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Working Meeting on Co-operation on
Production and Application of Machine
Tools among Selected Developing Countries

Shanghai, China
8-12 May 1989

REPORT*

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* This document has not been edited.

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EXPLANATORY NOTES

AAFMHA	The Argentinian Association of Manufacturers of Machine Tools and Allied Industries
ADB	African Development Bank
AIMPI	Indonesian Machine Tool Industries Association
CAD	Computer-aided design
CAM	Computer-aided machining
C3M	Arabic Company of Machine Tools
CKD	Completely knocked down
CMTI	Central Machine Tool Institute (India)
CNC	Computer numerical control
ECDC	Economic Co-operation among Developing Countries
EBM	Electron-beam machining
ECM	Electro-chemical machining
EDM	Electron-discharge machining
ENPMO	Entreprise Nationale de Production de Machine-Outils (Algeria)
FOMFEIA	Federation of Malaysian Foundry and Engineering Industry Association
HMT	Hindustan Machine Tools Ltd. (India)
IDRO	Industrial Development and Renovation Organization of the Islamic Republic of Iran
KOMMA	Korean Machine Tools Manufacturers Association
MIT	Ministry for Industry and Trade (Zimbabwe)
MITI	Ministry of Trade and Industry (Malaysia)
MMEI	Ministry of Machinery and Electronics Industries (China)
MOFFPT	Ministry of Foreign Economic Relations and Trade (China)
MTBC	Machine Tool Branch Chamber, China Chamber of Commerce for Machinery and Electronics Products Import and Export
NC	Numerical control
NMT	Nigerian Machine Tools Ltd.
R and D	Research and development
SMTC	Shanghai Machine Tool Corporation
SMTW	Shanghai Machine Tool Works
TCDC	Technical Co-operation among Developing Countries

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INTRODUCTION

The Working Meeting on Co-operation on Production and Application of Machine Tools among Selected Developing Countries was held in Shanghai, China, from 8 - 12 May 1989. The meeting was organized by UNIDO in co-operation with the Ministry of Foreign Economic Relations and Trade (MOFERT) and the Ministry of Machinery and Electronics Industry (MMEI) of the People's Republic of China. The event was a further effort in UNIDO's ongoing activity to foster production and application of machine tools in developing countries.

The purpose of the meeting was to:

- o Establish specific working agreements to co-operate between enterprises, institutions and government organizations, and to develop technical co-operation among the countries represented, with a view to introducing new production techniques, increasing their industrial productivity and improving the quality of their industrial products;
- o Inform participants on current technological trends in machine tools and their implications for developing countries at different stages of development; and
- o Identify information sources for developing a UNIDO data base that could serve future co-operation initiatives.

The meeting took place in conjunction with the China International Machine Tool Show 1989 (CIMT '89) at which exhibitors from 18 countries displayed their latest products. As part of the meeting programme, participants visited the exhibition both to learn the latest technological advances in the field of machine tools and to establish a mutual understanding of technological and economic basis for co-operation with Chinese machine tool and component manufacturers.

I. ORGANIZATION OF THE MEETING

The meeting was attended by 52 participants from 11 countries. The list of participants is attached as Annex 3.

Opening of the meeting

Delegates were welcomed on 8 May 1989 by Mr. Huang Zhe, Chief Engineer, Department of Machine Tools, Ministry of Machinery and Electronics Industry who served as Executive Secretary for the meeting. His Excellency, Mr. Tang Zhongwen, Vice-Minister, Ministry of Machinery and Electronics Industry (MMEI) formally opened the proceedings.

In a keynote speech, Mr. Tang Zhongwen said that the machine tools and tool industry in China was one of the important basic branches of the machinery and electronics industry. It was responsible for providing all sectors of the national economy with technology and equipment for machining. It was impossible to manufacture high-performance, high-quality engineering

and electronic products without advanced and suitable machining equipment. The level and quality of machine tools and tooling therefore exerted a major influence on the development of many industrial sectors. The Government of China thus attached primary importance to development of machine tools and had drawn up an industrial strategy giving it priority. The initiatives of central government, local government and enterprises contributed to overall planning for development of the industry.

The Government also gave full support for investments in technical improvements at enterprise level, and encourage enterprises to explore co-operation with foreign companies by way of joint ventures, co-production, technology acquisition and technology sales. Although China's machine tool industry had made considerable progress, meeting both domestic demand and supplying export markets, there was still a large gap compared to industrialized countries. This was evident in the backward industrial structure, low production efficiency and operations still at the initial stage of high technology products, such as numerical control (NC) machines and accessories.

The Vice-Minister added that many developing countries were striving to develop their national machine tool industries and faced similar difficulties. China recognised that strengthening international exchange and co-operation, in particular by exchange of experience and co-operation among developing countries, was conducive to the development of the machine tool industry of all countries. UNIDO had promoted that by sponsoring several beneficial activities. The present meeting was a good opportunity to exchange information and experience and to promote further co-operation. China's machine tools and tool industry wanted to learn from the experiences of other developing countries. Meanwhile, China welcomed the opportunity to develop technical and economic co-operation with all developing countries.

Delegates were welcomed on behalf of the Municipality of Shanghai by Mr. Li Chuwen, City Adviser. Shanghai, he said, was a developing city in a developing country, but with 40 years continuous expansion it now constituted an important industrial base. The city's comprehensive industrial system offered a good quality and skilled work force. Nevertheless, compared to international levels, it was behind in machinery technology, equipment and management expertise. The present meeting would therefore give new impetus to the industrial sector in Shanghai.

