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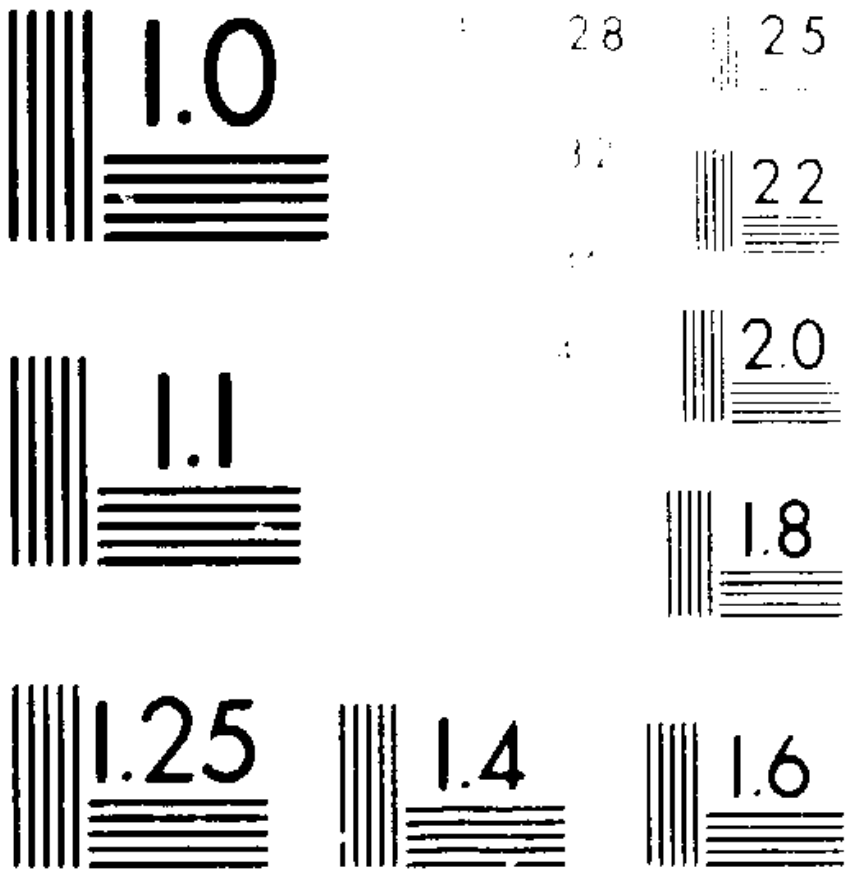

UNITED NATIONS
INDUSTRIAL DEVELOPMENT
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THE FEDERAL REPUBLIC OF
NIGERIA

14446

Nigeria.

INDUSTRIAL DEVELOPMENT CENTRE
OSHOGBO

UNIDO-Project DP/NIR/73/014

TERMINAL REPORT

by

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1.0. S U M M A R Y

This terminal report of the UNIDO-Project DP/NIR/73/014 studies the activities of the project during its duration from 1977 to 1984 until the closure of the project at the end of July 1984, and gives recommendations for the future development of the IDC´s in Nigeria and for the future development of small-scale industries in Nigeria in general.

According to the report the activities of the project were considerably affected by the fact that the necessary technical workshops for various engineering fields at IDC Oshogbo could not be completed and set up into operation, because no Government funds were available for the planned and necessary machinery and equipment for the workshops. Also the recruitment of national counterpart staff for the IDC´s was continuously insufficient and inappropriate so that many of the specialized UNIDO Experts did not have suitable counterparts to work with and to train them.

However, despite of this abovementioned imperfection, most of the project experts were able to assist the IDC´s and the Nigerian small-scale industrialists relatively succesfully, and excellent achievements were reached.

According to the recommendations the first priority has been proposed to the autonomous status of the IDC´s, and the necessity of the workshops of IDC´s has been strongly emphasized. Also advise and proposals have been presented concerning the organizational requirements for IDC´s, staff requirements and training, operational requirements, general development of small-scale industries in Nigeria and the possible further need of External Technical Assistance for this development work.

2.0. INTRODUCTION

The importance of the small-scale industry sector in Nigeria has been fully recognized by the Federal Government, and she has undertaken, within her National Development Programme, a comprehensive programme of assistance for the improvement and modernization of existing small-scale industrial establishments and the development of small-scale industries in all States of the Federation.

The following two industrial institutes had to be established: a) Industrial Development Centres (IDC's) for rendering technical and management services to small industrialists, and b) Small-Scale Industries Credit Schemes (SSIC's) for giving financial assistance (term-loans) to existing and prospective small-scale entre preneurs. The IDC and SSIC concepts provide a sound model on which to build a national institutional structure. The final plan is to establish one IDC and one SSIC in each State.

In May 1975 an agreement was signed between the Nigerian Government, UNDP and UNIDO (as Executing Agency) for Preparatory Assistance for the establishment of the IDC Oshogbo. This agreement covering a period of one year provided for the appointment of a project manager and training fellowships. The project manager took up his duties in July 1976, to evaluate project activities, follow the progress of construction of buildings, recommend equipment and machinery as well as expert requirements, assist in selection of staff and organize the work.

After this abovementioned preparatory assistance, another agreement between the Nigerian Government, UNDP and UNIDO (as Executing Agency) was signed in November 1977. A large scale UNIDO-Project was designed to set up the Industrial Development Centre in Oshogbo. The duration of the project was planned to be five years, the estimated UNDP inputs US $ 2,410,465.- and the Government inputs ₦ 5,808,001.- The project manager continued his duties in the project to organize the work, and the first experts arrived in May 1978.

The main assistance was to set up the IDC Oshogbo, but additional assistance was given to other four smaller IDC's in Benin-City, Akure, Abeokuta and Ilorin. The objectives of all these five Centres were to render comprehensive advisory services for the development of small-scale industries in the Western Region of Nigeria. The centres will have an adequate number of national extension officers in various basic trades covering the basic engineering fields such as foundry and mechanical engineering, metal working, woodworking, automobile-engineering, textile weaving, leather goods manufacturing etc. The assistance will cover all important stages in the establishment of a small plant like selection of product-line, selection of machinery and equipment, installation and

operation of the machinery in the workshop of the entrepreneur, etc.

The national programme for the development of small-scale industries envisages the establishment of one Industrial Development Centre in every State as a long-term objective and the development of two industrial estates per State to meet the requirements of developed factory plots and sheds for the growing small industries sector. The credit needs of small industrialists are being met by the Small-Scale Industries Credit Schemes which have been started in all the States by the Nigerian Government under a co-ordinated Federal-State Programme for financing small-scale industries.

3.0. FINDINGS

3.1. Project Plan of Operation

3.1.1. The Concept of Industrial Development Centre

The original purpose of Industrial Development Centres was to give technical and managerial assistance in the development of small and medium-sized enterprises in the country by offering the following services:

- technical appraisal of loan applications
- provision of industrial extension services
- training of entrepreneurs and staff
- applied research into industrial products
- industrial and technological information service

The centres should also help the small scale entrepreneurs to purchase and install their machinery and to assist the government to grant and supervise small scale industry loans.

Within this framework the Federal Republic of Nigeria has established various industrial development centres in the country. The types of services they are rendering are as follows:

1) Selection of promising small-scale industries for prospective entrepreneurs
2) Selection of proper manufacturing processes along with machinery and equipment for the product lines.
3) Installation and starting up operations of the machinery and equipment
4) Quality control and improvement of the end product
5) Repair and maintenance of the machinery and equipment of small industrialists
6) Manufacturing of parts and components to re-start machinery and equipment rendered idle for non-availability of spare parts
7) Training of small industry technicians and artisans in the handling of improved machines and their maintenance and repair
8) Improvement of product design and manufacture of prototypes
9) Adaption of technology and process improvement for small industries
10) Production Planning and Control
11) Book-keeping, accounting and cost analysis
12) Marketing counselling and sales promotion
13) Financial counselling and credit arrangements
14) Appraisal of loan applications of small industrialists for grant of loans under the Small Industries Credit Schemes.

15) Acting as a liaison between large and small industries for the manufacture of parts and components required by the former, on a sub-contracting basis by the latter

16) Undertaking of in-plant studies for cost reduction and improvement of productivity

The various methods adopted by the staff of the Industrial Development Centres to render the services listed above may be grouped as follows:

a) The individual approach in which direct contacts are maintained between the extension worker and the small industrial unit

b) The group approach through training courses and seminars held either at the centre or other convenient places to cater groups of small industrialists with similar problems

c) The mass approach through exhibitions, meetings and use of other mass media, such as radio and films.

3.1.2. The Objectives of the Project

1. The development and rational locating of small-scale industries, existing and new, in order to create employment opportunities, mobilise local resources, and stem the flow of rural migration to the urban centres.

2. Also, to ensure that the small-scale industry sector keeps pace with Government plans to industrialize Nigeria.

3. Improving the efficiency and productivity of existing small-scale industrial establishments in the six States of Bendel, Kwara, Lagos, Ogun, Ondo and Oyo by:

Providing a continuous training programme to upgrade the knowledge and skills of entrepreneurs, as well as by investigating and solving entrepreneurs' problems. Training will be provided in the fields of: a) Marketing, b) Book-keeping and Financial Control, c) Machine Installation, Maintenance and Repair, d) Product Design and Improvement, e) Quality Control, f) Production Planning and Control, g) Tool and Die Manufacture and Design, h) Plant Layouts, i) Purchasing, J) Store-keeping, k) Worker Training and Education, l) Technical Expertise and Machine Operation etc.

4. Fostering the development of new small-scale industry, according to requirements, and maintaining individual sectors at their optimum size by assisting the six States concerned in implementing the small-scale Industries Credit Scheme.

4. Developing a cadre of fully trained Government officers for IDC's and other Small-Scale Industry bodies, capable of carrying out consultancy and extension activities, surveys and market studies, loan appraisals and feasibility studies, and continuous training programmes for entrepreneurs.

6. Acting as a catalyst in creating links between large and medium industry on the one hand, and small-scale industry on the other, with a view to the securing of contracts for the supply of goods and services by small industry to large and medium industry.

7. Providing a comprehensive service to the Small-Scale Industry Industrial Estates which are to be set up.

8. Assist where required in the establishment of other new IDC's in the six States concerned. Give Technical and Management advice and assistance to Government on the planning, organization and operation of Industrial Development Centres.

9. Develop a register of Small-Scale Industry in the six States.

3.1.3. Work Plan

According to the original Project Document the project work plan was as follows:

1. Organize work of loan appraisal and follow-up of loan assisted cases, on a planned and systematic basis.
2. Assist in the selection, installation, maintenance and repair of machinery and equipment of small enterprises.
3. Organization and operation of Industrial Extension Services, over the broad field of Small Industries, covering method improvement, layouts, production and quality control aspects, as well as record and costing procedures.
4. Setting up and carrying out Industrial, Marketing and Economic Surveys, in the field of Small Scale Industries, and provide industrial information service.
5. Setting up of workshops, machines and equipment to cover the activities of general engineering, tool room, heat treatment, automobile repair and service, woodworking and leatherworking.
6. Design and Manufacture of Jigs, tools, fixtures, Dies and other aids to production.
7. Establish courses and training programmes to cover the whole range of management and technical aspects related to Small Scale Industries.
8. Setting up of workshops, machinery and equipment to cover the activities of foundries, weaving, plastics, electrical and electronic. Plus others such as ceramic, glass, pottery and food processing as required.
9. Continuous provision of fellowships abroad for suitable candidates, from the staff of IDC and in certain cases entrepreneurs.
10. Advise and assist Government as required on the technical and management aspects related to planning, organization, and operation of IDC's in Nigeria.

3.2. ASSESMENT OF PROJECT ACTIVITIES

3.2.1. Extension Services

One of the first activities after the commencement of the project was to carry out extension services in all six States in the western region of Nigeria by rendering technical and managerial assistance and advise to all those small-scale industrialists who have applied this assistance from IDC Oshogbo.

The experts have advised and assisted their counterparts in preparing industrial profiles and feasibility studies for new small-scale industry projects in various fields. Also they have carried out loan appraisals and follow-up of loan assisted entrepreneurs.

One very important activity in this regard has been the assistance in machine installation, maintenance and repair. The Mechanical Engineering Expert has mainly developed this service and it has been very succesful.

Additionally assistance in method improvement, plant layouts, productivity, quality control, record and costing procedures and accounting has been given to the small-scale industrialists in all six States.

3.2.2. Industrial Training

The main activity in the field of industrial training has been to organize seminars and workshops for the small-scale industrialists. During the whole duration of the project altogether 34 seminars were held in all six States in the following fields: Marketing, Loan Appraisals, Textile Engineering, Costing, Metal Work, Wood Work, Foundry Engineering, Establishment of Foundries, Industrial Safety, Production Management, Investment Management, Foundry Technology, Hand Weaving, Mechanical Engineering, Machine Shop Practice, Product Design, Design of School Furniture, Manufacture of Wooden Furniture, Industrial Safety in Woodworking Industry.

Individual Entrepreneur Training has been a significant form of training within the project. Numerous entrepreneurs have been given training in special technical skills or in particular areas of work such as production control, quality control, product design, process methodology, costing, sales promotion etc.

In-Plant Training activities have been also part of the project's work. Factory supervisors and operators have been given direct training in their workshops in textile industry, furniture industry, leather goods industry and metal industry.

The counterpart staff of IDC's has been given opportunities for fellowship training abroad. Altogether 96 man months have been spent this form of overseas training. Additional short group training courses abroad have been offered by UNIDO to IDC staff or to entrepreneurs.

Additionally, the Foundry Industry Expert and the Mechanical

Engineering Expert have given a special lecture serie of 30 hours each for a 3-month international training course of ARCEDEM (African Regional Centre for Engineering Design and Manufacture) in Ibadan, Oyo State, respecttively in Foundry Technology and in Mechanical Engineering and Product Design.

3.2.3. Industrial Surveys, Research Work, Information Service

Several plans to carry out techno-economic surveys, market studies and other important industrial studies were made, but because of lack of funds, most of them remained undone.

Some market studies in the fields of bakery industry, concrete block industry, leather goods industry and textile industry were carried out by the experts with their counterparts; but generally their importance concerning the nation-wide requirements was not so significant.

The only industrial survey which had some more importance was the Foundry Industry Survey carried out by the Foundry Industry Expert during the years 1978...79. This survey studied the situation of foundry industry in the whole Nigeria, it analysed the production outputs, process methods, raw material sources, quality level and existing problems of the existing Nigerian foundries, and studied the development possibilities, manpower requirements, needs for training and technical education as well as the demand and supply of castings in Nigeria. The report presented also valuable recommendations for the future development of Foundry industry in Nigeria, (see annex No.6)

Concerning research work, not much activities were possible, because the badly required workshops of IDC Oshogbo could not be equipped. However, some research work in the field of foundry engineering was carried out in close co-operation with Ife University and with private industries. First of all a foundry material study was planned to be carried out by IDC Oshogbo with assistance of the Geological Department of Ife University, but due to lack of funds the studies were not possible to complete. A part of this research was a special study concerning the use of local charcoal in melting cast iron in a cold blast cupola furnace. A small cupola furnace was built up and various types of local charcoal were used for melting iron. As a result it was found that only charcoal made of hard wood could be succesful for this purpose, (see annex No.7)

One very important activity within the project was the development of industrial information service of IDC Oshogbo and of other IDC's. The aim of this activity was to provide technical information for the small-scale industrialist in all possible engineering fields as well as other industrial information concerning questions in management, finance, business administration, economy, accounting, marketing etc. A considerable assistance in this respect was received from UNIDO Headquarters' Industrial Information Service, which was always ready to provide various special information on the request of the IDCs.

