag welding, in powder metallurgy, in new clean steel making technologies and advanced products, in advanced heat treatment, low carbon steel production and coating technology and in rapid solidification processes and thermo-mechanical treatment of composites on metal matrix;

- Acquaint developing countries with the latest technologies and measures related to energy and primary resource savings during the technological routes of metallurgical production.

PROJECT EXAMPLES

The following typical project examples are either based on completed or ongoing projects or reflect recently manifested interest or requests by developing countries which need to be pursued in the future.

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o Development and application of new technologies and advanced steel products in metallurgical industries

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Problem: Limited efforts for new steelmaking technologies and advanced steel production in developing countries, including lack of R & D. Obsolete plants and technologies; limited information of available technology and equipment.

Projects: Improving local capabilities, e.g. though the establishment, strengthening or reorientation of metallurgical centres; establishment of pilot and demonstration plants; organization of study tours and training programmes to modern plants abroad to create better awareness of technological alternatives. Provision of advisory services and technical assistance on possible modernization and expansion of existing iron and steel plants through application of appropriate, up-to-date innovative technologies and to enable local companies/ governments to take investment decisions. Preparation of master plans, techno-economic and opportunity studies. Undertaking of laboratory and/or pilot testing of local raw materials to establish their suitability for metallurgical processing considering various alternatives, e.g. direct reduction of iron ores. Direct technical assistance activities will be supported by the organization of awareness seminars and workshops dealing with various technological aspects of energy-conscious steelmaking.

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o Rational computerized systems in production processes, maintenance and related fields of iron and steel industry

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Problem: Many metallurgical plants suffer from "under-maintenance", i.e. preventive maintenance is practically non-existent. Plant availability and thus efficiency is reduced owing to unexpected and often occurring breakdowns. There is a lack of complex automation system designs for technologies and know-how. Also, maintenance personnel is inadequately trained and qualified in the field of computerized production process control, quality control, computerized managed maintenance systems (CMMS), total quality management and others.

Project: Advice on how to best introduce EDP supported systems and industrial automation in a given plant, including production planning and process control systems, CMMS, process optimization systems for sinter plants, BF, BOF, EAF, ladle treatment plants, continuous casting, rolling mills, etc.; Establishment of total quality management programmes; Plant condition monitoring (to manage and distribute the inspection and service orders) and elaboration of expert systems, e.g. for fault diagnosis. Establishment of software design centres; human resource development.

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o Energy conservation, environmental monitoring, promotion of environmentally sound steel technologies and utilization of industrial wastes

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Problem: Inadequate awareness by developing countries on how to achieve a more integrated and effective use of energy and other primary resources, through the introduction of coherent and comprehensive energy conservation and waste reduction strategies. Most developing countries lack experience in dealing with environmental problems. This is particularly true for the metallurgical industries sector, being a heavy pollutant with complex environmental impacts, considering the size of the overall operation, the immense volume of resource requirements, the variety of production steps involved, the age of the industry and thus use of obsolete equipment and technology.

Project: Creation of environmental awareness in developing countries to propose ways and means to save energy and to recover valuable materials from wastes, e.g. utilization of flue dust. To promote formation of increased local capabilities and capacities in identifying and evaluating the consequences of environmental degradation and to develop adequate industrial planning and coherent environment industrial policies with particular attention to:

- Introduction of modern approach to environmental control, including supply of mobile measurement units, e.g. for air pollutants;

- Application of environmental control and industrial hygiene techniques,

- Low waste and non-waste steelmaking;

- Waste management and processing of wastes, e.g. flue dust, slag, sludge;

- Introduction of environmentally sound technologies (Preparation of techno-economic studies for the rehabilitation of metallurgical plants focused on the introduction of environmental pollution control measures).