During the opening session, the Chief of the Section for Economic Co-operation among Developing Countries of UNIDO thanked the Ministry of Machinery and Electronics Industry and Mr. Liang Xunxuan, former Director of the Department of Machine Tools, MMEI, for inviting UNIDO to organize the meeting. As an important industry city, and a major centre for machine tool production, Shanghai was a very appropriate setting he added. The UNIDO representative also placed on record the Organization's gratitude to the Government of China for its generosity in bearing a substantial portion of the international and local costs of the meeting via its special-purpose contribution to the Industrial Development Fund and its funds allocated for promoting economic and technical co-operation (ECDC-TCDC). From UNIDO's standpoint, the meeting continued its support of ECDC-TCDC in the machine tool industry, following on from a similar meeting organized in Buenos Aires, Argentina in July 1988.

Election of officers

Mr. Chen Renhui (China), Deputy Director, Department of International Co-operation, MMEI was elected Chairman. Mr. Héctor Pasi (Argentina), Director, INTI Research Centre for Machine Tools and Tooling was elected Vice-Chairman. Mr. Ademola Banjo (Nigeria), Life Vice-President, Lagos Chamber of Commerce and Industry, was elected Rapporteur.

At the request of UNIDO, Mr. Huang Zhe, Chief Engineer, Department of Machine-tools and Tools, MMEI acted as Executive Secretary of the Conference. Mr. Lu Jicheng, Senior Engineer, Department of International Co-operation and Ms. Wang Xiaoyu, Deputy Chief, Division of International Co-operation, Department of Machine-tools and Tools, MMEI acted as Liaison Officers.

Adoption of the agenda

The meeting adopted the following agenda:

Opening of the meeting
Election of the Chairman, Vice-Chairman and Rapporteur
Adoption of the agenda
Presentation of the host country and expert papers
Presentation of national papers
Bilateral discussions on co-operation projects
Discussion and adoption of conclusions and recommendations
Adoption of the draft report
Closure of the meeting

The work programme is attached as annex 4. Formal papers presented or made available for the meeting are listed in annex 5.

Adoption of conclusions and recommendations

The meeting adopted the draft conclusions and recommendations at its last session on 12 May 1989.

Closure of the meeting

Reviewing the week's activities, the Chairman said that they had promoted mutual understanding on the requirements and possibilities for the development of the machine tool industry. In particular delegates had got to know better the capacity and level of machine tool and tool industries in China. They had explored possibilities for co-operation both in the bilateral discussions and daily contact, recording their results in working agreements on technical and economic co-operation.

The Chairman added that although the meeting had achieved its objectives, much follow-up work would be needed by the delegates in order to bring about the formal agreements necessary for technical and economic co-operation to materialize as effective collaboration.

The Chairman noted that developing countries shared a common task in developing their national economies and improving the welfare of their people. They should take advantage of each other's strong points, make up each other's deficiencies, help supply each other's needs and try to establish mutually-beneficial collaboration in every possible way in order to achieve common prosperity and social progress.

The Chairman also hoped that UNIDO could accept the useful proposals raised at the meeting and give them vigorous financial and other assistance. The successful holding of the meeting itself was a further example of UNIDO's work for promotion of friendly collaboration among developing countries.

The Chairman promised that China's Ministry of Machinery and Electronic Industry would always do its best and contribute persistently to south-south co-operation. He thanked the delegates for their contributions and the department supporting personnel in Shanghai, especially the Shanghai Machine Tool Research Institute, for their excellent arrangements.

The head of the Indian delegations, on behalf of all participants, thanked the organizations that had arranged the meeting. The Chief of the Section for Economic Co-operation among Developing Countries thanked the Chinese authorities and institutions for their excellent arrangements and their generous hospitality offered to the meeting participants. He assured participants that UNIDO, if requested, would continue to provide the necessary support within the limits of available funds.

II. SUMMARY OF STATEMENTS DELIVERED AT THE PLENARY SESSION

The representative of the UNIDO Engineering Branch explained UNIDO's role as a purveyor and mobilizer of technical assistance for the machine tool industry in developing countries. He described a number of examples where UNIDO had helped built up institutions concerned with machine tools, for example the Central Machine Tool Institute in India, the Institute of Controlled Machines in the Democratic People's Republic of Korea and the Machine Tool Design and Development Centre for the Machine Tool Association in Indonesia. UNIDO work on tooling, was exemplified by support for the Metal Industries Co. in Trinidad and Tobago. In China, special assistance had been sought in the field of fine blanking technology. Reference was also made to UNIDO substantial work in the form of studies to support development and planning the machine tool industry in different countries.

A representative of the UNIDO Special Projects and Activities Division explained the role of trust funds as a financial mechanism to assist industry at enterprise level, in particular as a vehicle to promote effective follow-up to working agreements reached between participants during the meeting. Trust funds were presented as a way in which UNIDO could respond quickly to requests for assistance with jointly-funded pre-investment activities, rehabilitation or revamping studies, training and technology acquisition. Trust funds, it was suggested, were a mechanism by which potential co-operation partners could save themselves time, trouble and money compared to a similar package of services from commercial, and less neutral, organizations.

The President of the China Machine Tool and Tool Builders' Association, whose over 1200 member enterprises account for some 96 per cent of China's machine tools and related tooling, invited participants to attend the China International Machine Tool Show, CIMT '89.

The head of the China delegation presented a detailed account of the development of the machine tool industry since the early days of the People's Republic. China was now giving serious attention to the characteristics of enterprises in other countries in order to work out a policy and guidelines for restructuring the industry.