3.2.4. Setting up of IDC Workshops

One of the main objective of the project was to build up the Industrial Development Centre as an institute with complete and operational workshops.

The Project Experts as specialists in their respective technical field were responsible to advise and assist in selection of the machines and equipment for the workshops, as well as to plan the equipment layouts and to give engineering advise for the installation work of the machines, and to assist in setting up the machines into operation.

According to the original plans the following workshops were to be built up during the first phase of the project: 1) Automobile Engineering Workshop, 2) Mechanical Engineering Workshop, 3) Wood Workshop, 4) Foundry, 5) Textile Workshop and 6) Leather Workshop. According to the original project agreement the buildings and the machines for the workshops were to be financed by the Federal Government of Nigeria. The purchase of all machines and equipment for these workshops was to be carried out with assistance of UNIDO so that according to a special Trust Fund Agreement, which was signed in 1981, the Puchase Department of UNIDO Headquarters should carry out the technical realization. Then after the arrival of the machines in Oshogbo, the team of UNIDO Experts with their national counterpart staff should take care of the installation work of the machines and set them into operation.

Concerning the other IDC's in Benin-City, Akure, Abeokuta, and Ilorin, they were supposed to get also workshops, but in later stage. On the request of the Federal Government the UNIDO Experts prepared complete technical plans with drawings for these four IDC's and made recommendations for equipment lists and machine layouts for each engineering workshop.

Because the original plan for the Workshops of IDC Oshogbo did not include a proper Foundry workshop, the UNIDO-Foundry Industry Expert - shortly after his arrival in Oshogbo in 1978 - made a complete plan with detailed drawings and equipment lists for the foundry workshop and the foundry laboratory. A full priority was given to build up this foundry shop as soon as possible by the Government. Unfortunately, due to financial constrains the work was postponed for several times, and has not yet started.

Because of the short fall of Government funds the UNIDO team made a proposal that the Workshops of IDC Oshogbo should be equipped by instalments. On the basis of this proposal an agreement with the Government was soon made about to set up immediately a basic mechanical engineering workshop at Oshogbo IDC to be equipped with essential machine tools and equipment by local purchase, All possible assistance in this partial equipping of the workshops were given by all the three experts in post. Workshop layout and plan for installation of the 250 kW generator plant were prepared, and quatations for the machinery were obtained.

The first stage plan of action and detailed costs estimates for the above basic workshop equipment procurement were prepared by the UNIDO-Mechanical Engineering Expert and the UNIDO-Foundry Industry Expert/Project Manager. A workshop committee of three senior officers of IDC Oshogbo was appointed to co-ordinate and co-operate with the UNIDO-team on this work of equipment procurement and installation of machinery.

The allocated funds for this partial equipping of IDC Oshogbo workshops (₦ 160,000.-) were made available in August 1983, but the release of the money was delayed.

3.2.5. Design of Prototypes

One of the planned basic duties of an Industrial Development Centre has been the improvement of product design and manufacture of prototypes. In this regard some succesful activities were carried out.

Four woodturning lathes as prototypes for small-scale industrialists were designed and manufactured at IDC Oshogbo by the UNIDO-Mechanical Engineering Expert and the UNIDO-Wood Working Expert together with their counterparts, in the temporary mini-workshop of IDC by using basic hand tools as well as assistance of Nigeria Machine Tools Limited, Oshogbo and Oshogbo Steel Rolling Company and two private small-scale industrialists in Lagos and Benin-City. Two of the lathes are 150 mm - steel fabricated woodturning lathes and the other two 175 mm wooden bed woodturning lathes.

Also considerable assistance in engineering design was given to ARCEDEM (African Regional Centre for Engineering Design and Manufacture) particularly in the design of centrifugal pumps and blowers as well as of some agricultural machinery.

Further contribution to the engineering design activity was given by the UNIDO-Foundry Industry Expert/Project Manager who participated in a special conference of ARCEDEM in Cairo, Egypt "Workshop on the Promotion of National Centres for Engineering Design and Manufacture in African Countries" held on the 30 th October...4 th November 1983. A paper "Discourse on the Necessity of Establishment of National Centres for Industrial Development and Engineering Design in African Countries. Guidelines and Recommendations for Planning and Implementation" was presented by him during the workshop, (see annex No.5).

3.2.6. Assistance in Manufacture of Spare Parts

The basic idea that various small-scale industrialists should get their spare parts for their machines manufactured locally by other specialized small mechanical engineering workshops in Nigeria was gradually developed. In several cases entrepreneurs were directed to contact a small-scale metal workshop, often located in another town or in other State, to manufacture an important spare part for a broken machine. The idea was further developed and assisted by the UNIDO-Mechanical Engineering Expert.

Additionally one small-scale industry metal workshop in Oshogbo was selected as a project object to be up-graded and developed for manufacturing spare parts for other small-scale industrialists. The UNIDO-Mechanical Engineering Expert together with his counterparts did indentify the capacity and the technical skill of this metal factory and found it appropriate for further developments. Ideas for prototypes were discussed and preparatory work was properly started.

3.2.7. Establishment of Foundrymen Association of Nigeria

According to the recommendations of the Foundry Industry Survey by the UNIDO-Foundry Industry Expert, a professional organization for the Nigerian foundry industrialists was required to be established.

After some preparatory work by the Expert and personal contacts with the foundry industrialists, a first meeting to establish this organization was called in March 1980. In that meeting the Foundrymen Association of Nigeria (F.A.N.) was founded.

The Foundry Industry Expert was frequently participating in the Association's meetings, and he gave all possible support and assistance to organize the new association and to strengthen its activities. The F.A.N. was officially registered in Nigeria in 1981, and in early 1984 it joined the "International Committee of Foundry Technical Associations",CIATF.

After a sudden death of the President and Chairman of the Association in February 1983, the UNIDO-Foundry Industry Expert was appointed as a Chairman, and he carried on this duty until the end of the UNIDO-Project, i.e. July 1984.

3.2.8. Assistance and Advise to the Federal Government

As originally planned one of the project activities was to advise and assist the Government on request on the technical and management aspects related to planning, organization and operation of IDC's in Nigeria.

Based on close co-operation and good relationship with the Federal Ministry of Commerce and Industry, the UNIDO team was able to give succesful proposals and useful recommendations to the Government, and contributed valuable information and advise concerning the development and operation of all IDC's in Nigeria.

3.2.9. Training of Counterpart Staff

One of the main duties of the international experts of the project was to train their national counterparts at IDC's.

However, in various engineering fields, which the IDC's were responsible for when developing and assisting the small-scale industries, no suitable technical staff was available. This means that many UNIDO Experts at the project could not carry out properly their duty to train their own counterparts in

their own specialized engineering field. The situation slightly improved towards the end of the project, but still it was not satisfactory.

Despite of the above fact the experts did their best, and they were able to train quite succesfully many counterparts. The best was the situation in the field of textile engineering, because there were 15 textile engineer counterparts out of 54, the total amount of senior officer counterparts at all the five IDC's.

3.3. MAJOR PROBLEMS AND DIFFICULTIES

1. The hold-ups in the release of the Government Trust Fund Money for the purchase of the machinery and equipment for the IDC Oshogbo workshops caused continuous delays to the execution of the project.

2. Later on the Government allocated funds for the partial equipping of IDC Oshogbo workshops (₦ 160,000.-) and made the money available in August 1983, but unfortunatelt the funds were not release before the final closure of the project at the end of July 1984.

In principle, this shortfall of funds was one of the main reasons, why United Nations Development Programme decided to withdraw all its assistance to IDC Oshogbo and to the other four IDC's, and to close the UNIDO Project in Oshogbo.

3. The recruitment of national counterpart staff for the IDC's was never based on the requirements which the proper operation of IDC's demands. Lack of counterparts in various special engineering fields did not give much chance to the UNIDO Experts to transfer their knowledge and expertise to the national staff.

4. The construction work of Oshogbo IDC workshops was started in 1974, but at the time of the closure of the project, i.e. in July 1984, the workshops were not yet ready for occupation, with the exception of one workshop (automobile workshop and garage) allocated for the temporary basic engineering workshop to be equipped immediately by local purchase.

5. Because of short fall of UNDP funds the project had to be continued on a reduced scale during the last two years before the termination of the project.

6. Due to shortage of Government funds the Federal Government was not able to finance the operations of the IDC's properly, and the activities had to be reduced considerably.

3.4. PROJECT ACHIEVEMENTS

3.4.1. General

Due to the fact that so many problems and difficulties had reduced the activities of the project during its whole duration, the final project achievements are less succesful than originally anticipated.

Very important assistance and work was carried out in various industrial and engineering fields in the development of small-scale industries in Nigeria, and hundreds of entrepreneurs were rescued from difficult situations or even from bankruptcy. This assistance has been part of the extension service duty for small-scale industrialists, which all IDC's should carry out, but often the valuable assistance was given directly by the UNIDO Expert because no suitable counterparts were available. Accordingly, the IDC staff was not enough able to get involved in the work concerned.

However, taking into consideration the extreme difficult situations of the project implementation in general, the contribution of the whole project to the industrialization process of Nigeria - with its 12 UNIDO Experts - was still very valuable and important, and the realization of the project was not waisting of time and money.

3.4.2. Industrial Training

One of the most succesful achievements of the project was the assistance in organizing and arranging of seminars and workshops for small-scale industrialists. Altogether 34 seminars in various fields were held during the whole duration of the project, (see annex No. 4

Also individual entrepreneur training was a significant form of training within the project, and In-Plant training activities were also a succesful part of the project work.

The counterpart staff of IDC's was given opportunities for fellowship training abroad, and altogether 96 man-months were spent in this form of overseas training. Also short group training courses abroad were offered by UNIDO to small-scale entrepreneurs and to IDC staff.

Additionally, two special lecture series of 30 hours each for a 3-months international training course of ARCEDEM were given by the UNIDO Experts.

3.4.3. Extension Services

The second most succesful achievement of the project was the assistance in industrial extension services rendered to the small-scale industrialists in the six States of the western region of Nigeria.

Hundreds of factories were able to solve their problems after receiving the assistance and support from IDCs. Mostly the assistance was given in the following engineering fields or areas of work: 1) Maintenance and repair of machinery and equipment, 2) Manufacture of spare parts, 3) Consultancy in feasibility studies and factory planning, 4) Advise in accounting and book-keeping, 5) Assistance in management and business administration, 6) Advise in product design and quality control, 7) Advise in costing and finance, 8) assistance in market studies and sales promotion as well as in many other detailed technical or managerial questions.

3.4.4. Design and Manufacture of Prototypes

Four woodturning lathes as prototypes for small-scale industrialists were designed and manufactured at IDC Oshogbo. Two of the lathes are 150 mm - steel fabricated woodturning lathes and the other two 175 mm wooden bed woodturning lathes.

Also considerable assistance in engineering design was given to ARCEDEM, particularly in the design of centrifugal pumps and blowers as well as of some agricultural machinery.

3.4.5. Development of IDC workshops

Although the main workshops of IDC Oshogbo were not able to be equipped, three temporary mini-workshops were set up.

First of all through the efforts of the UNIDO Textile Engineering Expert, a temporary shed for hand looms was set up and put into operation. The hand looms were purchased by IDC Oshogbo locally as second-hand. They were reconditioned and installed in the wooden shed which was built up for the purpose. The textile shop was later on succesfully used for seminars.

The other two temporary mini-workshops were basic metalworking shop and woodworking shop. The necessary hand tools for both of these shops were purchased by IDC Oshogbo from local suppliers. The above mentioned lathe prototypes were partly made in these workshops.

3.4.6. Establishment of Foundrymen Association

Through the efforts of the UNIDO Foundry Industry Expert a national association for foundry industrialists was established. The Foundrymen Association of Nigeria (F.A.N.) was founded in March 1980. The Foundry Expert gave all possible support and assistance to organize and build up the new association and to strengthen its activities. In early 1984 the association joined the "International Committee of Foundry Technical Associations", CIATF.

3.4.7. Co-operative Associations for Weavers

The UNIDO Textile Engineering Expert together with his counterparts was able to establish co-operative activities within the textile industrialists particularly within the weavers. Through the establishment of co-operative associations, the entrepreneurs were able to purchase raw materials easier and more economically.

4.0. RECOMMENDATIONS

Recommendations for the future development of IDCs in Nigeria and for the future development of small-scale industries in Nigeria, presented in this report, are based on the wide practical experience of the UNIDO Experts in the Nigerian industry and at IDC's, on the Government policy for small-scale industry development in Nigeria as well as on the mistakes and errors made in the past.

The following recommendations are presented:

4.1. Autonomous Status for IDCs

The Industrial Development Centres should be operated as an autonomous corporation or equivalent, and have an Executive Board appointed by the respective Ministry or Government Department. The Board should have a mandate to govern and direct the centre according to its constitution through the appointed staff of the centre.

4.2. Organizational Requirements for IDC's

As already several times proposed the three oldest IDC's in Nigeria, i.e. IDC-Owerri, IDC-Zaria and IDC-Oshogbo, should be operated as Zonal Centres, and all other IDC's should operate on State basis and subordinated to the Zonal Centres.

Each centre should be administered by a Director appointed by the Executive Board, and he should be in over-all charge of the centre and be responsible for the direction and control of the centre's activities and operations. A Deputy Director should be appointed to represent the Director whenever he is hindered to carry the daily administrative duties at the centre.

4.3. Staff Requirements and Training.

The senior staff of each IDC should be selected according to the requirements of the surrounding industries in the region. It might be advisable to divide the centre into few divisions or sections, such as 1) Technical Services Section, 2) Management Services Section, 3) Industrial Information Services Section, 4) Product Design , Research and Development Section, 5) Administrative Section, 6) Training Section.

Each of the Section should be headed by a suitable trained person, preferably with academic degree, and with necessary practical experience in the respective field.

The training section should take care of all further or basic training of the staff, and possibilities to participate

in special courses or seminars abroad or in the country should be taken continuously into consideration.

4.4. Necessity of Workshops for IDC's

Because Nigeria does not have yet a sufficient infrastructure of small-scale technical industrial capability, at least the zonal IDC's should possess the basic technical workshops, namely: pattern making shop, ferrous and non-ferrous metal foundry, metalworking and woodworking shops. Additionally, there could be workshops equipped for specialized trades selected in accordance with the list of priority industries, such as leather goods manufacture, textile processes, plastics, ceramics, printing, electronics and food processing.

The IDC workshops should be used for the following purposes:

1) Demonstrations to entrepreneurs and their employees on:
   - machine operation and utilization
   - manufacturing processes
   - material and quality control
   - workshop organization
2) Machine repair and the manufacture of spare parts for small-scale industry
3) Services to industry including heat treatment of metals and material testing
4) New product design and development and manufacture of prototypes
5) Product improvement and testing
6) Presentation of seminars and organization of in-plant training.

4.5. Operational Requirements for IDC's

For a succesful operation of a centre, a complete plan of action must be prepared and then according to this plan the running costs of the centre should be calculated. This will include materials for workshops operations, electricity, water, transport costs, administration and other overheads. The yearly budget of the centre will be then prepared on the basis of the real actual needs.

4.6. General Development of Small-Scale Industries

To give better and more efficient assistance and support to Nigerian small-scale industrialists the Federal Government should study the possibilities to strengthen the following activities:

1) To reactivate the Small-Scale Industry Credit Scheme's function and to improve the availability of loans for viable small-scale industry projects.