NON-FERROUS AND PRECIOUS METALS EXTRACTION

The programme for non-ferrous and precious metals extraction promotes and implements projects related to development of extractive metallurgy in the non-ferrous and precious metals industries, including selection and application of appropriate technologies. Special emphasis is attached to ore beneficiation, production of non-ferrous metals including rare and precious metals, introduction of environmentally sound technologies, abatement of pollution deriving from metallurgical operations by improving technology, and energy conservation.

PROJECTS AIM AT:

- Choice and selection of technologies and processes, including testing of raw materials;
- Environmental auditing, monitoring and control;
- Introduction of clean technologies and pollution abatement measures;
- Pilot production;
- Rationalization of production including assistance in waste management.

IN THE AREAS OF:

- Restructuring and rehabilitation of non-ferrous metallurgical industries;
- Small and medium mineral processing companies;
- Electroplating industry;
- Evaluation of ilmenite deposits and TiO_2 containing raw materials regarding their utilization and suitability for pigment production;
- Upgrading the level of welding technology;
- Identification of investment opportunities for new products in the aluminium downstream industries.

USING THE FOLLOWING TECHNOLOGIES

- Conventional, appropriate technologies;
- Computer systems for process control and energy conservation;
- Low-waste/non-waste, recycling and clean technologies;
- Biotechnology;
- Technologies for complex utiiization of raw materials;
- Mineral beneficiation technologies.

PROJECT AREAS AND TECHNOLOGIES

o Restructuring and rehabilitation of metallurgical industrial facilities with particular emphasis on waste minimization/recycling

* Adopting remedial measures to decrease the level of pollution being caused by metallurgical production. Providing assistance to rehabilitate and restructure industrial production;

* Promotion of low-waste and recycling technology;

* Recovery of non-ferrous metals from wastes, scrap, and intermediate products;

* Recycling of lead from lead-acid batteries:
  - increasing the metal recovery through a mechanical recycling system;
  - improving the environmental conditions and occupational health situation at the working sites;

* Waste minimization and remediation of contaminated soil in the metallurgical industry including extraction of metals from slag and similar metallurgical products;

* Proper disposal and utilization of alumina residues (red mud);

* Recycling of aluminium scrap, utilization of aluminium foil scrap for powder and paste production.

o Assistance to small and medium mineral processing companies

(a) to develop and improve their beneficiation activities, involving

* Application of highly intensive upgrading techniques;

* Application of computers for the automatic control of mineral processing operations, particularly in grinding and flotation;

(b) Transfer of know-how in the field of biotechnology

* Adoption of biotechnology for enhanced gold recovery as well as other processes for metal solubilization, ore beneficiation and metals concentration;

* Bacterial leaching of copper ores;

* Use of microbes which function at high temperatures in order to accelerate reaction velocity;

(c) Technological support to small and medium-size gold-mining companies

* Assistance on the application of mercury and cyanide free gold extraction technology.

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o Assistance to the electroplating industry

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* Establishment of a Light Industrial Electroplating Centre for mastering of surface treatment technology;

* Barrel plating of complicated-shape parts and development and improvement of new technologies for precious metal electroplating in order to reduce gold consumption and lengthen the life span of products;

* Application of nickel-saving electroplating technology; research on additives;

* Development of reliable control measures and technology for efficient treatment including disposal and treatment of toxic waste.

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o Evaluation of ilmenite deposits and TiO_2 containing raw materials regarding their utilization and suitability for pigment production.

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* Raw material investigations;
* Evaluation of amenability to mineral processing and thermal treatment;
* Techno-economic studies;
* Selection of production routes, e.g. electrosmelting.

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o Upgrading the level of welding technology

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* Assessment of the needs and available technical and human resources;
* Training of trainers;
* Introduction of up-to-date techniques;
* Establishment of mobile welding training units.

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o Assistance in the identification of investment opportunities for new products in the aluminium downstream industries

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* Forged aluminium products;
* Aluminium discs, slugs and circles;
* Aluminium gas bottles;
* Aluminium collapsible tubes and laminated tubes;
* Aluminium pastes, pigments, tinsels;
* High-strength aluminium bolts, nuts, screws, rivets, etc.;
* Architectural fenestration products and accessories, e.g. aluminium square panels, suspended ceilings, aluminium grille, and other products with aluminium extrusions (furniture and interior layout, building and construction).