Technology transfer, co-operation and exports had developed strongly under the Government policy of "reform and open to the outside world." By 1988 the industry had concluded over 100 contracts aimed at importing, digesting and assimilating advanced technology from industrialized countries. More than 40 enterprises were involved in co-production with foreign partners. To support and promote co-operation with further partners, favourable policies now include giving priority to co-produced goods over imports for the domestic market. The Chinese enterprises involved in such co-operation would receive investment support for rehabilitation. Foreign partners had also gained by their increased supply capability as a result of buyback agreements.

China's machine tool industry recognized that despite considerable export success with traditional and highly-engineered machines, there would have to be a wider variety of export products, improve product quality, cut down delivery time, offer better service and adapt products to different market conditions.

Alongside export of machine tools and tooling, there had been breakthroughs in export of technology and capital, especially in cutting machines, and measuring and cutting tools, where technology had been transferred and joint ventures set up in other developing countries. Strengthening relationships and co-operation among developing countries would certainly yield good results. China's industry could supply most of the mechanical machining at a suitable level of technology equipment needed by developing countries and featuring low price, easy operation, simple maintenance and adapted to local conditions. Offers ranged from turnkey plants to technology transfer and joint ventures.

In countries where the technical level of the machine tool industry was higher, China wanted either to acquire that technology or establish joint development and joint design capability. Key products in this context were electromechanical products and complete systems for the automobile, energy resources, raw materials and textile industries. China wished not only to export product technology and set up joint ventures abroad, but also to import technology to meet domestic needs. Delegates were warmly welcomed to invest in joint ventures in China.

All the participants presented a short summary of their formal papers outlining the situation of the machine tools industry in their countries. The presentations highlighted the present status of the development of this sector, the problems encountered by machine tools builders and users, and the possibilities for solving some of these problems by means of co-operation with other developing countries.

Algeria's co-operation potential derived from a national strategy aimed at increasing self-sufficiency, development of the capital goods sector, better maintenance capability and higher skill levels. In the medium-term production would be built up as follows: mechanical press unit (1989), metal carbide tools unit (1990), small machines unit (1992), metalforming machine tools and plastics processing moulds (1992), high-precision steel cutting tools (1995) and a research and development unit (1996). The Algerian delegation presented three specific co-operation proposals for consideration: (1) joint venture to manufacture boring and saw machines; (2) joint venture to manufacture high-speed cutting tools; (3) joint development of products in the existing range manufactured by Entreprise Nationale de Production de Machine-Outil.

In Argentina, the machine tools industry had suffered because of the general decline in investment and unfavourable trends in the rate of exchange, the Argentine delegation reported. Anticipating resumed industrial growth, the machine tool sector would probably see a number of manufacturers supplying equipment equally to domestic and export markets. Whatever the macroeconomic development, the industry would require changes in design and production technology, marketing and financing, and human resources. International co-operation could play a decisive role in the field of training human resources, for example management training for the metalworking industry and for CNC operators, for which a shortage was already foreseen. Together with UNIDO, Argentina was preparing a plan to establish a training centre for these and related topics, e.g. CAD, CAM and robotics.

India's delegation reported on future pattern of demand as seen by a Government working group. Some previous foreign collaborations would be optimized and some manufacturers would reap the benefits of their in-house R and D. There was a trend in the engineering sector to use increasingly sophisticated machine tools supplied by Indian manufacturers, who would regain some of the production share lost in recent years to imports. Indian machine tool manufacturers still depended on imports of critical components such as CNC systems, control, AC and DC drives, brake motors, ball screws and linear guideways.

In this context, the Indian delegation made a number of suggestions for collaboration: (1) given the limited overall demand, assistance and collaboration for their manufacture in larger quantities would be needed; possibilities included precision components such as ball screws, linear guideways, special quality bearings, servo and spindle motors and their controllers; production on a joint basis with other developing countries would be one solution; (2) similarly, both general purpose and special chips required in CNC systems and other controllers were imported from industrialized countries; such chips, together with software for NC/CNC machines could be developed in developing countries; those countries may need policies offering a preferential rate of import duty on such products, however; (3) there was also scope for joint ventures and collaboration in certain types of machine tools and auxiliary equipment, including certain varieties of CNC machine tools; (4) foreign manufacturers could consider joint R and D projects with India's institutions engaged in R and D and in adapting overseas machines and equipment for the Indian market; (5) many developing countries needed sophisticated tool rooms to back up their engineering industries: India was ready to set them up on a turnkey basis; (6) India's institutes and industrial enterprises had long experience in training technical manpower of India and from other developing countries in different fields of engineering, operation and maintenance, after-sales service, operation of NC/CNC machines and writing and programming of software; India could also set up training institutes on a turnkey basis.

Indonesia's plan to develop its own machine tool production had been a key element in the national industrial plan for 1984-1989, Pelita IV, the Indonesian delegation reported. During this period, the Indonesian machine tool builders started to produce standard and universal type machine tools. Under the current plan for 1989-1994, Pelita V, the industry would develop single-purpose, NC-machines, automatic machines, and non-conventional machines such as EDM. Domestic machine tool producers, which were organized as the Indonesian Machine Tool Industries Association (ASIMPI), would be supported with Government interest subsidies and fiscal incentives, and protective duties and regulations. Local technology would also be supported by industrial, R and D and testing and licensing institutions. Transfer of technology would be accelerated through increasing local content, licensing, technical assistance and development of joint venture businesses and production.