2) The small-scale industrialists should be able to enjoy special relieves or easements concerning the Government tax and custom duties, particularly during the first 3...5 years of operation after starting the production.

3) The basic industrial infrastructure in the country needs improvement. Particularly, the roads, railway, electricity supply, water and telephones should be made available in both rural and urban areas.

4) By building up Industrial Development Centres and up-grading their activities and capacity, the small-scale industrialists could get more useful support from the Government.

5) Efforts for improving the situation of technical education and industrial training in the country should be encouraged by all means.

4.7. Further Need for External Technical Assistance

If the Federal Government of Nigeria is willing to continue its assistance to small-scale industry and if the Industrial Development Centres are to be built up and set up into operation succesfully, it is recommended that the Federal Government should still apply external technical assistance for this development work.

To implement new methods and suitable technology in the development of small-scale industries and to transfer the necessary knowledge and skill to the small-scale entrepreneurs, is a big challenge to Nigeria, but if the work is carried out properly and with expertise, the success will be definitely there.

5.0. CONCLUDING REMARKS

According to the Lagos Plan of Action and the Final Act of Lagos, adopted in April 1980 by the Lagos Economic Summit, the African countries intend, during the present decade, to lay the foundation for i n d u s t r i a l integration at the subregional and regional levels and to achieve a minimum of 1.4 % of world industrial production by 1990. According to this plan the following recommendations have been presented:

i) Each African country should establish industrial development centres or strengthen those already in existence. These national centres can serve to implement the integrated industrial development programme and prepare sectoral development programmes. They should provide for project identification, preparation and evaluation, as well as for the preparation of feasibility studies for priority projects, and follow up the implementation of those projects, a particular feature being the provision of consultancy services and management advice.

ii) The services offered by these industrial development centres would relate not only to assistance in the development of small and medium-sized enterprises, but also to the problems of industrial decentralization and the introduction of industrial units into rural areas, in particular through the adoption of policy measures which encourage and facilitate domestic industrial initiatives; for example, on appropriate and efficient administrative, fiscal, financial and marketing framework.

With reference to the above, it seems obvious that the Nigerian Government is willing to follow up the proposed guidelines of the Lagos Plan of Action, and that the development of industrial Development centres in Nigeria will have full support from the Government.

Accordingly, if enough funds will be available, it is highly recommended that the completion of the IDC Oshogbo should have the first priority, and that all efforts should be made to build up the IDC Oshogbo as an important National Institute.

ACKNOWLEDGEMENTS

When carrying out the duties at IDC Oshogbo and at other IDC´s, the UNIDO-team has always received good co-operation and great interest from all Nigerians, both in the Government organizations and in the private sector of industry and other enterprises.

On behalf of the UNIDO-team the author of this report would like to express the team´s gratitude first of all to the Federal Ministry of Commerce and Industry for its efforts to direct and supervise the Government activities in the field of small-scale industry development in Nigeria so that the realization of the project was made possible. Additionally we express our particular thanks to Mr. Oluwumni, the Director of I.P.P. Department of FMCI, who always was prepared to spend his time for IDC Oshogbo as well as for the other IDC´s, and gave valuable directions and advise to the project.

We thank also the Federal Ministry of National Planning for positive co-operation in all matters related to the UNIDO-Project activities in Oshogbo, and express our kind gratitude to Mr. C.O. Idokogi, the Director at Economic Affairs Division of FMNP for his continuous support to the project.

Our thanks are also due to the Heads of the Small-Scale Industries Division of the Federal Ministry of Commerce and Industry, firstly to the former Head, Mr. Taiwo and secondly to the present Head, Mr. S. A. Uaboi for their continuous efforts and assistance for the operation of the project.

We are also grateful to Mr. O. A. Kayode, the Director of IDC Oshogbo for all the co-operation, assistance and hard work willingly put in during the whole duration of the UNIDO-Project in Oshogbo. We are also grateful to the Directors of the four other IDC´s, Mr. C. A. Akinseye, Director of IDC Abeokuta, Mr. A. O. Adetayo, Director of IDC Akure, Mr. I. O. Okitikpi, Director of IDC Benin-City, and Mr. M. D. Ashonibare, Director of IDC Ilorin for their excellent co-operation with the UNIDO Experts and for their friendly hospitality whenever the Experts visited their Centres.

Further we would like to thank the whole staff of IDC Oshogbo and the staff of IDC´s of Abeokuta, Akure, Benin-City and Ilorin for their willingness to co-operate with the UNIDO Experts and for their efforts and interest in all matters related to the project activities. We also present our thanks to the UNIDO-Project´s national staff, to the Secretary for her ample co-operation and hard work for the project, and to the all three drivers for their valuable work for the project and for driving safely on the roads with the Experts.

Finally, I as author of this report, would like to express my great gratitude to my all UNIDO colleagues at the Project for their willingness to work hard and co-operate with the Project Manager, as well as for the professional and co-operative discussions and their suggestions in my work.

APPENDICES

APPENDIX No. 1

LIST OF UNIDO EXPERTS AT THE PROJECT

Post Description	Name of Expert and Nationality	Duration
Project Manager/ Foundry Expert	M.J. Hakka (Finland)	Jun78 - Jul84
Mechanical Engineering Expert	J.W. Weston (U.K.)	May79 - Jul84
Woodwork Expert	C. Swaelas (Sweden)	Oct83 - Oct84
Training Expert	G.M. Casas (Peru)	Apr78 - Apr79
Management & Marketing Expert	A.J. Ahonen (Finland)	May78 - May79
Tool and Die Expert	W.G. Dowell (U.S.A.)	May78 - May79
Woodwork Expert	C. Holmes (U.K.)	Aug79 - Jul80
Industrial Engineering Expert	G.L. Page (U.K.)	Jan79 - Sep81
Woodwork Expert	R.H. Glossop (U.K.)	Sep81 - Aug82
Automobile Expert	E.L. Bauer (W.Germany)	Oct81 - Aug82
Project Manager	W.M. Thompson (U.K.)	Aug76 - Dec82
Textile Expert	G.V. Grunwald (Austria)	Jan81 - Jun82
Leather Expert	R. Mezeray (France)	Jan80 - May82

LIST OF NATIONAL COUNTERPART STAFF (GOVERNMENT PERSONNEL)

1. IDC OSHOGBO - OYO STATE

Post Description	Name of Incumbent
Chief Industrial Officer (Director)	O.A. Kayode
Senior Technical Officer (Auto)	T.O. Olujoka
Technical Officer(Textile)	T.A. Olowookere
Higher Tech. Officer(Textile)	O.A. Oshinowo
Technical Officer (Textile)	W.I. Esan
Higher Tech.Officer (Leather)	A. Matti
Higher Tech.Officer (Wood)	T.O. Apelehin
Industrial Officer(GradeII)	B.T. Gbenebichie
Industrial Officer (GradeI)	A.A. Atinsola-Moronto
Tech. Officer (Textile)	M.A. Adedeji
Tech. Officer (Textile)	R.A. Ogunsan
Industrial Officer II (Eng)	E.J. Gbikpi
Higher Tech. Officer (Eng)	F. Akingbemisilu
Industrial Officer (Eng)	K. Obadina
Youth Corp. (Management)	A.C. Akintewe (Mrs)
Youth Corp. (Marketing)	O.M. Omomoyesan

2. IDC ABEOKUTA - OGUN STATE

Proncipal Industrial Officer (Director)	C.A. Akinseye
Senior Technical Officer (Textile)	G.F. Adesodun

Senior Technical Officer (Electrical)	R.A. Bello
Senior Technical Officer (Automobile)	J.O. Ofume
Higher Technical Officer (Wood)	O.O. Sonubi
Higher Technical Officer (Wood)	S.A. Ogunsanwo
Technical Officer (Textile)	K.A. Mayungbe
Technical Officer (Metal)	L.A. Odunowo
Technical Officer (Leather)	K.T. Adesigbin
Assistant Tech. Officer (Textile)	A.N. Olowofela

3. IDC AKURE - ONDO STATE

Industrial Officer GD I (Director)	A.O. Adetayo
Industrial Officer GD I (Commerce)	F.R. Adeniyi
Industrial Officer GD II (Economics)	A.O. Adeseye
Higher Technical Officer (Textile)	I.A. Adamolekun
Higher Technical Officer (Wood)	E.A. Olaniyan
Technical Officer (Wood)	P.A. Omowaiye
Technical Officer (Textile)	A. Mohammed
Technical Officer (Textile)	A.O. Agbelusi

4. IDC BENIN-CITY - BENDEL STATE

Senior Technical Officer (Director)	I.O. Okitikpi
Senior Technical Officer (Automobile)	C.E. Omusi
Industrial Officer GD I (Management)	T.A. Abijo
Higher Technical Officer (Textile)	O.A. Otenuga
Higher Technical Officer (Wood)	J.O. Idemudia
Higher Technical Officer (Leather)	L.J. Erbunse

Higher Technical Officer (Ceramics)	A.T. Egbetola
Higher Technical Officer (Textile)	M.A. Kazeem
Industrial Officer GD II (Management)	O.O. Jaiyeoba
Technical Officer (Food)	A.Y. Ayodele
Assistant Technical Officer (Textile)	D.I. Adetula

5. IDC ILORIN - KWARA STATE

Asst.Chief Industrial Officer (Director)	M.D. Ashonibare
Higher Technical Officer (Metal)	P.O. Onare
Higher Technical Officer (Textile)	G. Adejumo
Industrial Officer GD II (Food)	B.O. Onyekelu-Eze
Technical Officer (Wood)	A.A. Oriola
Youth Corp. (Engineering)	S. Deminwa
Youth Corp. (Management)	G.A. Magbagbeola
Youth Corp. (Marketing)	A.O. Otokiti

U N I D O F E L L O W S H I P S

Fellowship Post	Name of Fellow and Country of Study	Duration
Small Industry Development Course	P.O. Onare (Eire)	3 months
Small Industry Technical Course (Leatherwork)	G.A.U. Imo (U.K.)	3 months
Foundry Technology	P.O. Onare (U.K. & Italy)	4 months
Industrial Management	J.A. Fapohunda (Holland)	5 months
Industrial Management	W.I. Ogunbode (Holland)	5 months
Textile Extension Work	S.O. Awatefe (India)	14 months
Textile Extension Work	O. Otenuga (India)	14 Months
Machineshop Practice	T.A. Omosebi (Italy)	3 months
Maintenance Course	S.E. Odezime (India)	3 months
Timber Studies	J.O. Odemudia (U.K)	6 + 3 months
Lace Manufacture	T.A. Olowookere (U.K.)	4 months
Project Management	O.A. Kayode (U.K.)	7 months
Woodwork	S.T. Fagbile (Eire)	4 months
Industrial Management	O.A. Oshonowo (Holland)	5 months
Industrial Management	J.O. Ofume (Holland)	5 months
Woodworking Machines (UNIDO HQS funds)	I.O. Okitikpi (Italy)	1 month
Industrial Management	C.E. Omusi (Holland)	5 months

LIST OF SEMINARS AND WORKSHOPS

Training Activity	Duration	Date	Number of Participants
Appreciation Seminar on Marketing for IDC Staff	8 hours	Jun78	8
Appreciation Seminar on Training for IDC Staff	10 hours	Jun78	9
Loan Appraisal Procedure - Small Scale Industry Credit Scheme	9 hours	Aug78	12
Seminar for Small Scale Textile Industrialists - Ogun State	3 days	Aug78	35
Costing Seminar for IDC Staff, Oshogbo	8 hours	Sep78	9
Metal Work Seminar, Preview for IDC Staff, Oshogbo	4 hours	Nov78	12
Loan Appraisal Form Review for IDC Staff, Oshogbo	4 hours	Feb79	18
Metal Work Seminar for Entrepreneurs at Abeokuta,Ogun St.	2 days	Nov78	24
Woodwork Seminar for Entrepreneurs at Abeokuta,Ogun St.	2 days	Feb79	33
Lesson on Investment Management for IDC Staff, Oshogbo	2 nours	Apr79	10
Seminar on Operation of Woodworking Establishments for IDC Staff, Oshogbo	3 days	Mar80	20
Seminar on Operation of Woodworking Establishments for Owners/Managers at Abeokuta	3 days	Mar80	24
Establishment of Foundries Seminar for IDC Staff,Oshogbo	2 days	Apr80	14
Foundry Seminar at Ilorin Kwara State	2 days	Apr80	28
Paper presented to Foundrymen Association of Nigeria	2 hours	May80	20
Foundry Seminar at Abeokuta	2 days	Jul80	24
Foundry Seminar at Ibadan	2 days	Jul80	29
Functions of Management, Abeokuta	1 day	Nov80	27
Production Management (at INDEXTRAC III)	1 day	Mar81	18
Work Study(at INDEXTRAC III)	2 days	Mar81	18

Project Evaluation (at INDEXTRAC III)	1 day	Mar81	18
In-Plant-Project Training (Textile Plant)	5 days	Apr81	4
Woodwork Seminar with Plant Visits at Ile-Ife, Oyo State	5 days	Mar82	23
Foundry Seminar at Benin-City Bendel State	2 days	Apr82	16
Foundry Seminar at Benin-City Bendel State	2 days	Sep82	20
Foundry Technology Seminar at Kwara State College of Technology	2 days	Nov82	25
Textile Seminar for Hand Weavers	2 days	Jun83	10
Lectures in Foundry Technology at ARCEDEM's international Course for Engineering Design, Ibadan	3 months	Aug-Oct83	20
Lectures in Mechanical Engineering and Product Design at AECEDEM's international Course for Engineering Design, Ibadan	3 months	Aug-Oct83	20
Woodworking Seminar for Small-Scale Industrialists	3 days	Nov 83	12
Woodworking Seminar for Small-Scale Industrialists	2 days	Jan84	15
Idustrial Safety in Woodworking Industry	2 days	Mar84	10
Production Technology in Furniture Industry	2 days	May84	20
Design of School Furniture (joined UNIDO/UNESCO Seminar)	5 days	Jul84	30

APPENDIX No. 5

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Original: ENGLISH

D I S C O U R S E

ON THE NECESSITY OF ESTABLISHMENT OF NATIONAL CENTRES FOR INDUSTRIAL DEVELOPMENT AND ENGINEERING DESIGN IN AFRICAN COUNTRIES. GUIDELINES AND RECOMMENDATIONS FOR PLANNING AND IMPLEMENTATION

BY

MIKKO J. HAKKA

UNIDO PROJECT MANAGER

NIGERIA

On the Occasion of Workshops on the Promotion of National Centres in African Countries to be held in Cairo, Egypt on the 30 th October.....4 th November 1983

This Discourse has been prepared by
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C O N T E N T S

THE NECESSITY OF ESTABLISHMENT OF NATIONAL CENTRES FOR INDUSTRIAL DEVELOPMENT AND ENGINEERING DESIGN IN AFRICAN COUNTRIES. GUIDELINES AND RECOMMENDATIONS FOR PLANNING AND IMPLEMENTATION

1. INTRODUCTION

According to the Lagos Plan of Action and the Final Act of Lagos, adopted in April 1980 by the Lagos Economic Summit, the African countries intend, during the present decade, to lay the foundation for industrial integration at the subregional and regional levels and to achieve a minimum of 1.4% of world industrial production by 1990. At the same time, they intend to do all within their power to attain self-sufficiency in the food, building materials, clothing and energy sectors.