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o Evaluation and utilization of bauxite resources

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* Laboratory and pilot scale testing of bauxites;
* Selection of most applicable technological route.

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o Production of special aluminas, alumina hydrates and sulphates

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* Selection, laboratory and pilot scale testing of raw materials;
* Market surveys, preparation of studies.

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o Upgrading of non-ferrous rolling mills, extrusion plants and foundries

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* Assessment of the plants;
* Preparation of rehabilitation plans;
* Introduction of new products;
* Introduction of cost-saving measures;
* Improved maintenance techniques.

PROJECT AREAS

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o Restructuring and rehabilitation of metallurgical industrial facilities

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(a) In bordering areas, e.g. of Czechoslovakia, Hungary and Poland (Sub-regional Project)

Problem: The level and extent of environmental pollution in transboundary subregions, particularly in eastern Europe, can be observed visually and documented by exact analyses, satellite pictures, ever growing areas of dead forests, acidity of rain, pollution of surface and underground water, elimination of many plants and animal species, etc. Harmful effects on human health in the subregion can be documented by statistical data about shortening of human life expectancy and increase of diseases. The operating industrial facilities in the sub-region are outdated.

Project: Elaboration of detailed techno-economic reports on selected industrial facilities in the subregion which will be modernized, rehabilitated and/or restructured with extensive application of low-waste/non/waste ("clean") technologies. At the same time, problems related to elimination/ recycling of industrial as well as municipal wastes (primarily of actually or potentially toxic nature) will be tackled in an extensive manner. Close co-operation between the countries will be promoted and the technological changes made in one plant will have a multiplier effect to be followed by other plants in the region.

(b) Promotion of low-waste and recycling technology

Problem: Metallurgical operations in pyro- and hydrometallurgy lead very often to the production and final disposal of huge quantities of metal containing waste. Through promotion of clean, low-waste, energy-efficient and recycling technologies, environmental pollution can be diminished.

Rising energy prices and increasing environmental concern about gaseous emissions and pollution of soil and groundwater

accelerated the development of high-intensive processes for the treatment of primary and secondary raw materials. Recycling, will conserve the metal and, in some cases, avoid the uncontrolled release of unwanted metal containing by-products into the environment. A major problem is recycling of lead from lead-acid batteries and such projects are promoted in the first place.

Project: Improvements of existing operations combined with techno-economic studies regarding the implementation of mechanized processes for recycling lead from secondary material.

Detailed design (blue-prints) for the establishment of battery scrap collection and processing centres with detailed plans for their implementation and technical assistance in the construction/ operating phase.

(c) Waste minimization and remediation of contaminated soil in the metallurgical industry.

Problem: Slag and other residues to be recycled exist in non-ferrous metallurgy and in the iron and steel industry as well. A typical material in this category is lead smelter slag from shaft furnace operations, which usually contains more than 10% lead plus zinc. In several developing countries, such slag have been accumulated since decades. Lead and zinc from these slag can be recovered by pyrometallurgical operations leading to a saleable product with enriched contents in heavy metals and a slag for final disposal.

Another metallurgical residue posing an environmental threat is the cake from the electrolytic production of zinc. This material contains a number of dangerous heavy metals like cadmium, manganese and zinc. Safe disposal in plastic-lined ponds or further metallurgical treatment is necessary.

Project: Recovery of non-ferrous metals from waste materials (for example from lead smelter slag);

Avoidance of soil and ground-water pollution by eluted heavy metals (for example from zinc cakes) through safe disposal methods;

Preparation of techno-economic studies on heavy metal extraction from metallurgical wastes.