Planning reported for the machine tool industry in the Islamic Republic of Iran featured new projects designed to produce self-sufficiency in conventional machine tools and capability of exporting, while having flexibility to manufacture non-conventional machines later. Special purpose machines would be designed and manufactured in specialized engineering centres. A centre would be established for technical information and data collection to assist technology transfer. R and D centres would follow trends in advanced technology, design and production of CNC machines and industrial robots. R and D units would be activated at industrial plants.

Despite good engineering and research capabilities for electronic maintenance, design and manufacture of digital reachouts and spark erosion machines, the delegate from the Islamic Republic of Iran noted shortages of expertise and qualified engineering manpower, special in product design, technology and production processing were still evident. A further problem was that user industries did not use machines effectively and economically and optimum benefits were not achieved because CAD and CAM were not well enough known.

Capacity limitations meant that part of the \$100 million estimated annual demand for machine tools in the Islamic Republic of Iran could not be covered by domestic production. Co-operation with other developing countries would therefore be welcomed.

In the Republic of Korea, the machine tool industry could now supply the majority of domestic needs, the head of the Korean delegation said. Prospects were for increased growth as local demand expanded with large-scale investment in automobile and electrical goods, supplementary and replacement equipment for the small- and medium-scale sector, and increasing preference for domestic machine tools as their technology advanced. International joint ventures would increase with the industrialized and advanced developing countries for high-level machine tools, with less developed countries for lower-level products. Korea's development strategy included Government-supported programme for NC gear-hobbing and gear-shaving machines, internal grinders, NC vertical lathes, angular cylindrical grinders, multi-spindle NC lathes, NC tool grinder, and jig grinders. The aim was to raise the domestic production of parts for NC machine tools (some 50 per cent in 1985) with development of NC controllers, rotary index tables, hydraulic chucks, servo motors, hydraulic motors and accessories for NC controllers.

Malaysia was embarking on a strategy of phased development in which production of machine tools would be taken up as engineering moved into medium-level production technology. Priority would be given to core products, where production of moulds and dies headed the list. Mould and die manufacturers together with metal fabricators were the major users of machine tools. Malaysia was not yet a producer of machine tool but they were accorded priority under the Promotion of Investments Act, giving producers tax exemption.

The Morocco delegation reported the progress of the multinational production enterprise, Arabic Company of Machine Tools (C3M) between Tunisia and Morocco, and the Arab Industrial Investment Co. (Baghdad). Based on licences from industrialized countries C3M manufactured lathes and milling machines and intended to develop NC machines. Past co-operation with developing countries included purchase of components from China and Algeria, manufacture of castings for Algerian milling machines and sales of C3M machines in Tunisia. C3M was interested in (1) buying other components from developing countries and expanding its supply of castings; (2) joint development of NC machines adapted to the Arab market; (3) joint ventures to expand the existing range of C3M machines.

Nigeria's machine tool industry owed its existence to a UNIDO study in 1978 and substantial economic and technical co-operation with HMT Ltd. in India to provide designs, machinery, equipment, technical and engineering manpower and management skills for a selected range of machine tools. The plant, Nigeria Machine Tools Ltd. (NMT), which had operated since 1980 required a foundry and development of in-house castings. It also needed to develop a design and development capability to progress to the next generation of machine tools, i.e. training and laboratory facilities. Nigeria now intended to develop smaller machine tool firms each specializing in one or two types of related machine tools. Local firms would also develop cutting tools and accessories. Three areas were proposed for immediate co-operation by the Nigerian delegate: (1) production of abrasives for grinding and hard-finishing operations; (2) manufacture of drilling and tapping tools, milling cutters and gear-cutters; and (3) production of measuring tools and appliances for workshop use.

Zimbabwe's machine tools - drilling machines, milling machines, lathes and grinding machines - were initially imported, but spare parts were than partly met locally. Users had suffered from obsolete machinery and suppliers' failure to meet specifications and standards, the Zimbabwe delegate reported. Another constraint was the high cost of imports and spare parts. The prospects for the industry depended on an ADB financed-study that inter alia would examine the feasibility of a revolving fund for companies to procure new equipment with CNC and CAD features. Manufacturers believe a number of small machine tools should be produced in Zimbabwe and would be seeking joint ventures and other technology transfer arrangements.

III. IMPLICATIONS OF CURRENT TECHNOLOGICAL TRENDS FOR DEVELOPING COUNTRIES

During the opening session, the UNIDO consultant presented a plenary paper on the implications of current technological trends in machine tool technology for developing countries. Noting developments in machine tool design - including structure, guideways and bearing surfaces, spindle systems, feed drives, mechanical drive elements, design accuracy, the trend to modular construction, computer-aided design, high-speed machining, noise and safety, and energy management in metalworking - he reported on research aimed at higher and easier chip disposal, improved systems of workpiece loading and unloading, safety, ergonomic, energy conservation, faster tool and workpiece clamping, and cutting with more than one tool simultaneously.

Machine tool control systems, the consultant pointed out, had changed rapidly in the last ten years. Development of computer technology had made possible introduction of CNC machine tools which themselves had drastically changed manufacturing technology. Further developments would increase machine tool capability in order to allow more functions to be monitored and controlled by uses of advances in computer technology. There would be new complex and high-performance controls, together with simple low-cost versions suitable for less complex parts, compatible with manufacturing systems. In the design of machining centres, more sophistication was now built in to permit machining in a single set-up, with four- and five-axis now replacing two axis, and contouring tables to function as the fourth axis. Control systems were not being built as an integral part of the machine tool itself, production of NC tapes through voice command was already a reality, and microprocessors would soon replace wheels, gears and mechanical relays--all leading to unmanned operations at factories.