The implementation of this plan is a demanding but challenging job for African Governments. It is also very important, because at present the standard of living in Africa is the lowest in the world. The earlier the economic growth and the overall development can take place the better chances there will be for successful results.

According to the joint report of UNIDO, ECA and OAU on the proposed industrial development decade for Africa, the key to the success of the Decade will depend, in the final analysis, on developments at the country level, since the main responsibility for the implementation of the programme lies with the countries themselves, individually and collectively. Also the said report continues that "In full awareness of the complexity of this task and the difficulty of the hurdles to be overcome, Africa must meet the challenge with determination and exploit to the full its tremendous natural and human resources. To take any other course of action would result in further weakening and impoverishing Africa for future generations (Ref. No. 1)

This discourse intends to give supporting material and information as well as guidelines and recommendations for this industrialization process in general, but particularly detailed guidance and practical proposals for establishment of National Industrial Development Centres and National Centres for Engineering Design in African Countries.

2. CURRENT TRENDS IN WORLD INDUSTRY

2.1. General Dimensions

During the last ten years the trends in world industry have been considerably different from what was forecast in the nineteen seventies. Particularly the structural adaptability of the industrialized countries has declined whilst on the other hand the rate of industrial growth in the developing countries has been less than expected.

The imbalance in world industry between developed and developing countries remains. The high rate of inflation and the continuous growth of foreign debts in most developing countries have worsened the situation.

According to the latest Industrial Development Survey of UNIDO, "World Industry in 1980" (Ref. 2) a comparison of the global distribution of population and net manufacturing output shows clearly the present imbalances and inequities associated with the world industry. For example, in 1960 the developing countries' share of world manufacturing value added (MVA) was 8.2%, while their share of world population was 57.4%. In 1980 the corresponding figures of world MVA and population were 10.9% and 65.0% respectively. The share of the developing regions in world MVA in 1980 was distributed as follows:
Africa 1.0%, Latin-America 6.1% and West-South and East Asia 3.8%.

In another study carried by UNIDO the results indicate that the developing countries accounted for 13% of world's net output in food products, 16.9% in textiles and only 7.1% for industrial chemicals.

2.2. Financial Situation

The g p between the amount of international finance presently available to the developing countries and to their future requirements is widening as the result of various complicated reasons. First of all the increase of foreign private investment has been less than anticipated. Secondly, although net foreign private investment in developing countries in 1978 was more than twice than in 1970, inflation eroded much of the apparent gain. Also the developing countries share in stock of direct foreign investment has actually declined.

Consequently, the conditions governing the availability of international finance to the developing countries are well known. For example, while the debt of the developing countries increased threefold during 1970-77, the annual debt service charge rose fourfold, (Ref.2). According to the Brandt Report the existing debt of the developing countries between 1980 and 1985 would have to increase by US $ 300...500 billion in order to sustain even their present low growth rate.

2.3. Science and Technology

We must all agree that the modern industrial world has its roots in a history of successful development of science and technology, and today industry relies more than ever before on a continuation of this development.

The demands for higher quality, more efficient performance and greater capacity in manufactured products are increasing continuously. As a result more complicated manufacturing processes are being introduced with greater demands on precision and accuracy.

World competition compels continuous research in economical production methods, the introduction of new materials and product innovations in order for manufacturing to remain viable and profitable.

The high degree of technology required to design and build modern industrial machinery, instruments and equipment is also reflected in the need for high technology and know-how on the part of the eventual owner and user of such complicated products. No matter how automatic and "foolproof" a machine may be, it will still require the support of skilled and experienced manpower to install and maintain it, and to protect it from abuse by unskilled operators.

The proper care of machines, instruments, tools and automatic control devices is nowadays requiring a much higher level of scientific knowledge. This fact has been forgotten too many times or has not been understood at all.

Technology is one of the most necessary and important components in any industrial process and it must be made available if any progress and success in an industrial operation are to be expected. The term: "Transfer of Technology" is often used when setting up a new industry in a developing country, and it is often thought that technology can be as easily transported as industrial machinery.

In this connection I would like to suggest that this term "Transfer of Technology" is far too loosely applied. I think it is an inappropriate expression because it implies that technology is a commodity to be purchased and shipped in a packing case. To my mind technology is simply information relating to a particular technical subject and that this information is of no use to anyone who does not have the capacity to receive it. This capacity can only be acquired through a well-established system of technical education and industrial training. The proper organization of technical education and industrial training is the cornerstone of the industrialization process.

3. INDUSTRIAL DEVELOPMENT IN AFRICA

3.1. General

Although vast sums of money and much human effort have already been expended on various industrial development programmes in African countries, no significant improvement in the overall manufacturing capacity is evident.

Many explanations to account for this low economic growth and slow progress have been advanced but none has provided a satisfactory answer. The causes are many and varied and the factors may be of external or internal origin. It is not the purpose of this paper to address this whole problem, but a study of some of the factors involved may help in formulating a planning strategy for the advancement of small-scale industry through the establishment of national industrial development centres.

Typical external factors in this context are:

(i) The international economic crisis

(ii) The high price of petroleum as it effects oil-importing countries

(iii) Fierce competition in world trade

(iv) Slow growth in foreign private investment in developing countries.

Respectively the internal factors include:

(i) Lack of natural resources, in some countries.

(ii) Lack of suitable skilled manpower

(iii) Inappropriate technical education and industrial training

(iv) Lack of realistic national economic policy

(v) The influence of cultural and ethnic differences

(vi) A lack of motivation, encouragement and innovative enthusiasm.

Every country has its own problems and shortcomings. Each government is responsible for the national policy and economic planning of its country. But the members of the general public have responsibilities affecting their own wellbeing which depends directly on how hard they work and how well they plan, design, control and manage their business enterprises.

Many questions and problems are of such a general nature that people at the grass roots level of different countries may face identical difficulties. Such problems can be discussed, analysed and resolved at regional or international levels. Certain principles and methods may be applied to arrive at standardized solutions to problems, and then these regional recommendations could be made available to individual countries for disseminating to their entrepreneurs. A good example of how this principle will work is illustrated by the intention of the African Regional Centre for Engineering Design and Manufacturing (ARCEDEM) to help member countries in the design and manufacture of capital equipment. From the foregoing it can be seen that the detailed planning and work must still be done at the national level.

3.2. The Role of Technology in African Industrialization

By definition technology is the scientific study of mechanical arts and applied science. Up to the present time technology has been introduced into Africa in an inappropriate manner. Government departments and private companies often have their special ambitions and favourite status symbols. When the market for an industrial product has been recognized, instead of choosing a proved and familiar manufacturing process appropriate to the quality and ability of the available labour resources, they select machines and equipment representative of the very latest state of the art. The machines are usually extremely sophisticated and are often fully automatic. This equipment is of course very expensive, and often it requires expensive raw materials.

More often than not these companies do not have sufficient technically skilled manpower, experienced engineers and works managers with a strong enthusiasm for their work.

With a limited source of technically-skilled manpower less sophisticated equipment is more justified. The maintenance, service and repair of machines of too advanced design create insurmountable difficulties. Spare parts are too complicated for domestic manufacture and import restrictions make their purchase from abroad prohibitively expensive and slow. Very often the factory comes to a standstill and eventually goes into bankruptcy.

It can happen that the high quality of the products of sophisticated machinery may not appeal to the local buyer who prefers to stay with a familiar product. This has often been the case when modern labour-saving cultivating tools or food processing machinery have tried to

compete with traditional implements. The market might thus be limited. Furthermore, full mechanization and automation of an industry deprives workers of employment opportunities, whereas a more labour-intensive manufacturing process creates employment with consequent benefit to the country's national economy.

If the level of technology is to be improved there may have to be changes in the system of technical education and industrial training. At the present time graduate engineers do not seem to be conditioned for or even interested in creative and constructive engineering work. They prefer to concentrate on "administration" and to leave the real engineering work to others. But the "others" may be technicians or mere mechanics who are not qualified to be given such responsibilities.

It may be necessary to completely change the curricula of the engineering universities so that a course of study provides more intimate contact with modern engineering practice. Polytechnics and technical colleges should be brought up to date and should include more practical instruction on such subjects as foundry practice, pattern making, heat treatment and machineshop practice. Technical schools should be turning out mechanics trained in machine maintenance; instead of which, their own equipment they are operating is more often than not in a sorry state.

3.3. Purpose of Research and Development (R & D)

One very important and actual fact I would like to express in this context and draw your serious attention to it, is the concept of Research and Development (R & D). It is possible to find that the interest and enthusiasism in high level scientific and technological research work is really very common in Africa, and in most Universities and Research Institutes in African continent the real s t a t u s s y m b o l in science seems to be the ability to do modern scientific research work, which will match the programme of the modern research institutes and universities of the most advanced countries. In fact, this has only an academic interest, because all the expensive work done, helps and gives contributions only to the industrialized world, and the country concerned cannot apply anything from the research results. Why this is happening? One can think that, in most cases the misdoers are the scientists of the Universities or Research Institutes who want to upgrade their personal scientific merits for their own interest, and their actual interest in their country's national economy is very small. In other words, the only beneficiary might be the developed industrialized world. Why the researchers and scientists should assist the already developed world and why they should neglect their own country's problems? Why? This means that the R & D programmes and objectives might be in most cases wrongly designed and wrongly orientated.

R & D institutes should implement applied research, which means studies and investigations how to apply the already existing technology to the local conditions. There is no need to invent or creat new instruments or machines, because practically everything has already been designed and created in hundreds of ways in this world. The only remaining need is to research the possible applications and find out which type of instrument, machine or tool is the most applicable, practical and favourable for the existing local conditions.

Also the R & D institutes should be able to test, measure and control of functions, properties and quality of different industrial products, because the design and manufacture of goods and machines does not work properly if there are no possibilities to check and test the excellence of the product.

If the Research Institute is able to do these analysis, it might have also the chance to develop something which is useful. The product development and the system development is of course the other important function of the R & D institute, and if the development results can promote the existing stage of the industry in one way or another, the R & D institute has fulfilled its duties.

3.4. Engineering Design in Africa

3.4.1. The Situation Today

Despite the fact that in Africa today there is no shortage of mechanical engineers with degrees earned at Univerties at home and abroad, it is not easy to find examples of good engineering design and manufacture.

Except in automobile assembly facilities and other foreign-controlled joint ventures, academically qualified young men may be seen holding ostensibly responsible positions but who have so far not made any contribution to the advancement of product design and manufacture.

The cause may be in the fact that industrialization has not yet reached the stage where the ability of graduate engineers can be utilized in a creative capacity.

But industrialization is proceeding, no matter how slowly and the time has arrived when we must seriously question whether the up coming engineers are sufficiently equipped to meet the product design challenge.

Design engineering demands such a wide range of practical knowledge and experience that we suspect that this aspect of technical training is being neglected.

Many of us here may have seen in the engineering departments of the universities, students engaged on so-called 'practical projects'.

We have seen weird contraptions of bicycle chains and foot pedals intended to revolutionize agriculture or food processing in tropical countries. These are admirable objectives but they are not subjects for inexperienced designers.

In several African countries, the only other activities in machine construction may be seen in roadside workshops where untrained welders and mechanics contrive to manufacture simple machines, without any knowledge of machine elements or materials.

3.4.2. What is Needed

The urgent need in Africa today is to extend the practical knowledge of the academically qualified design engineer in a much more intensive and specialized degree than he has hitherto received.

This could start by overhauling the practical aspect of university teaching so that instead of a group of students being allowed to "express themselves", on a misguided project, they would be led step by step to produce in the university workshop or engineering laboratory a real and recognizable machine without the need to 're-invent the wheel'.

Suppose, for example, we select a group of students to concentrate on all the theoretical aspects of centrifugal fan design and then give them the task of designing a simple radial vane blower of say, two horsepower capacity. The group would then participate in the actual construction of a prototype fan made of sheetmetal with a steel shaft and pulley produced in the machine shop. They would also be asked to devise all the test equipment and run performance tests on the fan coupled to a two horsepower electric motor.

At the present time and in the foreseeable future, after leaving the university a graduate mechanical engineer requires extensive instruction on the facts of life in modern manufacturing engineering. He needs the help of foreign design and manufacturing engineers but this help must be received in his own country and that is the purpose of the ARCEDEM programme of technical assistance in design and manufacture.

The ambitious design engineer must become familiar with all the technology necessary to enable him to enter the profession of design engineering. To remain effectively in this field of engineering science, he must acquire copies of all the international engineering standards and manufacturers' catalogues of modern engineering materials, machine elements and instruments. He must have a full knowledge of manufacturing methods including:

Foundry practice; forging methods; presswork, welding, die forming and casting; precision measurement and quality control; machine shop practice including gearcutting, jig and tool design; pneumatic, hydraulic and electronic control systems; workshop organization and management; material testing; heat treatment.

3.4.3. The Drawing Talent

With all this knowledge, a would-be design engineer would not succeed unless he has the wish and ability to express his ideas on the drawing board.

So many engineers consider that drawing work is strictly for the draftsman, but all the famous engineers and creative engineers of the world have possessed that necessary talent of being able to illustrate their ideas by making clear drawings.

For example, Leonardo da Vinci is a world famous artist but he is equally well-remembered as one of the World's most creative inventors. His achievements include practical military machines, hydraulic systems and even a practical proposal for a heavier-than-air flying machine.

Leonardo da Vinci was so fascinated by the design of the human body that his accurate and beautiful drawings of the human skeleton are appreciated by the medical fraternity to this day.

3.5. Establishment of National Industrial Development Centres

During the preparatory phase of the Industrial Development Decade the Lagos Plan of Action presents the following objectives at the national level:

1) Prepare and implement a programme for the promotion and popularization of the Decade

2) Prepare or update integrated industrial development plans

3) Develop a national technology programme

4) Establish a financial programme for national industrial projects

5) Introduce a national energy development programme and policy

6) Establish or strengthen national industrial development centres

7) Prepare an overall consultation and negotiation framework and strategy.

As we can see from the above list, one of the basic requirements at the national level for industrial development is to establish or strengthen national i n d u s t r i a l d e v e l o p m e n t c e n t r e s. The need of these centres has been repeatedly emphasized in the programme for the Industrial Development Decade for Africa as well as in so many other contexts.

The framework and basic concept of national industrial development centres has been laid out already many years ago in various countries. The main objectives and the mode of action of these centres vary considerably, and often their contribution to the developing industries as well as their capacity to give advice and assistance are far too small.

One of the main objectives of this paper is to introduce various requirements and aspects from the practical point of view, when establishing or strengthening the Industrial Development Centres (abbrev. IDC) and to give useful guidance and advice on how to operate and run these IDC's so that they will give the maximum benefit for the country's industrial development.

Before the IDC's are planned and established, the National Technology Policy must be declared and the Priority Industries identified.

The national technology programme should at least include as follows:

- research and development
- standardization and quality control
- engineering design and technology adaption
- strengthening and negotiating capabilities for the acquisition of foreign technology
- development of science and technology
- development of industrial and technological manpower
- systems for technical education and industrial training.

The national technology policy should also observe the requirements and conditions of the respective country concerning natural resources, availability of manpower, size of the country, volume of demand and supply, structure of existing industries in the country, priority industries, situation of the agricultural industries etc.

With these informations the planning and establishment of IDC's will be well justified.

3.6. Need of National Centres for Engineering Design

As indicated in the programme for the Industrial Development Decade for Africa (Lagos Plan of Action), the before-mentioned industrial development centres will have the following responsibilities among other things:

- development of engineering design and technology adaption

- design and development of new products and manufacture of prototypes

- product improvement and testing the excellence of the products

Accordingly, the development work on engineering design and manufacturing at the national level could be carried out by those I.D.C's, particularly if they are furthermore strengthened, so that their capacity in this designing field is enough and satisfactory for the country's needs.