(d) Scrap collection and recycling of non-ferrous metals

Problem: The production of non-ferrous metals from scrap requires 5-10 times less energy than the production of primary metals from ores. There are considerable amounts of metal scrap, spread over a number of countries. At the same time the metallurgical/foundry shops experience a serious shortage of scrap to feed their melting facilities, leading to under-utilization of capacities. None or a very limited system, exist for collection and processing of metal scrap. Knowledge in sorting of scrap is important since a mixed scrap can almost completely lose its value owing to the technological difficulties of eliminating certain dangerous impurities detrimental for the properties of the future alloys.

Project: To strengthen the industrial sector by improving the supply of raw materials - metal scrap - and, hence, upgrading the competitiveness and outputs of the existing metallurgical/foundry enterprises; improvement of environment conditions.

The project needs to be implemented in three phases:

1. Techno-economic analysis and report for establishing scrap collection and processing including government policy measures.

2. Basic design for the establishment of a scrap collection and processing centre; with detailed plan for its implementation.

3. Physical facilities of a demonstration scrap collection and processing plant or, in case the country decides to establish immediately an industrial plant: technical assistance in the construction/operating phase of the plant, training programmes for the personnel.

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o Assistance to small and medium mineral processing companies to develop and improve their beneficiation activities

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Problem: Mineral processing increasingly involves the treatment of complex and finely intergrown ores. High recovery rates of valuable constituents of the ores require intensive comminution, resulting in very fine fractions of the material to be processed. Complex utilization of raw materials can be regarded today as an economic necessity, however, it implies specific technical problems related to energy-intensive grinding for mineral liberation, complicated water and water purification circuits, safely disposal of the fine grained tailings.

Project: Establishment of appropriate mineral testing laboratories and bench scale mineral processing units or support of R&D facilities in developing countries to serve small and medium-size mining companies. Promotion of a more complex utilization of raw materials by introduction of highly intensive upgrading techniques and/or computerized control of mineral processing operations.

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o Transfer of know-how in the field of biotechnology

Problem: Introduction of biotechnology into the mining industry will substantially contribute to decrease gaseous emissions deriving from metal production. Moreover, mobilization and solubilization of non-ferrous metals by micro-organisms is a cost-effective process which already found widespread application in copper and uranium metallurgy. There is limited access by developing countries to this high-tech.

Project: Training of experts and the supporting R&D work in hydro-metallurgical operations aiming at new developments in equipment for less expensive and more effective bioreactors and adaptation of microbes to conditions which increase the attractiveness of the process.

Establishment of centres of metal biotechnology in developing countries for the co-ordination of the multi-disciplinary R & D activities.

Set up and operation of bench and pilot scale units for the bacterial leaching of non-ferrous metals, especially copper.

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o Technological support to small and medium-size gold-mining companies

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Problem: A great proportion of gold from alluvial deposits is extracted by artesanal operations through simple routes. In many cases gold separation from the rocks or sands is done by gravity separation in mobile or semi-mobile units. Depending on the applied technology, the tailings of this process still contain gold in considerable concentration. Recent technologies have led to improved gold recoveries e.g. bowl concentrators and centrifugal bowl type hydrostatic concentrators.

Project: Introduction of centrifugal concentrators in small co-operatives of miners resulting in low operating costs and production of saleable gold concentrates without amalgamation.

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o Assistance on the application of mercury and cyanide free gold extraction technology

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Problem: The simplicity of the process, the low cost of investment and the high gold recovery are the reasons that amalgamation is the favoured technology of artesanal gold miners. Health risks and ecological dangers remain completely disregarded when working with mercury. Improper application of this technology, results in chronic mercury poisoning. Biochemical surveys in Brazilian mining areas show significant Hg anomalies in drinking water, in the air, in local food, especially in fish, and in the human body.

Project: Development of strategies for overcoming the mercury pollution of the environment due to artesanal gold extraction operations.

Application of alternative gold extraction processes.

Establishment of a pilot demonstration unit.