The share of metal-forming machine tools, accounting for barely 10 per cent in the 1950s had been steady at 24 per cent until 1988, but would rise to 30 per cent by the end of the century. Forming had a bright future because it allowed reductions in machining sequences, and material conservation. Newly developed high-precision die-casting and forging techniques, precision-blanking and sheet metalworking, advances in powder metallurgy, fine-blanking, NC and CNC punching, investment castings and cold extrusion, and forming by compressed gas-, water hammer-, fuel combustion- and explosive-forming offered more economical production routes. Also non-traditional electromechanical, electrochemical, plasma, laser, machinery had found increased application.

Turning to the technology gap and its implications for developing countries, the consultant said that licensors were unlikely to license their latest designs, which in any case would entail massive investment in resources to master the technology. Nevertheless, despite the low volume of demand for highly sophisticated machine, several newly industrializing countries (the People's Republic of China, the Republic of Korea, Singapore, India) and Taiwan Province of China had moved into CNC machine tools and machining centres. But the technological gap could only narrow if modernization took place in the production technology employed by the machine tool using industries.

The major technology gap lay in the area of microelectronics, where for example the industrial application of modern computer technology had a lot to catch up. Developing countries producing CNC machine tools used designs belonging to older generations, the consultant warned. In manufacturing systems, although large-scale introduction of robots was a distant cry or even undesirable for most developing countries, but robots could be used for specific tasks that were impossible or undesirable for human performance. This could not be achieved, however, without strong support of computer science.

In metalforming, while industrialized countries were moving ahead with research on processes to form high-strength alloys into complex shapes, even the newly industrializing countries were confined to licences of simple types of cold forging, extrusion, fine blanking and NC punching. In non-traditional machining, a survey showed developing countries employing only electron-discharge machining (EDM), electrochemical machining (ECM) and electron-beam machining (EBM). Of these, EDM was used increasingly to produce high-precision die and press tooling; EBM welding had growing importance in aircraft, aerospace and atomic energy industries.

Economic and technical co-operation was one approach to minimizing the widening technological gap between developed and industrialized countries, the consultant advised. While this could be highly profitable to both parties, there were many practical hurdles. Co-operation in machine tools took time and patience, requiring closer understanding and friendship between the partners. It should also be on a continual basis. As in North-South collaborations, there also existed scope and possibilities among the developing countries themselves for turnkey projects, licensing, selective collaborations, production sharing, joint development of designs, joint ventures and third country collaboration.

IV. RESULTS OF BILATERAL DISCUSSIONS ON CO-OPERATION PROJECTS

The bilateral discussions, aimed at identifying co-operation opportunities among participating countries, were held on 11 May 1989 following an all-day visit to assess China's machine tool technology displayed at the concurrent China International Machine Tools Show 1989.

A total of 31 working agreements were reported. They included exchange of information, technical assistance, training, joint ventures, co-production, supply of components and representation.

UNIDO together with China's Ministry of Machinery and Electronics Industry would undertake follow-up activities to promote practical realization of the working agreements.

The results of the bilateral discussions are summarized as Annex 2.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The meeting recognized that, because of the high added value of metalworking and capital goods, manufacturing contributed significantly to economic growth in nearly all countries. Machine tools and their applications played a key role in development, improvement, diversification, expansion and upgrading of product quality of both sectors. The machine tool industry, developed and expanded through technological innovation, therefore represented one of the most important capital goods.

Delegates confirmed the four categories of developing countries identified at the 1988 ECDC machine tools meeting in Buenos Aires as:

- o Little or no manufacturing of machine tools
- o Capability to manufacture but not yet committed
- o Capability to manufacture basic machine tools and wishing to diversify into advanced CNC machine tool manufacture
- o Established suppliers of all types of machine tools, including CNC.

The group nevertheless noted that some developing countries still had not sufficiently developed the machine tools industry and the related training required for tool design, manufacture and application. An appropriate response in such cases would be to establish, where they did not already exist, metalworking and/or machine tool associations of manufacturers and users in order to pool common interest and formulate national policies and strategies for supporting the metalworking industry and its machine tool suppliers. This would accelerate development of metalworking and capital goods as well as machine tools.

It was agreed that technical co-operation would advance the state of machine tool technology and develop new markets as common interests of participating countries. Delegates felt that technological and economic co-operation should be particularly encouraged among those developing

countries with comparatively solid foundations in machine tools, such as the People's Republic of China, India and the Republic of Korea. Areas of mutual interest were joint R and D, joint design and production sharing. To achieve this, however, further efforts aimed at improving mutual understanding were necessary. At the same time, these countries could assist less developed countries with a large machine tool demand to update their industries.

The meeting agreed that co-operation among developing countries in the field of machine tools should involve improvement in design and engineering capabilities, as well as commercial benefits. Thus engineering training would be included in every agreement. The Islamic Republic of Iran was ready to provide training opportunities in selected areas for the benefit of other developing countries. Because of financial constraints, commercial relations should emphasize exchange of industrial components and products, taking advantage of markets, facilities, manpower and other opportunities.

Delegates considered that workshops such as the present one on production and application of machine tools among selected developing countries should be organized by UNIDO annually. Delegates felt they were effective for strengthening relationships and promoting co-operation. Some participants saw them as a vehicle for providing participants with information on, *inter alia*, production statistics, market trends and guidance on what standard equipment to produce for education and training purposes. They would also exchange information and views on problems encountered in areas of design and production technologies using both conventional and advanced systems such as CNC machining, CAM and CAD.