It has been also suggested that each country should have a special National Centre for Engineering Design which in close co-operation with the regional centre ARCEDEM, adopts and implements the new ideas and proposals of ARCEDEM, suitable for the respective country's local conditions and requirements.

This kind of national centre for engineering design should have an organization which is nearly similar to ARCEDEM, but in small scale. Also, in order to be able to operate successfully, the basic engineering workshops are very necessary.

This all means, that the establishment of these national centres for engineering design in every country, would cost an enormous amount of money, especially if they are properly designed and built up.

On this basis I would like to suggest that this question should be further studied in details and by experienced people with time. When enough information and facts are available, new proposals and suggestions may be produced and necessary actions made.

Additionally, I would like to repeat still the above mentioned possible idea, that the national Industrial Development Centres, which are already existing in some countries, could quite easily take this responsibility for engineering design at national level, because they in any case are going to do this kind of work, and they do have also the necessary engineering workshops. If this mandate is given to the IDC's, they could be easily reorganized and adequately strengthened so that they have the full capacity to carry out these duties.

4. THE CONCEPT OF NATIONAL INDUSTRIAL DEVELOPMENT CENTRES

4.1. General

The original purpose of Industrial Development Centres was to give technical and managerial assistance in the development of small and medium-sized enterprises in the country by offering the following services:

- technical appraisal of loan applications
- provision of industrial extension services
- training of entrepreneurs and staff
- applied research into industrial products
- industrial and technological information service

The centres should also help the small scale entrepreneurs to purchase and install their machinery and to assist the government to grant and supervise small scale industry loans.

Within this framework for example the Federal Republic of Nigeria has established various industrial development centres in the country and some of them have been in existence more than ten years. The types of services they are rendering are as follows:

1) Selection of promising small-scale industries for prospective entrepreneurs
2) Selection of proper manufacturing processes along with machinery and equipment for the product lines
3) Installation and starting up operations of the machinery and equipment
4) Quality control and improvement of the end product
5) Repair and maintenance of the machinery and equipment of small industrialists.
6) Manufacturing of parts and components to re-start machinery and equipment rendered idle for non-availability of spare parts
7) Training of small industry technicians and artisans in the handling of improved machines and their maintenance and repair.
8) Improvement of product design and manufacture of prototypes
9) Adaption of technology and process improvement for small industries
10) Production Planning and control
11) Book-keeping, accounting and cost analysis
12) Marketing counselling for sales promotion
13) Financial counselling and credit arrangements
14) Appraisal of loan applications of small industrialists for grant of loans under the Small Industries Credit Schemes

15) Acting as a liaison between large and small scale industries for the manufacture of parts and components required by the former, on a sub-contracting basis by the latter.

16) Undertaking of in-plant studies for cost reduction and improvement of productivity.

The various methods adopted by the staff of the Industrial Development Centres to render the services listed above may be grouped as follows: (Ref. 8):

a) The individual approach in which direct contacts are maintained between the extension worker and the small industrial unit

b) The group approach through training courses and seminars held either at the centre or other convenient places to cater groups of small industrialists with similar problems

c) The mass approach through exhibitions, meetings and use of other mass media, such as radio and films

According to the joint report of UNIDO, ECA and OAU on the Lagos Plan of Action and the Final Act of Lagos the following recommendations have been presented: (Ref. 1)

i) Each African country should establish industrial development centres or strengthen those already in existence. These national centres can serve to implement the intergrated industrial development programme and prepare sectoral development programmes. They should provide for project identification, preparation and evaluation, as well as for the preparation of feasibility studies for priority projects (where appropriate, in collaboration with the project sponsors), and follow up the implementation of those projects, a particular feature being the provision of consultancy services and management advice.

ii) The services offered by these industrial development centres would relate not only to assistance in the development of small and medium-sized enterprises, but also to the problems of industrial decentralization and the introduction of industrial units into rural areas, in particular through the adoption of policy measures which encourage and facilitate domestic industrial initiatives; for example, on appropriate and effecicient administrative, fiscal, financial and marketing framework.

4.2. Technical Requirements and Operational Framework

4.2.1. Types of National Development Centres

Different countries have established slightly different types of national industrial development centres. There are Metal Industry Development Centres (MIDC), Industrial Development Centres (IDC), Rural Development Centres (RDC) and combinations of all these.

Secondly, the size of these centres varies, depending on the size of the area or region they are operating and also depending on the volume of the work to be carried out.

Thirdly, the way of operation can also vary considerably. For example, a well equipped larger centre with staff of specialists for all possible industrial fields can give assistance in all possible ways, but a smaller centre without any workshops, can render only extension services and engineering consultancy or other assistance in a limited way.

In general, it would be advisable for every country to study and plan this aspect as carefully as possible. One possible way to build up these centres may be that if there is need to establish more than one centre in the country, the centres could be of different size and possibly also of different mode of operation, such as follows:

a) there are one, two or three main centres, which each can render nearly all necessary assistance to the industries

b) under each "main centre" there are 3...5 "Sub-Centres" which are located in the country so that they can easily reach all industrialists in their zone and meet the requirements of the existing local industries have. They might have less facilities and specialized staff, and whenever assistance beyond their capacity is requested, the main centre respectively is responsible to render this special assistance.

c) Each "Sub-Centre" might then have a few "area-offices" or branch offices for less populated areas or rural areas, where the density of industry is low and where the demand of technical assistance is small. They are operating more likely as co-ordinating bodies for the sub-centres, and the real concrete assistance for the industries is offered by the sub-centres.

4.2.2. Organizational Requirements

In this context we concentrate more on the organizational requirements of a "main centre" i.e. of an industrial development centre which, with its engineering workshops and with its specialized staff, is a "complete unit" and can render most of the services requested by various industries.

The centre must have an Executive Board appointed by the respective Ministry or Government Department, and which should have a mandate to govern and direct the centre according to its constitution through the appointed staff of the centre. The centre should be administered by a Director appointed by the Board and he should be in over-all charge of the centre and be responsible for the direction and control of the Centre's activities and operations.

A Deputy Director should be appointed to represent the Director whenever he is travelled or hindered to carry the daily administrative duties at the centre.

The senior staff should be selected according to the requirements of the surrounding industries in the region. It might be advisable to divide the centre into few divisions or sections, such as
1) Technical Services Section, 2) Management Services Section, 3) Administrative Section, 4) Industrial Information Services Section (including library and data bank) 5) Training Section, 6) Product Design, Research and Development Section.

Each of the Section should be headed by a suitable trained person, preferably with academic degree, and with necessary practical experience in the respective field. How many senior technical officers, industrial officers or economists are required, will depend entirely on the size and activities of the centre. Also the supporting administrative staff as well as the operational staff for the workshops must be recruited, but detail requirements and quantity depend on the size and activities of the centre.

4.2.3. Industrial Development Centres' Workshops

Because many African countries do not have an infrastructure of small-scale technical industrial capability, the main industrial development centres should possess the basic technical workshops, namely: pattern making, ferrous and non-ferrous metal foundry, metalworking and wood-working. Additionally, there will be workshops equipped for specialize d trades selected in accordance with the list of priority industries, such as leather goods manufacture, textile processes, plastics, ceramics, printing, electronics and food processing.

Industrial development centre workshops will be used for the following purposes:

1) Demonstrations to entrepreneurs and their employees on:

   - machine operation and utilization
   - manufacturing processes
   - material and quality control
   - workshop organization

2) Machine repair and the manufacture of spare parts for small-scale industry

3) Services to industry including heat treatment of metals and material testing

4) New product design and development and manufacture of prototypes

5) Product improvement and testing

6) Presentation of seminars and organization of in-plant training.

4.2.4. Operational requirements

To be able to operate successfully the industrial development centre must be properly staffed. The disciplines and duties of each staff member must be specified in a detailed job description. The organizational chart and the manpower requirements must be first studied and planned according to the demands for assistance from various industrial fields of the country, and then the recruitment of staff carried out on the basis of the plan.

When the centre is ready for operation, a complete plan of action must be prepared and then according to this plan the running costs of the centre must be calculated. This will include materials for workshops operations, electricity, water, transport costs, administration and other overheads. The yearly budget of the centre will be then prepared on the basis of the real actual needs.

The more extension services are offered the more transport costs are involved. Vehicles are very essential, and they should be enough in number and their maintenance and servicing should be organized properly.

General facilities such as duplicating machines, scanners, photocopying machines, other essential office equipment as well as audiovisual aids and other training materials must be purchased.

A suitable drawing office must be established with adequate equipment such as drawing boards, drawing instruments, standardized drawing papers, pens, ink etc. Possibility for making blue prints from engineering drawings is a must.

Yearly funds for increasing the amount of books and other information material should be allocated, the collection of industrial standards should be kept up-to-date, and continuous flow of information from other national, regional or international organizations should be maintained.

Also general communication facilities must be provided. Telephones, telex services, radiotelephones, pouch services or any other methods should be implemented according to their availabilities and the prevailing infrastructure in the country.

The mode of operation should in principle follow the practice of ordinary consulting companies or other engineering consultants. Whether the service is free or some fees are charged depends on the individual organization. It is advisable that in certain cases some fees should be charged for the work carried out, but all these questions are up to the policy and constitution of the respective industrial development centres.

4.2.5. Buildings and Land

Many institutions or organizations start often in temporary premises. The permanent site of the institution is selected then during this first period of operation, and the final buildings are planned and built up according to the site plan and the architectural drawings.

The land of the site should be big enough for future expansions and it should be by all means even and level. The location is also very important, and this means that the site should not be too far away from the area's business centre and from the other activities in the area including the industries.

The workshops are often planned without consulting the engineering specialists or the operating personnel, who normally are well aware what are the technical requirements and specifications for the buildings. Also the proper design of the workshop buildings guarantees that not extra costs are spent for the building constructions. Additionally, the equipment often require certain special applications and design, and therefore it is very important that the buildings, particularly for the workshops are planned and designed with expertise. Some basic ideas are presented in the Appendix No. 1, which decribes the most common standard solution for any engineering workshop in the whole world.

4.2.6. Problems experienced in the past

To establish an industrial development centre requires a lot of good planning and organisation and also adequate expertise in various professional fields. What has happened in the past in various countries, is not in our records and to obtain this information is not quite easy, but some typical examples of problems and mistakes can be presented herewith.

The common problems and mistakes have been as follows:

- lack of funds, caused by the improper budgeting of the project
- lack of skilled manpower
- lack of co-ordination and co-operation between government departments, universities, research institutes and other essential organizations
- engineering workshops designed wrongly without consulting engineers and specialists
- no properly planned programme and time table for the implementation of the project
- the necessary infrastructure often built up too late or neglected completely

- recruitment of operational staff often improper or not done at all
- materials for operation and maintenance not available. Purchase policy and system not established
- organization of the management and senior staff has been not planned properly
- the definitions for the main objectives and activities of the centre have been not clear or are missing
- funds for operation too short

If the above-mentioned problems and mistakes could be avoided in the future, the achievement in this area of work in the industrialization process could be much more successful and the country concerned could benefit from that considerably much more.

5. Planning and Establishing Industrial Development Centres

5.1. Necessary Information for the Planning Work

Until information is available, the Planning of an industrial development centre cannot be started. All necessary information must first be collected.

What kind of information is the most important and necessary? This question is often relatively difficult, because the situation is new, the proposed project is new, nobody has yet studied the local requirements and the environmental questions as well as the technical, economical and industrial priorities.

At least the following information should be available before the real planning can be started:

- the number of existing industries and their production capacities.
- available natural resources, and the rate of their utilization.
- size and structure of the market for existing industrial products and for possible new products.
- which new industries are required in the country and how big should the production output be
- present availability of skilled manpower for the projected industries
- how much manpower must be trained immediately and in the long term
- what are the possibilities to train the required skilled manpower in existing educational institutes and schools
- to what extent the proposed industrial development centre can offer training assistance for the required manpower
- are funds available for establishing an industrial development centre
- is external technical assistance needed and in what form? (e.g. United Nations)

5.2. Technical Requirements of I.D.C's

5.2.1. General

The required engineering fields to be covered by the centre must be studied and decided on the basis of the planned priority areas of industries.

In the proposed plan of an industrial development centre the mode of operation must be formulated and decided. A detailed plan for the following functions is required:

- Public Relations system, advertising
- Extension services and consultancy
- Assistance in maintenance and repair
- Seminars and workshops
- Individual entrepreneur training
- Loan appraisals, feasibility studies and factory planning
- Are all services free or are some of them chargeable
- Industrial information service and library
- Assistance to small scale industry credits scheme's loan management committee
- Techno-economic surveys, marketing studies, research
- Workshops operations
- Material and manpower requirements

5.2.2. Workshops Design and Equipment

The planning and the selection of equipment for each workshop must be conducted by a specialist engineer or consultant. The first stage is to design the building to ensure that it is appropriate to the purpose. It would be advisable that at this stage the proposed equipment list with technical specifications is already available, because sometimes special equipment might demand special structure to the wall or floor.

A building specification will be written by the specialist engineer so that the architect's final design will meet the special requirements of the workshops in regard to machine foundations, floors, access for installation and maintenance of the plant.

The specification will also ensure that natural and artificial lighting and ventilation are adequate and that the structure will accommodate such special requirements as lifting cranes.

When drawing up the building specification, the engineer will have prepared a lay-out drawing or block plan showing in their proper places all the machines and equipment he has selected. By appointing a specialist experienced in the particular field of the intended workshop, we can avoid the acquiring of unnecessary equipment one can sometimes see in universities and colleges.

The national technology policy and plans for priority industries should be studied to avoid unnecessary duplication. For the same reason other institutes and engineering workshops in the region should be visited and appraised.

5.3. Planning Strategy

When the final decision has been made to establish an Industrial Development Centre, the planning and design of the proposed project can be started. The planning procedure should be studied well and the final planning strategy established.

At the first stage the following questions must be studied:

- Which government department is responsible for the project
- How the planning work will be implemented
- Programme for the project's implementation and estimated time-table.

The second stage of the planning should include as follows:

1) The operational characteristics and the technical functions of the centre must be declared and finally decided.
2) The organization and management of the centre must be designed and the necessary specialists and advisers appointed.
3) The final plans for infrastructure, buildings and equipment are prepared.
4) Other detailed plans for following functions must be prepared:

- Manpower requirements, job descriptions, work programme
- Transport requirements, vehicles
- Administration
- Finance (budget for total investment and operation costs)
- Raw material (purchase, storage, control)
- Operational rules and regulations
- Staff rules
- Security arrangements (guards, fire prevention)
- Health Clinic (first aid station)
- Publicity, Information service
- Communication (Post, telephones, telex, radio telephones
- Staff Canteen, social services, sport facilities
- Hostel for seminar students or trainees.
- Required external technical assistance.

5.4. Implementation Programme

After the Planning and Designing work has been completed, the implementation of the project can start.

The implementation programme normally follows the following pattern:

1) the first part of staff will be recruited and accommodated in suitable temporary offices
2) Building the infrastructure should start: Roads, Site Levelling, Fencing, Electricity, Water, Telephones, Landscaping, etc.
3) Construction of buildings should be started
4) Start of equipment procurement
5) Purchase of operational materials
6) Recruitment of operational staff for workshops
7) Completion of the buildings
8) Installation of workshop equipment
9) Training of operational staff
10) Testing of machines and setting them all into operation
11) Arrangements for maintenance and overhaul programme for workshop equipment
12) Working rules and operation standards are to be established
13) Commissioning of the workshops and the whole centre.