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o Assistance to the electroplating industry

Problem: In many developing countries both technology and facilities for electroplating are rather backward and labour productivity of related industry is 5 to 10 times lower than that of the international advanced level. Consumption of valuable metals,

energy and labour is high. The level of automation of the electroplating industry is often low, technology and parameter-control are outdated, quality assurance is insufficient, rules, regulations and relevant standards are lacking.

Project:

- Training of engineers and technicians in various fields, such as electrochemistry, organic chemistry, analytical chemistry, electronics, computer application, machine design, environmental engineering;

- Increase of productivity and adoption of new technologies, specially in the fields of noble-metal alloy plating; savings in traditional coatings such as nickel;

- Propagation of environmentally safe technology for efficient purification and waste treatment/disposal;

- Techno-economic comparison study on the profitability of the coal-gold-agglomeration technology with other competitive processes.

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o Evaluation of TiO_2 containing raw materials regarding their suitability for pigment and subsequent titanium production.

Problem: Since some years the TiO_2 pigment market shows a growing demand versus limited supply of suitable titaniferous materials. Some developing countries are already important producers of TiO_2 concentrates whilst others have almost untouched reserves of TiO_2 containing raw materials and could therefore participate in the boom, if their resources could be exploited. Titanium is a high-tech metal, with properties suited for the air space industry. Dioxide is widely used for paints, paper, rubber and plastics.

Project: Development of local resources, e.g. ilmenitic sands, with laboratory and pilot testing of titaniferous raw materials and determination of an environmentally sound production route for:

- Beneficiation of the sands
- Pre-reduction and electro-smelting of the concentrates

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o Upgrading the level of welding technology.

Problem: With industrial development, a large number of new industrial facilities together with their infrastructure, office buildings and housing are under construction; these projects require huge amounts of sophisticated, skilled welding work. The quality of welding can determine the strength and quality of the entire structure; therefore, construction work in several fields can be performed only by highly qualified and certified welders, equipped with proper welding machinery, jig and fixtures, and applying well-selected welding techniques and consumables.

Project: Technical and training assistance to upgrade the level of technologies and human resources in the field of welding technology, based on an assessment of capabilities. Training courses will be organized by international experts on the spot and a mobile welding training unit will be procured.

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o Assistance in the identification of investment opportunities for new products in the aluminium downstream industries

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Problem: In most countries the aluminium downstream industry consists of a large number of medium and small scale private enterprises which produce "semis" (rolled, extruded, drawn etc.), castings and some finished products mainly for domestic use. Insufficient R & D and limited product mix make diversification problematic and slow. New technologies and know-how are usually imported. However, in order to produce value-added products instead of exporting primary metal, the establishment of aluminium downstream industries would be a viable option.

Project: Based on discussions with national associations of producers and users of aluminium products and relevant manufacturers and authorities domestic market information will be collected and recommendations on new investment possibilities for aluminium downstream industries will be made, as well as suggestions on the product mix.

COMPUTERIZED MAINTENANCE MANAGEMENT IN METALLURGICAL INDUSTRIES

Under this programme particular attention is devoted to the introduction of computerized managed maintenance systems (CMMS) as a means to improve productivity. Maintenance is one of the most critical areas for an industry. A number of problems arising in industrial operations originate in the maintenance sector. Some define maintenance simply as repair after breakdown (emergency maintenance); others usually include planned maintenance, both preventive and corrective, the former being either fixed time maintenance or condition based maintenance, the latter being further qualified to breakdown versus shutdown maintenance and still others, more advanced, include plant condition monitoring into both of these categories.

PROJECTS AIM AT:

- Increased plant availability (reduced number of breakdowns and idle machine time);
- Increased manpower utilization (improved manpower performance, reduced non-productive time);
- Reduced spare parts and materials stock;
- Reduced direct and indirect production costs (e.g. energy saving extended plant/equipment life, etc.);
- Other intangible benefits and improvements e.g. improved customer service, managerial control, etc.