A key element in such meetings was identification of areas of co-operation among developing countries which could be of mutual interest and benefit. In one proposal, visits to local manufacturers should be arranged for a period of two days during the meeting. Some delegates took the view that participation should be invited via machine tool industry associations, and that the benefits were such that association members would finance their own travel and expenses. One delegation proposed that the next meetings be held in India and the Republic of Korea. Indonesia also expressed willingness to host such a workshop. An early opportunity for a follow-up meeting in connection with a machine tool show, mainly for participants from North African and Arab countries, would be the International Trade Fair in Morocco in 1989 or 1990.

Recalling a recommendation of the Buenos Aires meeting that a data bank in the technology of machine tools be established to enable rapid access to information for countries wishing to enter into technology transfer agreements, delegates considered that a flexible and fast-acting mechanism should be set up exclusively for machine tools. This would match supply and demand for machine tool technology in all countries, both developing and industrialized. Such a mechanism could be established by UNIDO and interested machine tool builders associations in each country. The task of the associations would be to gather appropriate information from their members, and to circulate information on technology required and offered on machine tools and accessories in other countries. UNIDO would process the data received and redistribute it in computer-readable form to the associations. On request, and subject to funds, UNIDO would also assist the parties in any negotiations that resulted from matching supply and demand within such a system.

Recommendations

- (1) Based on contacts established during the meeting and identified areas for co-operation, participants should continue negotiations in order to establish legally binding co-operation agreements;
- (2) Co-operation should be promoted in the fields of research and technical development for machine tools, the priorities being determined on the basis of consensus. The substance, scope, implementation and distribution of costs of such co-operation should be subject in each case to special agreements between contracting parties. Such co-operation, which could be supported by UNIDO trust fund arrangements, could involve exchange of information on machine tools, exchange of experts and other research and technical personnel, expert meetings, provision or procurement of advisory and other services, and implementation of co-operative or co-ordinated research or development projects. Based on project plans drawn up by the contracting parties, each country would provide experts, researchers, technicians and the facilities for their effective performance. Representatives of the contracting parties should meet regularly to inform each other of the progress and agree on further measures.
- (3) UNIDO should, on request of the co-operating partners, and subject to availability of funds, promote the follow-up of preliminary agreements reached during the meeting, particularly by means of trust-funded supporting activities such as pre-feasibility and feasibility studies, study tours and exchange of experts.
- (4) UNIDO should, at the request of Governments, and subject to availability of funds, continue to provide technical assistance to developing countries in the field of machine tools; specifically this should include development of short and introductory training courses, geared particularly for the needs of the African region. These would cover: an introduction to the machine tool industry, the role of the machine tool industry in the economies of developing countries, TCDC in machine tool industries and machine tools in selected user industries (vehicle manufacture, railway maintenance, standards and quality control, metrology).
- (5) UNIDO should continue its efforts to promote regional and inter-regional co-operation among developing countries in this industry; in particular it should support, subject to availability of funds, and arrange mutual visits to the more advanced machine-tool producing developing countries; at the same UNIDO should assemble expert study teams from these countries to advise and assist their counterparts in less-advanced machine tool producing countries and promote economic co-operation with them;
- (6) UNIDO should, subject to availability of funds, respond to specific invitations from the countries represented at the meeting, and annually organize similar meetings in connection with other international machine tools shows as a follow-up to the present meeting in Shanghai;

- (7) UNIDO should take the initiative in establishing an inter-regional network of national machine tool manufacturers and users associations as the focal points of a machine tool technology supply data base and information system. Comprising data on technologies available from both developing and industrialized countries, the data base would rely largely on the associations to supply information on their own members technologies and to disseminate to them information received from UNIDO biannually. Subject to availability of funds, a pilot scheme could be demonstrated at the next ECDC machine tools meeting.

Annex 1
Machine tool technology offered by China's machine tool industry

Project sponsor	Type of co-operation	Project description
China Czechoslovakia Friendship Works, Shenyang	Technology transfer and supply of equipment and services	Transfer of drilling machine technology: (1) radial drilling machine with 32-50-mm maximum drilling dia.; (2) longitudinal boring machine with 90-130-mm dia. boring spindle
Jinan No.1 Machine Tool Works, Jinan	Expertise and advice, supply of equipment and services, joint ventures	Export of complete technology for manufacturing general purpose lathes: (1) 320 mm dia. series/parallel lathe; (2) CNC lathe with or without CNC control systems
Kunming Machine Tool Works, Kunming, Yunnan	Technology transfer	Transfer of manufacturing technology for horizontal boring machines: (1) Model T619A, 90-mm boring spindle dia.; (2) Model TX619A, 90-mm boring spindle dia. with digital display
Shanghai Machine Tool Works, Shanghai	Supply of equipment and services, joint ventures	Transfer of grinding machine technology: (1) Model 1432B universal cylindrical grinding machine, dia. 320 x 750; (2) Model M7120D horizontal surface grinding machine with rectangular table, 200 x 630 mm
Shanghai Metalforming Machine, Shanghai	Technology transfer	Transfer of technology for straight-side single-point press: (1) Model JA31-160 1600 KN straight single-point press; (2) Model J44-55 5500 KN underdrive-type double-action press
Changsha Machine Tool Works, Xin Kaipu, Changsha, Hunan	All types of co-operation	Transfer of technology for shaping and broaching machines: (1) Shaping machines, 630 mm and 1,000 mm maximum shaping length; (2) Broaching machines, 50-, 100-, and 400 KN
Shanghai No.2 Metalforming Machine Plant, Shanghai	Technology transfer	Transfer of technology for open-back inclinable press: Models J23-16, J23-40 and J23-60