To execute the project successfully and according to the original plans, depends much on the overall management and supervision of the project as well as on how well the project has been planned.

6. CONCLUSION

It is to be hoped that this discourse will give at least some supporting information and assistance to those institutes and government departments which are involved in the development of small and medium scale industry and which are also responsible for planning and building up the national industrial development centres.

Concerning the basic characteristics of the industrialization process, I once again would like to appeal to the industrial development authorities in individual African countries and also to the planning authorities and engineering consultants in each country, and recommend them to take into consideration the following expression: "Without appropriate technology there is no successful industry, and without successful industry there is no prosperity". In other words, the industrialization of Africa must undergo the proper procedure and the planners must respect the historical facts and rules about the importance of science and technology in industrial operations. At the same time the local demand and supply of industrial products should be well studied and recognized and their adaptability identified.

I would like to express my wish to see that the industrial development in Africa becomes a fact and does not remain as a plan, and furthermore that the would-be industrial development centres throughout Africa will be at once meaningful institutes with ambitions and a strong will to improve the development possibilities in each country and to support the struggle towards a better life for the people.

APPENDIX NO. 2

TABLE FOR APPENDIX NO. 1

Dimension	Small	Medium	Large
a	4	4	5
b	12	12	15
l	20	30	50
h_1	8.5	8.5	10
h_2	6	6	7
h_3	3.5	3.5	3.5

All the above dimensions are given in metres (m)

APPENDIX No. 6

Survey on

FOUNDRY INDUSTRY IN NIGERIA

REPORT ON PRESENT SITUATION, FUTURE REQUIREMENTS AND DEVELOPMENT POSSIBILITIES

Prepared by

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C O N T E N T S

S U M M A R Y

This report gives a cross-sectional analysis about the present situation of Foundry Industry in Nigeria and gives some detailed information about the types and number of foundries, about their production output, location, problems, raw materials and energy supply, manpower requirements, e.t.c. For example the number of foundries which are in operation in Nigeria is relatively low compared with the population and the size of the country. All together there are about 50 foundries. (* More than half of these foundries are located in Lagos State and Cyo State.

Only a few of the 50 foundries have modern equipment and on average the quality level is much below international standards. Most of the foundries do not have any quality control system at all, and those which have carry out the work with insufficient instruments and control. In general there is a serious lack of technical know-how. Secondly the lack of sufficient modern equipment and tools causes continuous problems in the production and quality of castings.

Material, energy and manpower requirements are also analyzed, and calculations and estimations for future requirements, particularly for the next 10 years' period, have been presented. It is estimated that in 10 years' time the total output of all Nigerian foundries can be about 2 to 3 times more than at the present.

Also the role of the Industrial Development Centres has been introduced in the report and especially their importance in developing the foundry industry in the country, has been emphasized. For example the Industrial Development Centre of Oshogbo in Oyo State will have a special demonstration foundry with modern equipment and a complete testing laboratory, and this plant could be used successfully for all kinds of technical assistance and engineering training in developing the Nigerian foundry industry.

The report also gives recommendations for future requirements of manpower development as well as technical education and engineering training.

In general, the report strongly recommends encouraging small and medium scale industry in Nigeria, considering it as an unavoidable necessity without which the basic large scale industry and the whole economy of the country cannot survive. Especially the development of the Nigerian foundry industry needs this support, and this means that first of all the Industrial Development Centres should have the obligation and responsibility for this important development work. Expressly the I.D.C. Oshogbo with its special foundry facilities and technical resources should show the new way to the future.

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*) See appendix showing names and location of existing foundries by states.

1. DEFINITIONS

Foundry work or Foundry Engineering is a specialized field within the engineering industry where metallic castings are made of molten metal. To get the required shape of the casting, the molten metal is poured into a mould which is made by using a pattern. When the metal has cooled, the mould is opened and the casting is ready for use or further treatment.

Nowadays there are various types of foundries producing different castings of all possible metals and metal alloys. Normally the engineering industries use the following metals for their castings:

1. Ferrous metals:
   - Cast Iron (grey, white, ductile, malleable) Low and high carbon steels
   - Alloy steels
2. Non-ferrous metals:
   - Copper-base alloys (brass, bronze)
   - Aluminium, zinc and magnesium-base alloys
   - Lead and tin alloys (white metals)

Usually foundry technology or foundry engineering is considered as a special sub-field of Metallurgical Engineering.

2. THE IMPORTANCE OF FOUNDRY INDUSTRY FOR ECONOMIC GROWTH

The industrial development of a country depends essentially on the possibilities of the production of castings. The manufacture of every machine and each piece of equipment used in manufacturing industries, transportation, farming, mining etc. relies upon castings. For example parts may be broken or wear out and they must be replaced. Therefore an effective local source of castings (= their replacement parts) is

very important to avoid long delays in purchasing items from original manufactures which sometimes are far away abroad.

This abovementioned urgent need for parts to keep machinery operating or for the supply of simple tools and utensils creates the first step of the growth of a casting industry. In this first stage the foundry needs to have only the minimum equipment required for production of simple castings and the working methods are generally primitive and the control of process and quality insufficient.

Once the economy of the country expands this above-mentioned type of primitive foundry cannot meet the demand for more complicated castings of better quality at reasonable price. This means that either many castings must be imported at high prices to ensure continous operation of the machinery or the local foundries must be further developed.

When the local manufacture of tools, machine tools and equipment expands, it is then necessary to create sources of commercial-quality castings. In this case the local machine manufacturer may develop a foundry for the supply of castings only for his own plant. Alternatively a separate foundry business can be established.

Further on the next step of growth depends on the expanding market for locally manufactured machinery for both export and domestic use. The quality standards must be high and the production facilities efficient in order to be competitive in the international market. And so the development goes on and on.

Consequently, the requirements of the country's foundry industry depend entirely upon how rapidly the industrial development and economic growth take place. And when the economy is really growing up the highest priority should be given to improve and support the country's foundry industry.

3. CHARACTERISTICS OF MODERN FOUNDRY INDUSTRY

When the industrial revolution took place in Europe and America about 200 years ago it caused a growing demand for castings and step by step the quality requirements became tighter and tighter. The whole foundry industry had to go through a tremendous development process and adopt the new technical specifications, quality standards and safety regulations.

None of the modern sophisticated equipment for machinery, such as aircraft, spacecraft, satellites, diesel engines, turbines, automobiles, trains, computers, computorized machine tools, nuclear power stations, televisions, automatic washing machines, tape records, pocket calculators etc., could exist at all if the successful development in metallurgy, metal technology and foundry engineering had not been carried out by skillful and experienced engineers and technologists during this period of modern industrialisation.

The technical requirements and quality standards are now so high that without proper technology and know-how it is impossible to make these castings. You need qualified foundry engineers and metallurgists, you need skilled technicians and foundry operators as well as pattern makers, you need laboratory engineers and metal analysts as well as sufficient equipment and instruments. You need adequate raw materials, you need specified quality standards, technical drawings, casting designers, etc. And all this is necessary because of the high quality required.

Why must the quality be so high? The reasons for the demand of high quality castings everywhere in the world are briefly as follows:

- safety standards and regulations require better strength and physical performance for the metallic machine parts
- higher working capacity or speed of the machine require quality

- for economical reasons higher quality is preferred because the machine or machine part will last much longer
- for pure technical reason; the design or the way of operation may require certain rigidity, strength, hardness or other good physical performance
- for environmental reason; tropical heat, arctic cold, stormy wind and rain, heavy corrosion of metals, etc.
- limitations in weight; for example aircraft industry.
- competition between manufacturers demands improvement in quality
- demands of consumers; better outlook or more elegant design is required, more comfortable performance is required, extra more luxurious accessories are required, etc...

However, beside these abovementioned quality requirements there are hundreds of other reasons which cause this continuous technological development and modernization of working methods in engineering industries throughout the world.

4. PRESENT SITUATION

4.1. Existing Nigerian Foundries and their Production

According to the information collected and investigations carried out the present situation of the Nigerian Foundry Industry looks as follows:

The total number of foundries in operation in Nigeria is about 50. About 5 of them are medium size, about 7...8 of them are smaller medium size and the rest, about 35, are small scale foundries, all of them producing castings mostly of bronze, brass, aluminium or grey cast iron. Most of the foundries have primitive equipment, simple working methods and unsufficient or no quality control. More than half of the foundries are situated in the two western Nigerian Stat i.e. Lagos State and Oyo State, (Lagos/Ikeja and Ibadan)

The rest is in Ogun State, Bendel State, Anambra State, Kwara State, Plateau State, Kaduna State and Kano State.

The production output of various foundries varies considerably. Most of the foundries are so small, that they do not even keep good records to know how much they produce during the month or the year. Some of the largest make grey cast iron castings and their annual output is about 500 to 1500 metric ton. Majority of the smaller foundries make non-ferous metal castings, mostly of brass, bronze and aluminium. They normally use small oil-fired crucible furnaces or simple coke-fired pit furnaces. The cast iron foundries use oil-fired rotary furnaces, cupolas or ordinary oil-fired crucible furnaces.

Only some of the large ones have partly mechanized their foundries, and they have few instruments for basic quality control. In most foundries the moulding, core making and other work is done manually and with primitive tools. Many foundries even do not use moulding flasks. The most developed foundries have a small pattern shop and probably a pattern maker, but the others often make moulds without patterns and they don't have pattern shop or pattern makers.

4.2 Raw Material, Energy and Manpower Supply

In most countries almost all foundries use scrap for their metallic raw material and there exist an organised scrap-dealer network throughout the country, the scrap is always sorted so that different quality classes can be purchased separately at different prices. The availability of the scrap depends essentially on the quantity and capacity of the existing basic engineering industries, from where the scrap generally comes.

In Nigeria the quantity and capacity of the engineering industry is relatively low, but there are signs that it continues to expand. With regard to the availability of metallic scrap for the foundry industry, there is plenty of scrap but lack of organized scrap dealers. If the foundry industry expands the situation cannot become worse, because

at the same time the basic engineering industries are growing up, and more scrap will be "produced".

Concerning moulding sand and core sand sources as well as various refractory materials, there are good deposits in the country but the mining techniques, treatment, processing and transportation need to be further developed and made known.

Some special materials such as ferro-alloys, special fluxing materials, core-sand binders, crucibles etc are still to be imported, but they represent less than 20% of all material costs.

One of the most serious difficulties at present is the lack of skilled manpower and lack of technical know-how. This means that any further expansion in the foundry industr is hardly possible before more foundrymen have been trained. In other words the development work in the near future shoul include more effective training and technical education in the field of metallurgy and foundry technology.

4.3. Major Problems

As already mentioned the main problem in the Nigerian foundry industry at present is the lack of skilled manpower and lack of sufficient technical know-how.

Some foundries suffer from lack of good scrap, which mainly is caused by lack of transportation and lack of organized scrap dealers.

A very common problem is moulding sand. In fact there exist reasonable sand deposits in the country, but due to lack of knowledge and experience, the existing sands have not been used. Part of lining materials, refractory bricks and clay must still be imported, but in future nearly all could be manufactured locally.

As a result of the abovementioned problems the quality level of most castings is too low. Defective and poor quality castings, made as spare parts of various machines,

have caused serious problems and break downs in the Nigerian industry and sometimes there has even been serious safety risks.

5. FUTURE REQUIREMENTS

5.1. Demand of Various Castings

If the next national development plan will follow approximately the same lines as the present "Third National Development Plan (1975-80)" it means that during the next ten years the engineering industries and the whole economy of the country will expand progressively. This also means that demand of spare parts for engineering industries will grow up steadily and need for high quality castings for this purpose as well as for machine tool and automobile industry increase considerably. Civil engineering, road construction, railways, transportation, water supply and sanitation etc will require more and more special good quality castings. Also manufacturing of agricultural machinery and equipment will need more castings. The basic large scale industries such as steel industry, paper industry, textile industry, wood and forestal industry, oil refineries etc. should not be excluded either, when estimating the total need of castings in the country.

The following table shows the possible growth in demand of various castings during the next ten years. The figures have been estimated on the basis of the present information about the Nigerian foundries and on the basis of the forecasted industrialisation in the country during the next ten years.

A better forecast could be estimated in 2...3 years time when some progress has been established.

Engineering field	Grey Cast Iron (annual output tons)		Steel Castings (annual output tons)		Non-ferrous met. (annual output tons)	
	Present	1990	Present	1990	Present	1990
Machine tool industry	-	2000	-	300	-	10
Automobile industry	-	1000	-	200	-	200
Water supply and sanitation, piping	800	1600	-	50	100	300
Railway, transport	800	1500	-	50	30	60
Road construction	200	500	-	50	-	10
Manufacturing of agricultural machines	150	500	-	100	50	100
Forestry and wood-working industry	50	100	-	20	10	20
Electrical machinery & instrument manufacturing industries	10	50	-	10	10	30
Basic large scale industries (steel, paper, textile, oil, mining etc.)	50	200	-	50	20	50
Civil engineering	500	1500	-	50	50	100
Manufacturing of machines, tools and spare parts for engineering industries	150	500	-	200	75	150
Various other industries (food processing, printing, stone processing, furniture, metal, hardware, souveniers etc)	800	1500	-	200	2000	4000
TOTAL	3510	10950	-	1280	2345	5030

5.2. Increasing Quality Requirements

To be able to replace the imported high quality standard castings by local products the foundry industry must be considerably improved and a modern comprehensive quality control system introduced. The quality control system should include mechanical testing of metals, chemical analyses, microstructure analyses (physical metallurgy), testing of moulding sands and testing of various foundry materials. In special cases it might be necessary to use ultra-sonic testing, surface crack detecting and pressure testing, X-rays radiography and Isotope-radiography.

In order to be able to make high quality castings which fulfil the technical requirements according to international standards, the foundry where they are made must have a well equipped modern testing laboratory and every casting and/or every melt batch must undergo the scheduled control system. The results must be recorded properly so that even later on if for example the casting is broken, it is possible to check the test results and under which conditions the casting was made.

All this means that increasing quality requirements require more technical know-how and special instruments for the foundry industry especially in the fields of metallurgy, laboratory techniques and analytical chemistry of metals. Also more skill and knowledge are required in moulding techniques, pattern making, gating and risering techniques as well as heat treatment technology.

Further on these facts mean that more advanced technical education and engineering training is necessary. Therefore universities, polytechnics and technical colleges should be equipped with necessary equipment and facilities required for this special training, and qualified teachers, lecturers and professors should be trained to carry out this training. Also young students should be encouraged to enter into this new and still little known field.

5.3. Required Technical Know-how and Manpower

If the development in foundry industry proceeds as estimated in paragraph 5.1. the number of total skilled foundrymen required in Nigeria after ten years could be as follows:

- Foundry Engineers/Metallurgists	20...30
- Foundry Technicians	50...70
- Laboratory Technicians	20...30
- Pattern Makers	75...150
- Moulders	500...700
- Core Makers	100...150
- Furnace Operators	100...150
- Fettlers (semiskilled)	500...700
Total	1365..1980

If we assume that the average training period for each skill varies from 3 to 5 years it means that the training should be started now in order to get all these, about 1500, foundrymen trained within ten years.

Part of the technical education and training will be carried out in Universities, polytechnics and technical colleges which means that they should also be prepared for the future requirements.