IN THE AREAS OF:

- Introduction of CMMS, computer based production and computer based process control;
- Computerized energy conservation;
- Software development and training centres;
- Establishment of Total Quality Management programmes;
- Introduction of computer automation;
- Plant condition monitoring;
- Application of expert systems.

USING THE FOLLOWING TECHNOLOGIES:

- Application software (which supports selected computerized maintenance functions) written in a particular programming language;

- Various computer and communications hardware (Mainframes, local area networks and PCs) and supporting system software.

ACTIVITIES

Activities are mainly devoted to

- Preventive maintenance and repair planning;
- Maintenance jobs planning;
- Spare parts requirements planning;
- Spare parts inventory and purchase control;
- Spare parts manufacturing and recondition planning and control;
- Maintenance monitoring and history.

PROJECT AREAS

The main project areas covered by the sub-sector relate to

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o Introduction of computerized managed maintenance systems (CMMS) in metallurgical plants

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o Application of computer based production and maintenance management systems

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o Computer application for production process control in metallurgical industries

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Through the introduction of computerized process control, quality control, production control, production planning, integrated information system, etc. these projects aim to improve productivity and capacity utilization and the quality of the output, particularly for competitive advanced technology products.

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o Computerized energy conservation in metallurgical industries

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Such projects will establish computerized energy auditing and monitoring and, in a later stage, a model computerized energy centre to serve the local metallurgical industries to monitor the production and utilize all energy to facilitate control over the distribution of such energy.

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o Software Development and Training Centres

The local establishment of such centres will reduce the time to put programmes into service through the local software development/ procurement by making full use of available national intellectual human resources for the automation of the metallurgical and other basic sectors of the economy. This will save foreign exchange through reduced imports of software "know-how" and licenses and adaptation to local requirements.

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o Establishment of Total Quality Management (TQM) programmes

TQM may be defined as the ability of a company to organize itself into an efficient supplier/ customer chain, with the management of information being the key to this.

Projects aim at increasing product cost competitiveness through introduction and dissemination of advanced methodologies oriented to the improvement of the quality. Simple, computer aided systems need

to be developed to avoid failures and mistakes. At the heart of any TQM there must be a system for gathering, analyzing, organizing and presenting information. Particular emphasis is given to train senior plant managers in the understanding and use of the basic tools of quality in marketing, quality specification and design, process controlling, corrective actions, statistical methods and problem solving.

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o Technical assistance in the introduction of computer automation in rolling mills

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Activities will include roll pass and reduction schedule computer automation, rolling mill order scheduling and tracking, with computer links to product distribution network, rolled product distribution and storehouse network.

The purpose of introducing computer automation in rolling mills is to ensure a smooth operation of the complex rolling process, to increase productivity of rolling mills, and to give uniform, better quality of end rolled products. The initial expert assistance covers diagnosis, analysis of rolling mill (roll wear and maintenance considerations and recommendations for improvements) pass/reduction model build-up, hardware and software support and selection and procurement, training, transfer of know-how, etc.

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o Plant condition monitoring

Predictive maintenance depends on monitoring the operation and condition of machinery. It is an effective approach to schedule repairs based on machine condition. Plant condition monitoring manages and distributes the inspection and service orders. Feedback data is stored and evaluated (weak points). Technical changes are planned and elaborated, and studies of economic efficiency are carried out. It allows the execution of the precise intervention at the ideal moment, just before a fault is about to occur. The strategy is composed of four main facets:

- condition detection;
- analysis of this condition and subsequent trend plots with alarm level setting;
- predictive detection of fault occurring;
- diagnosis of defect parts.

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o Expert systems (ES)

About a decade ago a new tool emerged to help manufacturers to solve complex problems - Artificial Intelligence. It involves the art of making computers perform tasks, which until recently only man could perform. In order to achieve this aim, powerful techniques are used to represent and manipulate the kind of knowledge that human "problem-solvers" normally apply. It can be applied to all areas, including maintenance, process control, and quality control. Most of the ES software is applied on PC platforms. However, moving of the ES to the mainframe can nowadays be done.