Project sponsor	Type of co-operation	Project description
Tianjin Metalforming Machine Tool Works, Tianjin	Supply of equipment and services, joint ventures and co-production	Transfer of hydraulic press technology: (1) Grinding wheel hydraulic press; (2) 100-ton lapping hydraulic press; (3) Four-column hydraulic press; (4) Single-action stamping and drawing press
Suzhou Grinding Wheel Factory, Suzhou, Jiangsu	Supply of equipment and technical services, joint ventures	Transfer of technology for vitrified bond grinding wheel and sintered corundum grinding tools
Hanchuan Machine Tool Plant, Hanzhong, Shaanxi	Technology transfer, co-production and joint ventures	Provision of drawing and manufacturing know-how for: (1) HCD series of EDM machines; (2) Model T611A-B horizontal boring machines
Shanghai Punching and Shearing Machine Works, Shanghai	Technology transfer and joint ventures	Transfer of technology to manufacture hydraulic swing beam shears and hydraulic press brakes: (1) Model QC12Y - 4 x 4000 hydraulic swing beam shears; (2) Model WC67Y - 100/3200 hydraulic press brakes
Sichuan Dujiang Woodmaking Machine Tool Works, Dujiangyan, Sichuan	Technology transfer, co-production and joint ventures	Transfer of technology to manufacture woodworking machinery to manufacture furniture, furniture components
The Sixth Institute of Project Planning and Research of the Ministry for Machinery and Electronics Industry	Transfer of technology, supply of equipment and advisory services	Co-operation in design of complete plants and individual equipment: machine tool plants; measuring and cutting tool plants; fastener plants; foundries, forges and heat treatment facilities; special-purpose machine tools and industrial and domestic buildings
Shanghai Die Casting Machinery Works, Shanghai	Technology transfer and supply of equipment and advisory services	Transfer of technology to manufacture die casting machinery: (1) Model JZ213B 25 T hot chamber die casting machine; (2) Model JII25E 250 T cold chamber die casting machine

Annex 2

Results of bilateral discussion of
co-operation projects

Proposer or main beneficiary	Country of Counterpart	Counterpart Organization	Type of Co-operation	Project description
Algeria:				
P.M.O.	Morocco	C3M	Joint venture co-production co-production	Mutual representation by 1989; arrangements for complementary industrial production; exchange of licence and processes know-how; participation in joint ventures
P.M.O.		UNIDO	Technical assistance	Expertise to develop factory standards; study tours on CNC control units and R and D institutions
P.M.O.	China	Shanghai Tool Works	Joint venture	Joint feasibility study for a cutting tool factory to manufacture high-speed cutting tools; transfer of know-how, equipment, technology and training
Argentina:				
AAFMA	China	MMEI	All types	Co-operation in CNC punch presses, sintering presses, rotary table for hydraulic press, turning centre, heavy-duty milling machine, hobbling machines, combined shear and punch press.
China:				
MMEI	Argentina	AAFMA	Licence, joint production, joint ventures	Study tour for discussion of technology and finalization of co-operation projects
MMEI	Argentina	AAFMA	All types	Purchase by China of technology and products from Argentina; purchase by Argentina of Chinese machine tool technology, and machine tool components; distribution of Chinese promotion materials to AAFMA members

Proposer or main beneficiary	Country of Counterpart	Counterpart Organization	Type of Co-operation	Project description
Shanghai No.2 Metalforming Machine Tool Works	Argentina	AAFMHA	Technology transfer	Quotation on open back press; proposal for open-back Metalforming and high-speed precision press production in Argentina
Jinan 1st Machine Tool Works	Argentina	AAFMHA	Distribution	Sales of lathes and component parts for assembly in Argentina and neighbouring countries; exploration of design co-operation
SMTW	Argentina	AAFMHA	Licence	Production of grinding machines in Argentina
Chengdu Measuring and Cutting Tool Works	Indonesia	ASIMPI	Joint venture	Production of high-speed drill in Indonesia
Jinan First Machinery Works	Indonesia	ASIMPI	Technology transfer	CKD supply of CNC lathe without controller; Tool technical assistance to produce other lathe.
Kuming Machine Tool Works; The Sixth Institute of Project Planning and Research, MMEI	Iran	IDRO	Technology transfer	Design and supply for new machine tool plant in Iran; training assistance for Iranian engineering research and training centres
Shanghai Machine Tool Works	Republic of Korea	KOMMA	Co-production	Production of components and parts for large mechanical and Metalforming hydraulic press for automobile industry in Korea; exchange of technical data; supply of technical personnel to Korea; exchange of visits
Chengdu Measuring & Cutting Tool Works	Republic of Korea	KOMMA	Co-production, joint venture	Production of tools and measuring equipment in China