5.4. Raw Material Requirements

If the development in Nigerian foundry industry proceeds as estimated above, the approximate annual demand of various foundry materials in the whole country after ten years period, i.e. in 1990 could be as follows:

- Pig Iron	1000...1200 ton
- Sorted steel scrap	1200...1500 ton
- Sorted cast iron scrap	10000...12000 ton
- Sorted aluminium scrap	2000...4000 ton
- Sorted bronze scrap	1500...2500 ton
- Other metal scrap	1000...1500 ton
- Silica sand	1000...1500 ton
- Natural clay sand	4000...6000 ton
- Metallurgical coke	500... 800 ton
- Graphite (carbon) for carburizing	50... 100 ton
- Limestone	100...150 ton
- Silica lining material	100...150 ton
- Various furnace lining materials	150... 250 ton
- Other refractories (bricks etc)	100... 150 ton
- Bentonite	200... 300 ton
- Core sand binders	25.... 30 ton

- Graphite powder (for moulding)	20... 30 ton
- Metals, alloys and ferro-alloys	
Ferrosilicon	250...350 ton
Ferro-manganese	75...125 ton
Ferro chrome	15... 20 ton
Granular Nickel	5... 10 ton
Tin ingots	10... 15 ton
Lead ingots	25... 35 ton
Zinc ingots	5... 10 ton
Alluminium ingots	300... 500 ton
Copper ingots	75... 100 ton
White metal ingots	50... 70 ton
- Various fluxing materials	50...150 ton
- Fuel for melting furnaces	3... 5 million litres

It is believed that all metallic scrap should be obtained locally from Nigerian scrap dealers. Only smaller quantities of special metal alloy scrap might be necessary to import into the country. Regarding sand and various refractory materials possibly all can be made and processed in the country once the necessary equipment and techniques have been developed, because there exists several good deposits in various parts of the country. Bentonite and metallurgical coke must be imported for the time being. Also some special metal alloys and materials still remain to be imported, but their share is relatively small compared with the total.

6. DEVELOPMENT POSSIBILITIES

6.1. The Role of Industrial Development Centres

The principal aim of the Industrial Development Centre is to develop viable and modern small scale industries and also improve the existing small scale industries through the adoption of more efficient techniques of production and better organization and management methods.

There are three Industrial Development Centres in the country at present located at Owerri, Zaria and Oshogbo, with four more centres in process of starting up at Benin city, Uyo, Maiduguri and Sokoto According to the National Development Plan the final aim is to establish one Industrial Development Centre in every State.

The main function of the I.D.C's are briefly as follows:

- technical appraisal of loan applications
- provision of industrial extension services
- training of entrepreneurs and staff, including management training
- to provide consultative and extension services for proprietors and managers of small scale enterprises
- applied research into industrial products involving design of products for small scale industries
- to help entrepreneurs to purchase and install machinery

To improve the present stage of Nigerian Foundry industry and particularly the small scale foundries, the utilization of Industrial Development Centres is the most ideal way to carry it out.

Especially the Oshogbo I.D.C. would have excellent possibilities to take responsibility for the main development work of small scale foundry industry in Nigeria because the centre will get a complete modern demonstration foundry plant with well equipped testing laboratory, and the Technical Assistance Development Project of United Nations (UNIDO) engaged to the centre has a considerable capacity to assist in developing foundry work and foundry industry in the country.

Consequently, the development work could be started first in the surrounding states of Oshogbo and later on extended to all states of the Republic in close co-operation with the other existing or planned I.D.C's.

6.2. Capacity of Oshogbo I.D.C.

The Plan of Operation of the UNIDO-Project within Oshogbo I.D.C. includes among other things development aid for foundry engineering in the form of technical assistance, know-how and advice through the foundry specialist and of arranging possibilities for fellowship training abroad as well as all kinds of technical training within the workshops of the centre. Additionally the project budget includes machinery and equipment for establishment of a demonstration foundry at the Oshogbo I.D.C. Through this demonstration foundry excellent services could be given to the entrepreneurs and their employees by arranging seminars and training courses, demonstrations and in-plant-training courses as well as technical consultancy and any other assistance related to this field.

The foundry building will be constructed so that it demonstrates an ideal pattern for other foundry industrialists. Also an O.H. crane will be built in the main hall, because lifting and transportation are the most charasteristic movements in foundry work.

The melting equipment have been planned so that all kinds of metals, i.e. steel, cast iron and non-ferrous metals can be melted in the foundry. The various sections of the foundry will show the ideal arrangement and model for a small scale foundry and they also give advice for the entrepreneurs how they could improve their production capacity and quality control. Also a small testing laboratory will be built up in connection with the foundry shop. The laboratory will have the following testing units: 1) mechanical testing, 2) sand testing, 3) chemical laboratory for metal analyses, and 4) microscope laboratory.

6.3. Technical Education and Engineering Training

As mentioned earlier in the report the great emphasis should be put on the development of technical education and engineering training in the field of foundry engineering. The question is: "How can this be implemented?" The purpose of this report is not to present a final programme and detailed advice how the training should be arranged, but some suggestions and estimations are briefly presented.

First of all the practical trade training, mostly in form of in-plant-training for craftsmen can be easily organized by the Industrial Development Centres or partly by the factories of the foundry entrepreneurs. Regarding higher technical education and more advanced engineering training, it should be done through universities, polytechnics and technical colleges as well as through specialized fellowship training abroad. The said educational institutes should become involved with this particular field and the whole education plan should be prepared accordingly. For example the Federal Government should undertake the financing of the necessary costs for teachers and lecturers as well as for teaching materials and equipment. Possibly a coordinating and planning committee should be established and the Federal Ministry of Industries and the I.D.C.'s should be involved.

6.4. Other Methods and Aids for Development

Standards: The technical specifications and standards concerning foundry materials, cast metals, castings and testing methods should be developed and established on the national level based on international recommendations. The Nigerian Standards Organization should undertake this development in co-operation with technical specialists and foundry industrialists.

Foundrymen Association: In all industrialized countries the foundrymen and foundry engineers are regularly in close contact with each other in order to exchange views and experiences on various technical subjects or even on day to day problems either directly or through their national foundrymen association. Accordingly, it would be advisable to establish in Nigeria a countrywide Foundrymen Association, and later on each state could have a local sub-division.

The Foundrymen Association could hold regular meetings and all foundrymen could have a chance to meet each other and exchange their opinions and experiences. Even the meetings could be used as a forum for speeches or lessons on foundry engineering or on the latest development in foundry technology. The association could also make visits to technical institutes or to some better equipped foundry of a member of the association.

Foundry Bulletin: All kind of technical information is always important for any industrial field. Therefore the before-mentioned Foundrymen Association should also start to publish a monthly or quarterly foundry bulletin for all members and by means of this magazine it could be possible to transfer technical information and knowledge to Nigerian foundrymen.

General Conditions for Supply of Castings: When the country's foundry industry expands and gets more nationwide characteristics the sales development and marketing should also be taken into consideration. For example the central organization, i.e. the foundrymen association could prepare and agree upon general conditions for supply of castings, which first of all is a sales promotional measure, but which also protects casting producers from malpractices and dispute cases.

7. CONCLUSIONS AND RECOMMENDATIONS

As it has been already mentioned several times before, the economic growth and the industrial development of a country depend essentially on the proper development of small scale industry. Furthermore concerning particularly the engineering industries the most important basic field of which is the foundry industry. The foundrymen have always been pioneers when industrializing the country's economy, therefore the development work should be started from this end.

Taking into consideration the role of Nigeria's Industrial Development Centres in this particular field it is strongly recommended that all necessary support is given to these centres, and especially to the Oshogbo foundry plant so that they can meet the planned objectives successfully.

Also technical education and engineering training in the field of foundry engineering should be reviewed, and all possible means used to get it improved and developed. More industrial training opportunities should be arranged for young engineers, technicians and other foundrymen. Furthermore, a certain kind of nationwide Foundry Bulletin or magazine shoul be established and also an engineering organization for foundrymen set up.

More good publicity for foundry business should be arranged and more Nigerians should be encouraged to undertake a career in this challenging and technically complicated engineering industry.

M.J. HAKKA.

20/6/79

APPENDIX No. 7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
PROJECT DP/NIR/73/014
I.D.C. OSHOGBO
NIGERIA

MELTING CAST IRON WITH CHARCOAL

A special report on a small scale foundry project in Nigeria where a low-cost cupola furnace was designed and built up locally by UNIDO-Experts with their counterparts, and put into operation by using domestic charcoal as fuel.

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C O N T E N T S

MELTING CAST IRON WITH CHARCOAL

1. Introduction

For the development of Nigerian small scale industries the Federal Government has established Industrial Development Centres (I.D.C) in various States of the Republic.

The first two I.D.C. have been established already more than ten years ago and the third I.D.C. was planned to be built up in Oshogbo, Oyo State, primarily rendering services for six western states of Nigeria, i.e. Lagos, Ogun, Oyo, Kwara, Ondo and Bendel States.

This Oshogbo I.D.C was planned to be a relatively large and well equipped centre covering nearly all engineering fields and having modern workshops with good equipment and facilities. To assist in building up this Oshogbo I.D.C the Federal Government had requested technical assistance from United Nations, and as result UNIDO- Project DP/NIR/73/014 was established in 1976 to develop this planned Oshogbo I.D.C and get it in full operation. Since 1976 UNIDO has assigned various technical experts to the centre.

The UNIDO-Foundry Engineering Expert assigned to the Oshogbo Project in 1978 has assisted various Nigerian small scale foundries in several States during his mission in Nigeria. This particular report describes a special case where some new ideas were practiced in one Nigerian small scale foundry establishment in Ibadan. Namely, a small cold blast cupola furnace was designed and built up locally using local materials, and it was operated using local hard-wood charcoal as fuel.

2. The Aim of the Charcoal Cupola Project

The major part of the world's grey cast iron is still melted in cupola furnaces which are operated with metallurgical coke as fuel. In Nigeria the foundry industry has not yet grown up and developed as much as many other industries in the country, and particularly the iron foundries are very rare. Approximately ten iron foundries exist in the country and only four of them use cold-blast cupolas for melting cast iron. Also the production methods are primitive and the quality of finished iron castings is relatively low.

Because cupola furnace needs special metallurgical coke as fuel, - which is not locally available in Nigeria and must be therefore imported, - this fact has discouraged the most foundry entrepreneurs to establish iron foundries using cupolas as melting furnaces. Accordingly, a question was arisen, what are the possibilities to replace the imported metallurgical coke by the local charcoal? This has been done in some other countries before and with good success. Also UNIDO has reported one successful case some years ago (UNIDO-Publication No. ID/178-1976).

Consequently, if the local charcoal in Nigeria could be used successfully in small foundries, it would open a completely new channel to develop and improve the badly needed iron foundry industry in the country. Secondly, the idea to design and build up a small cupola locally with simple tools and simple methods, could encourage the foundry industrialists more to undertake foundry projects which can produce cast iron castings.

On the basis of these ideas some foundry entrepreneurs were contacted in order to find out if they are interested in the proposed charcoal project. Most of them were very willing to undertake this type of experiment. As the first "testing ground" was selected Ibayomi Foundry Works in Ibadan, Oyo State.

This foundry has been already producing cast iron castings by melting the iron in a small oil-fired crucible furnace.

3. How the Furnace was built up

3.1 General

Complete drawings for a cold blast cupola furnace of 300 mm internal diameter were first made by the UNIDO-Mechanical Engineering Expert in co-operation with the UNIDO-Foundry Engineering Expert. Then quotations for material and fabrication costs were requested from a local steel/welding construction company. However, the costs were found too high for this particular purpose. Therefore other alternatives were thought over, and finally a proposal to build up a smaller cupola using two empty oil-drums was found viable, and was accepted.

A detailed plan was made and accordingly, the following materials and equipment were required for the project:

- two empty oil-drums (560 mm diameter)
- one air-blower, capacity about 30 m^3/min with air-pressure of 200-300mm water.
- bottom stand for the furnace (made of steel by welding)
- cupola lining material, approx. 600 kg
- materials for melting (iron, limestone, charcoal)

A suitable air-blower was already existing in the foundry, and only the two drums and the bottom stand had to be purchased as well as the various materials.

When all materials and items were provided, the construction and installation could be started. The cupola was completed within about three weeks. The installation and lining work were carried out strictly under the guidance and assistance of the UNIDO-Foundry Engineering Expert, who spent seven long days in the foundry shop at that time, to be able to complete the work in a proper way and in reasonable time.

The total material costs to build up this cupola furnace were about US $ 1500.-

3.2 Technical Details (see appendix No. 2)

a) Dimensions and Characteristics

- External diameter : 560 mm
- Internal diameter : 320 mm
- Number of tuyers:
  - a) first design: One tuyer, 100 x 100 mm
  - b) after making wind belt: three tuyers, 80 x 80 mm each
- lining material: Acid cupola ramming mass, imported from U.K., ca. 500 kg
- air blower: 2950 rpm, IHP, air volume 30m^3/min, pressure 200 - 300mm water (10....12 inch water)
- Total height of the furnace: 236 cm
- Melting capacity: 600 - 700 kg/h

b) Installation and lining:

The two drums were piled on each other and joined with ½" bults, and fixed on the bottom stand with similar bults. The bottom stand was installed on a concrete block of 1m x 1m and about 40 cm deep.

The lining work was started from the bottom by using a cylindric stone (core) which was gradually lifted upwards according to the progress of the ramming work. Before ramming the lining material was moistured with water to a moisture content of 6 %. When the ramming process was completed the lining was let to dry for four days. After this drying period some fire-woods was burned in the furnace to reach the basic dryness of the lining.

The final drying and warming up was carried out by burning fire-woods slowly in the furnace for about three hours just before the first melt process.

4. Description of the Melt Process

4.1 Raw Materials

The three basic raw materials for melting cast iron are: 1) iron 2) limestone, 3) Coke. Normally ferro-silicon and ferro-mangemese are also required in small quantities. Also some fluxing materials are normally used if available.

In this project only the following materials were used and they were all of local origin:

- grey cast iron scrap
- limestone
- hard-wood charcoal

When the process will be more developed and the operational characteristics of this particular furnace are thoroughly studied, additions of necessary ferro-alloys as well as possible fluxing materials can be calculated and also use of steel scrap as part of the charge can be implemented.

The final average composition of each charge was as follows:

40 kg iron scrap
9 kg charcoal
1.5 kg limestone

4.2. Melting Process

About three hours before starting charging of iron into the furnace, the furnace bottom was prepared by using ordinary moulding sand. Thereafter fire-wood was put into the furnace and set on fire with kerosene. This slow heating - drying process was kept on going about three hours. Then some bucketful of charcoal was charged in. When this charcoal was hot and well in fire the remaining part of "bed-coke", (i.e. charcoal) was put into the furnace. After about thirty minutes the blower was switched on and the air was blasted about ten minutes. Thereafter the height of the bed-coke was checked and little more charcoal added. The tapping hole was closed, and the charging could be started. The materials were charged in the following order: limestone - iron - charcoal. After about 6 - 7 minutes drops of molten iron could be seen if looked at the glowing charcoal through the tuyer. The melt process was well on.

When slag started to run out from the slag spout, that was an indication that the furnace bottom was getting full of molten iron. The time for the first tapping had come. The tapping hole was opened with a sharpened steel rod. Molten iron started to run through the spout to the ladle held under the spout.

4.4. Problems Encountered

Six previous melting tests were carried out during the final project-work (cf. appendix No. 1) in order to find out the requirements and characteristics of the new furnace, and to eliminate mistakes and errors made during the operations.