The field of maintenance lends itself to ES application. A large part of maintenance tasks consists in fault diagnosis. Diagnosis is a domain where ES are very efficient and reliable. Good human expertise

in maintenance is extremely rare and is never available 24 hours a day.

PROJECT EXAMPLES

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o Introduction of computerized managed maintenance systems (CMMS) in metallurgical plants

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o Application of computer based production and maintenance management systems

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Problem: The growth of costs of maintenance and repairs is marked by a steady increase in many developing countries. The increased demand for both qualified maintenance manpower and management and planning personnel calls for rationalization and improvement in maintenance productivity, planning and management. The application of Modern Maintenance Systems provides a solution to this problem.

Project: Project activities may cover major maintenance subsystem structuring and development on mainframe or PC-LAN; procurement, installation and operation of computer and communications hardware facilities, consultancy subcontracting and software packages development and extensive home and international training as well as the follow-up activities for the dissemination of know-how upon project completion. The first **CMMS project was introduced in Czechoslovakia** (East Slovakian Iron and Steel plant at Kosice). Subsequently, the project favoured technical co-operation among developing countries (TCDC) as it provided training on CMMS development, on an international level and under UNIDO auspices to other countries for example, Algeria, Egypt, India and Mexico.

In all above projects the introduction of CMMS led to a significant increase in production as well as in savings accruing from improved stock control and organization of spare parts manufacture.

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o Introduction of CMMS on a regional basis

Problem: To increase the utilization of production capacities of metallurgical and other basic industries through national and/or regional co-operative efforts in the application of computer based production and maintenance systems and introduction of related rationalization techniques. There are a number of developing countries at different stages of computerization with a need to facilitate the establishment of regional self-sustaining network of countries and through this network to enable a more dynamic development of participating countries in the sphere of industrial computerized management systems, specifically CMMS and office automation systems.

Project: To increase the self-reliance and competitiveness of the metallurgical industries of a given region, oriented to assuring high effectiveness of resource utilization, and high operations productivity without incurring large investments. Key aspects in the pursuit of higher productivity, is the better and efficient utilization of available resources and plant capacities

through the introduction of computer aided technologies. One important source of resource savings are activities related to maintenance and equipment repairs.

Through the help of the local focal point institutions, identified and made responsible for the transfer of operational know-how, the system can successfully be introduced in the agreed number of metallurgical and other plants in the region. The participating countries divide the work of system development and enhancement and promote exchange of know-how. A project along this line ("Industrial Computerized Management Systems") was successfully implemented for the European region.

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o Supporting activities

The CMMS technical assistance programme is supported by other activities, mainly the organization of Expert Group Meetings/Seminars/ Workshops on the subject of CMMS. The first expert group meeting was held at Prague, Czechoslovakia, in 1985. The second expert group meeting was held at Cairo, Egypt, in 1988. A Third Expert Group Meeting on Computerized Maintenance Management Systems was held at Singapore, in December 1991. These meetings provided fora for discussion and development of recommendations leading to formulation of preparatory assistance and technical assistance projects in the field of CMMS in the participating countries. Specifically, they come up with concepts for the formulation of preparatory assistance projects, identify cooperative opportunities (e.g. training, expert services, etc.) among the participants within the framework of economic and technical co-operation among developing countries and distribute a report with results of bilateral discussions, plan of action and recommendations and guidelines for follow-up action. Participants to the EGM are not only technical personnel with engineering/ metallurgical backgrounds, but also senior members of R and D institutions, private sector or Government planning agencies responsible for development, application and adaptation of advanced technologies.

Within ongoing project activities, UNIDO is also organizing participation by representatives from developing countries at international workshops/conferences/congresses/ fairs such as the TPM (Total Preventive Maintenance) World Congress, Tokyo, Japan, or the National Maintenance and Environmental Technology Show, Birmingham, United Kingdom, which highlight latest trends in the maintenance field.