Proposer or main beneficiary	Country of Counterpart	Counterpart Organization	Type of Co-operation	Project description
CMEC	Malaysia	FOMFEIA	Joint venture	Development of machine tool plant in Malaysia
Changsha Slotting Broaching, Shaping Machine Research Centre	Malaysia	FOMFEIA	Representation	Sales of shaping machine in Malaysia
Tianjin Metal-forming Machine Tool General Works	Malaysia	FOMFEIA	Representations	Sales of metalforming machines in Malaysia
Chengdu Measuring & Cutting Tool Works	Malaysia	FOMFEIA	Joint venture	Production of cutting tools and/or measuring instruments in Malaysia
Souzhou Grinding Wheel Factory Sixth Institute of Project Planning and Research, MMEI	Nigeria	Lagos Chamber of Commerce	Technology transfer	Provision of project proposals including preliminary plant design for (1) carborundum and silicon carbide (up to 5,000 t/y); (2) manufacture of grinding wheels (1,000 - 2,000 t/y) and abrasives cloth paper; establishment of two factories in Nigeria
India:				
HMT/CMTI/Indian industry	Algeria	ENPMO	Licence and joint venture	Feasibility studies for cutting tools, carbide inserts and development of R and D capability
HMT/CMTI/Indian industry	Argentina	AAFPHA	Licence and technology transfer	Sintering press, rotary table for hydraulic press, universal iron worker (combination shearing and punching), CNC turning centre, CNC punching machine, hobbing and shaping machine, heavy mills and other equipment

Proposer or main beneficiary	Country of Counterpart	Counterpart Organization	Type of Co-operation	Project description
HMT/CMTI/Indian industry	China	MTBC	Technology transfer	Identification of Chinese machine tools not made in India
HMT/CMTI/Indian industry	China	MMEI	All types	Exchange of visits to explore co-operation
HMT/CMTI/Indian industry	Iran	IDRO	R and D	Joint R and D (CMTI and IDRO); training in welding; India experts to guide and train at Iranian institutes
HMT/CMTI/Indian industry	Malaysia	FOMFEIA	Licence, technical assistance	Establishing auxilliary unit for production of automobile accessories
HMT/CMTI/Indian industry	Zimbabwe	MIT	Training	Training of post-graduate engineers of Zimbabwe
Indonesia:				
P.T. Dacau	China	Shanghai Machine Tool Works	Information exchange	Chinese samples for display at Jacoda Indonesia exhibition (August 1989); discussion of possible agency agreements. Indonesia to detail required machine tools for pricing purposes and further negotiation
P.T. Toolsindo	China	Hanchuan Machine Tool Works	Joint production	EDM production in Indonesia with output of 100 units/y; technical assistance on manufacture of components and parts
P.T. Dacau	China	SMTC	Joint venture	Production of lathes, milling machines and punching machines with 65% of components supplied by SMTC

Proposer or main beneficiary	Country of Counterpart	Counterpart Organization	Type of Co-operation	Project description
Islamic Republic of Iran:				
IDRO	China	MMEI	Training	Assistance to engineering research and training centres in the Islamic Republic of Iran
Malaysia:				
FOMFEIA		UNIDO Engineering Branch	Technical assistance	Expert to assess infrastructure to support metalworking industry, identify bottlenecks and propose solutions aimed at progressive entry into machine tool manufacture
Morocco:				
Compagnie Arabe de Machine-Outil (C3M)	China	Gansu Provincial Machine Building Industrial Corp.	Co-production	Manufacture of lathes in Morocco

Annex 3

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Annex 4
Work Programme

Monday 8 May 1989

- Opening ceremony
- Election of officers
- Presentation of UNIDO programmes for promoting economic and technical co-operation among developing countries, technical assistance in the field of machine tools and the trust fund programme as a means to support follow-up of working agreements
- Presentation and discussion of the China national paper on development of co-operation among developing countries' machine tool industries
- Presentation and discussion of technology trends in machine tools and their implications for developing countries, conducted by the UNIDO consultant

Tuesday 9 May 1989

- Presentation of country papers on national developments in machine tools and possibilities for co-operation with other developing countries
- Organized visit to the Shanghai Machine Tools Works and Shanghai Cutting Tool Works

Wednesday 10 May 1989

- Organized visit to the China International Machine Tool Show (CIMI 89) in small groups

Thursday 11 May 1989

- Bilateral negotiations guided by UNIDO staff and international consultant

Friday 12 May 1989

- Continuation of bilateral negotiations
- Discussion of recommendations
- Meeting conclusions and closing ceremony

Annex 5

Formal papers presented or
made available for the meeting

UNIDO technical assistance and studies in the field of machine tools
(UNIDO Secretariat).

The UNIDO Trust Fund programme (UNIDO Secretariat)

Technological trends in machine tools and their implications for
developing countries (UNIDO consultant)

National papers

Algeria--La machine-outil en Algerie: situation actuelle et strategie de
developpement (the machine tool industry in Algeria: the present state
and strategy for growth)

Argentina--Argentine report to the working group on co-operation on
production and applications of machine tools

India--National paper on machine tools: India

Indonesia--Presentation in the working group on co-operation on
production and applications of machine tools

Islamic Republic of Iran--Development of machine tool industries in Iran

Republic of Korea--The machine tool industry of Korea

Malaysia--The development of the machine tools industry in Malaysia

Nigeria--Development of the machine tool industry in Nigeria

Zimbabwe--The manufacturing sector in Zimbabwe: the scope for machine
tools and equipment development

Background papers

Technological requirements for the machine tool industry in developing
countries (IS.642)

Technological perspective in the machine tool industry and their
implications for developing countries (ID/312)

Technological changes in the machine tools industry: implications for
industrial policy in developing countries (UNIDO consultant)

UNIDO's new approaches to enterprise-level industrial co-operation
(UNIDO Secretariat)

UNIDO activities for promoting and implementing economic and technical
co-operation among developing countries