For example, it was found that the local charcoal used during these tests was slightly too soft. For future melting harder and stronger charcoal is required. Also the air pressure was first too high. It was reduced by changing the pulley wheels of the blower and the motor.

By using first one tuyer the distribution of air was not so even, and therefore a wind-belt was built and three tuyers made.

4.5. Recording the Project on a movie film

During this cupola project the UNIDO-Foundry Engineering Expert was taking several film shots with his own movie camera, with intension to make a short introductive documentary film about the experiments and achievements. All the films have been now processed and the whole film has been edited and completed. The film is a colour film of super 8 mm. It's length is 11 minutes. It shows briefly all the main actions and work carried out during the project, being so a complementary record to this report.

5. Results and Achievements

The objectives of the project were met quite well and the whole experiment was very satisfactory.

However, some more melting tests must be still carried out to find out the most optional conditions for the melt process and the maximum melting capacity of the furnace. Also mechanically harder and stronger charcoal must be found to ensure longer melting periods.

The most important experiment of the project was, that the charcoal created enough heat for the process. The iron could be melted easily and relatively fast, and the temperature of the molten iron was high enough. On the other hand the mechanical properties of the used charcoal were not as good as required, and the charcoal was burning slightly too fast.

If a good quality charcoal made of hard-wood can be found, and if it is available in larger quantities, there will be no difficulties when melting iron in this type of cupola furnace.

6. CONCLUSIONS

As the achievements of this project show, the possibilities to operate a simple cupola furnace in Nigeria by using local raw materials are very promising. Also the costs to build up this type of small cupola are very low, and the technical skill required to construct the furnace could be easily available in the country.

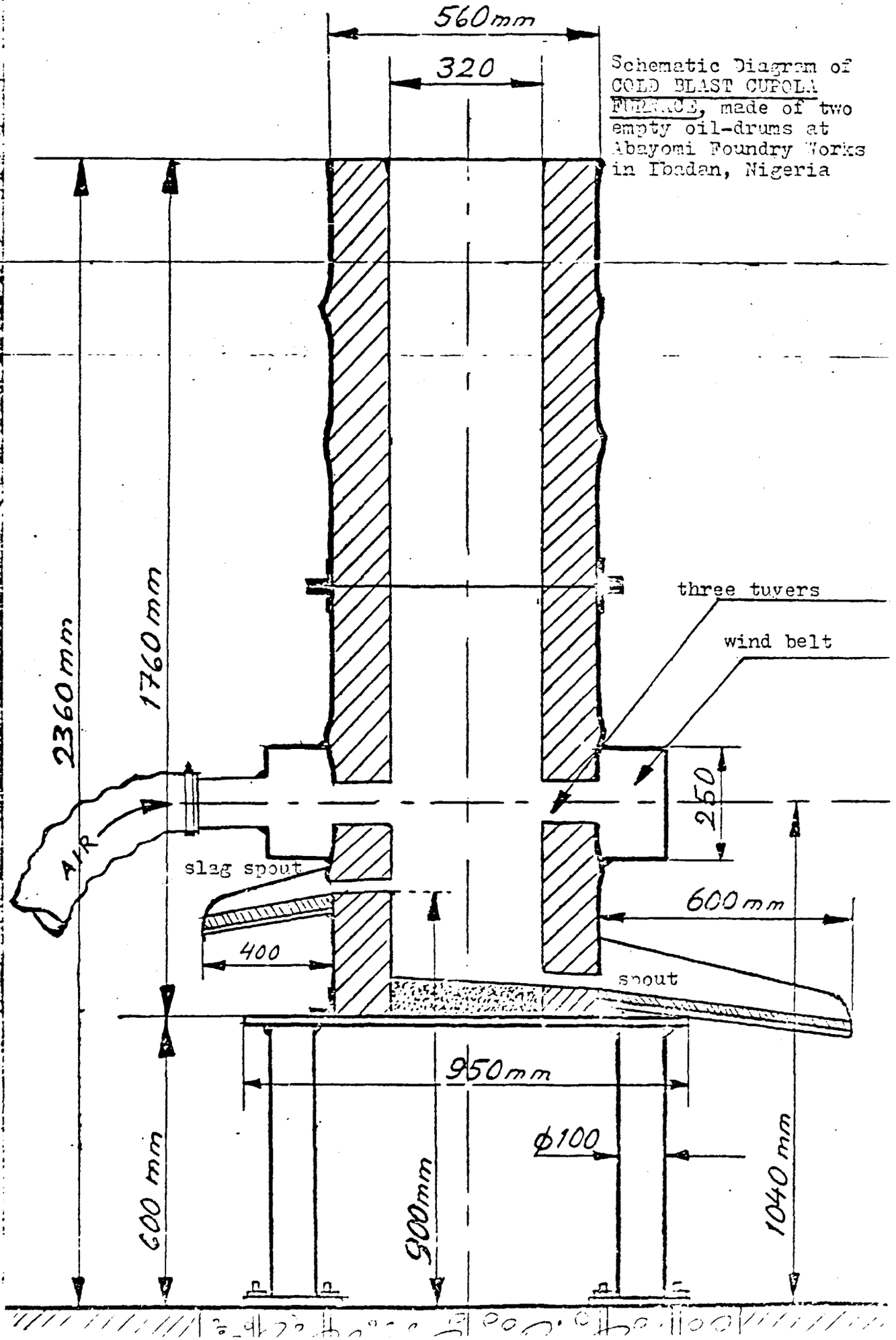
This means that the method could be adopted by foundry industrialists without any difficulties, and on the other hand it will encourage foundrymen to start producing more the badly needed iron castings in Nigeria.

APPENDIX NO. 1

SUMMARY OF MELT REPORTS

DESCRIPTION	MELT REPORT NUMBER					
	1	2	3	4	5	6
Date of the experiment	2/2-81	17/2-81	12/3-81	8/4-81	28/4-81	20/5-81
Estimate air pressure (inch water)	30	30	30	12	12	12
Estimate air volume (m^3/min)	20	20	20	20	20	20
Bed coke height (cm)	85	85	85	85	85	85
Weight of bed coke (kg) a) with charcoal b) with coke	30	30	50	40	50	30
Size of the charge (kg) - iron	50	40	40	-	40	40
- limestone	2	2	1.5	-	1.5	1.5
- charcoal	9	9	-	-	-	8
- coke	-	-	8	-	8	-
Number of charges melted	5	5	4	-	5	2
Melt procedure (timewise) - furnace bed prepared (hrs)	11.00	11.45	08.40	09.10	11.00	11.00
- fire-wood in + fire (hrs)	11.20	12.00	09.00	09.25	11.15	11.15
- $\frac{1}{3}$ bed coke charged (hrs)	14.40	13.40	10.30	10.30	12.00	12.00
- rest of bed coke charged	15.00	13.55	10.50	10.50	12.30	12.20
- closing of the tapping hole	15.00	13.55	11.00	10.55	12.50	12.40
- 10 min blasting	15.00	13.55	11.05	11.00	12.50	12.40
- bed coke remedy	15.10	14.05	11.15	-	13.00	12.50
- charging started	15.10	14.05	11.15	-	13.10	12.50
- 1st tapping	15.30	14.30	12.20	-	13.30	13.10
- Last tapping	15.50	14.45	12.40	-	13.50	-
- Number of tappings	2	2	2	-	2	1
- Estimate iron temperature	1250°C	1300°C	1250°C	-	1250°C	1200°C
- Charging finished	15.35	14.40	12.30	-	13.40	13.10
- Blasting finished	15.55	14.50	12.45	11.30	13.50	13.15
- Bottom opened	16.00	14.55	12.50	11.35	13.55	13.20
REMARKS: - Major changes from previous melt	-	better char-coal	coke	air pres-sure redu-ced	lower air pres-sure	wind-belt
- Rate of success	poor	satisf.	satisf.	good	satisf.	satisf.
- General	Too soft char-coal	iron-coke ratio chang-ed	air pres-sure too high	new air pres-sure tested	wind belt re-quired	more bed-coke required

APPENDIX No. 2



Schematic Diagram of COLD BLAST CUPOLA FURNACE, made of two empty oil-drums at Abayomi Foundry Works in Ibadan, Nigeria

APPENDIX No. 8

A PAPER DELIVERED BY MR M.J. HAKKA, UNIDO PROJECT MANAGER AT I.D.C. OSHOGBO, ON THE OCCASION OF THE MONTHLY MEETING OF "FOUNDRYMEN ASSOCIATION OF NIGERIA, F.A.N. " HELD IN OSHOGBO ON 11-12th MAY 1984

May 1984

A PAPER DELIVERED BY MR M.J. HAKKA, UNIDO PROJECT MANAGER AT I.D.C. OSHOGBO, ON THE OCCASION OF THE MONTHLY MEETING OF "FOUNDRYMEN ASSOCIATION OF NIGERIA, F.A.N." HELD IN OSHOGBO ON 11TH - 12TH MAY 1984

THE IMPORTANCE OF ENGINEERING INDUSTRIES IN THE SMALL AND MEDIUM SCALE INDUSTRY DEVELOPMENT IN NIGERIA

General

The industrial development of a country depends essentially on the possibilities of the manufacture of basic industrial equipment and machinery as well as spare parts, but also on the ability to carry out a wide range of repair and maintenance activities. The basic engineering industries form the field which can produce these above-mentioned items.

What is generally understood to be the concept of basic engineering industries? The fundamental units supporting the basic engineering industries are the foundry, forging shop, machine shop, heat treatment, tool room, fabrication shop, metal coating shop, pattern shop and woodworking shop.

Accordingly, the industrialization of a country based on the development of self-reliance and economic independence would first of all require, that the basic engineering and particularly the allied metal working industries should be given the very first priority, and they should be developed as rapidly as possible.

What the Engineering Industries Can Offer

With the establishment of basic engineering industries, natural resources, particularly basic metals, are increasingly utilized, capital formation is accelerated, and the manufacture of components, spare parts, machinery and equipment is possible.

Also badly needed foreign exchange is conserved for the other economic activities in the society, and contributions are made to the maintenance and productivity of agriculture and the other industrial sectors.

Basic engineering industries provide a basis for the development of science and technology, including research and development activities. There is no point in establishing high level research centres or scientific laboratories if the country does not have the basic engineering industries.

Engineering industries increase employment opportunities, not only within their own sector, but also in the other economic sectors of the nation, and they offer highly qualified and skilled labour which can be absorbed in other industrial activities.

The setting up of small and medium-scale engineering enterprises would help form the basic infrastructure on which to build an expanding technical capability and thereby create the self-reliance, which could lead to the manufacture of exportable products.

What are the Priorities?

The manufacturing capability of an established engineering subsector covers a wide range of engineering products including capital goods such as machinery and equipment for metalworking and related industries and plant for most other industries.

The most immediate and urgent requirement at the present time however, is the engineering industry's ability to transform raw materials into essential spare parts and to restore repairable machine parts and assemblies by the employment of modern workshop processes.

The most rewarding strategy would be to encourage the establishment of small and medium scale foundry and machine shop enterprises.

The following capacities of casting, forging, fabrication and machining facilities should be the first aim:

- foundry complexes for grey cast-iron, brass and aluminium castings capable of casting machine beds up to 5 ton.

- forging and heat treatment complexes capable of forming parts up to 30... 40 kg.

- machine shop complexes for machining castings up to 5 ton and forgings up to 150...200 mm diameter and length of one meter.

- toolroom complexes for the production of jigs, tools and fixtures, for repair of tools and for manufacture of precision parts.

- fabrication complexes for production of welded parts and components.

- metal-coating complexes for nickel-chrome plating etc.

In Nigeria, at least one large machine tool manufacturing complex is well on the way to completion as a Government-sponsored joint project.

The present manufacturing programme includes metalworking milling machines, centre lathes, drilling machines, power saws and pedestal grinders.

The small and medium scale workshops we recommend would be complementary to the Machine Tool Complex and the equipping of these businesses would be logical outlet for the products of the Machine Tool Complex.

The priority products of the small-scale workshops must include the manufacture of spare parts and assemblies already in urgent demand. As experience is gained, the workshops could progress to the manufacture of well-designed machines for agriculture, food processing and the building trades. Certain workshops might then specialize in the manufacture of hand tools, such as shears, hammers, pliers, blacksmith tools, chisels and saws. When supplies of special steels become available, other workshops could venture into the manufacture of cutting tools such as hacksaw blades, files, twist drills, taps and milling cutters. We see no reason why small and medium scale businesses could not then progress to the manufacture of power-operated hand tools including drilling machines, grinders, circular saws and sanders. With experience gained in such precision, the domestic manufacture of measuring equipment, precision

instruments and accessories would logically follow.

Practical Limitations

If we think the development strategies and the practical realities for example in the case of Nigeria and the industrilization process in Nigeria, we can identify certain fields and specialities which should be carefully studied and taken into consideration before local manufacture can be started.

When we talk about machinery and spare parts industry, which for example is now one of the first priorities to be developed in Nigeria, it does not mean that every spare part and every machine component should be made locally. No, - there are various special products and components as well as metallic raw materials and other items, which cannot be yet manufacture locally, firstly because the required skill and knowledge is not yet available, and secondly because it will not be profitable. It is more economical to buy these items from other sources. This practice has been implemented in nearly every country in this world.

Usually these special items include ball and roller bearings, oil seals, transmission components, automobile parts, high speed steel cutting tools, carbide tools, abrasives as well as various steel alloys and metal alloys and also ferro-alloys and other foundry and metallurgical chemicals.

As circumstances change and industrial development makes good progress, the possibilities of local manufacturing of these more difficult products can be studied and accordingly implemented.

Need for Design Engineers

Despite the fact that in Africa today there is no shortage of mechanical engineers with degrees earned at Universities at home and abroad, it is not easy to find examples of good engineering design and manufacture. Academically qualified young men may be seen holding ostensibly responsible positions but who have so far not made any contribution to the advancement of product design and manufacture.

The cause may be in the fact that industrialization has not yet reached the stage where the ability of engineers can be utilized in a creative capacity, or there is not enough encouragement or motivation for this complicated career.

But industrialization i s p r o c e e d i n g, no matter how slowly and the time has arrived when we must seriously question whether the up coming engineers are sufficiently equipped to meet the product design challenge. Design engineering demands such a wide range of practical knowledge and experience that we suspect that this aspect of technical training has been somewhat neglected.

The urgent need in Africa today is to extend the practical knowledge of the academically qualified design engineer in a much more intensive and specialized degree than he has hitherto received. The ambitious design engineer must become familiar with all the technology necessary to enable him to enter the profession of design engineering. To remain effective in this field of engineering science, he must acquire copies of all the international engineering standards for materials, machine elements and instruments.

He must have a full knowledge of manufacturing methods including:

Foundry practice, forging methods, presswork, welding, die forming and casting, precision measurements and quality control, machine shop practice including gear-cutting, jig and toold design, pneumatic, hydraulic and electronic control systems, workshop organization and management, material testing, heat treatment.

With all this knowledge, a would-be design engineer would not succeed unless he has the wish and ability to express his ideas on the drawing board.

Conclusions

Concerning the basic characteristics of the industrialization process, I once again would like to emphasize the importance of basic engineering industries in every country where the industry should make some progress.

In Nigeria, we have so many industries already existing in the society, but unfortunately the supporting basic engineering industries are very very few. Without these important sectors of industry, such as foundries and machine shops, no proper development is possible. Every factory is depending on imported components, spare parts, tools and various materials. If most of these components and parts could once be manufactured locally, the whole industrialization process could make much more progress, and Nigeria could become step by step more self-reliant.

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