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# FINAL REPORT

on

Bicycle Research & Development  
Centre, Ludhiana, India

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May 1988

**tkp** consultants ltd

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RESTRICTED

English

PROJECT IN INDIA  
BICYCLE RESEARCH AND DEVELOPMENT CENTRE  
LUDHIANA, STATE OF PUNJAB, INDIA

F I N A L R E P O R T

prepared for the  
PROJECT AUTHORITIES  
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the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION  
Purchase Contract Service, Vienna, Austria  
and  
the TKP CONSJLTANTS LTD., Warsaw, Poland  
(UNIDO Contract No 84/110 - Act. Code DP/02/31.9)

Warsaw, May 1988

Note:

This report has not been cleared with the United Nations Industrial Development Organization, which does not therefore necessarily share the views presented.

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ABSTRACT

Ref. - PROJECT DP/IND/79/028

- CONTRACT 84/110 between UNIDO, Vienna, Austria and the TKP CONSULTANTS Ltd., Warsaw, Poland.

The purpose of this Final Report is to present activities, works carried out and results achieved by a team of consultants assigned under the contract to assist the Bicycle Research and Development Centre in Ludhiana, India.

The Bicycle R.D. Centre has been set up as an UNDP/UNIDO-assisted institution - building project with the purpose to initiate, perform and implement research, development and associated activities aiming at modernization of the Indian bicycle industry, especially the small scale manufacturing units.

A foreign expertise input has been provided in the form of a UNIDO subcontract.

Immediate objectives of the Project have been presented. They are considered achieved and in some areas even exceeded (e.g. manufacture of prototypes of newly designed bicycles and fabrication of special purpose equipment were not stipulated by the Terms of Reference - vide Annex No. 4 to this Final Report). For consolidation thereof, an extension of the Project duration by 6 months has been proposed. Another example for the Project objectives having been exceeded is providing free of charge by the Contractors samples of new models of bicycles and bicycle components to be developed by the Centre. This, having been done without any obligation resulting from the Contract with UNIDO, has greatly contributed to the Centre's preparedness for new products development.

The new products development objectives are considered long term ones, so their full achievement is expected to be completed within a period extending beyond the life of the Project. To speed up achievement of the final goals, extended UNDP/UNIDO assistance in form of a 2nd phase of the Project

is considered useful.

In the concluding part, it is indicated that the activities of the team of experts have been consistent with conditions put down in the Terms of Reference, being oriented for achievement of outputs expected according to the Project Document. Basic information on the Project, evaluation of the team leader's activities, utilization of the Project results and proposals for future activities are presented in the main body of this Final Report.

## I. INTRODUCTION

This report is the FINAL REPORT worked out according to the requirement of Clause 2.10 of the Contract No. 84/110 between the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION, Vienna, Austria and the TKP CONSULTANTS Ltd., Warsaw, Poland for the provision of services relating to the RESEARCH AND DEVELOPMENT CENTRE FOR BICYCLE INDUSTRY IN INDIA, a UNDP/UNIDO assisted Project.

This FINAL REPORT has been prepared by the Technical Adviser on Bicycles, acting as the Team Leader of a team of experts from the TKP CONSULTANTS Ltd., assigned under the said Contract No. 84/110, after completion of the mission in the Project Area of all the members of the Team.

The purpose of this FINAL REPORT is to present the work and activities performed by the members of the team in the Project Area and at the Contractor's Home Office, taking into consideration the UNIDO Terms of Reference DP/IND/79/028 dated 26 November 1984 (Annex D to the above mentioned Contract) and the Proposal No 100-4/0066 dated 12 September 1984 which the Contractor submitted to UNIDO in response to UNIDO's Request for Proposal No. P. 84/81 of 9 August 1984. The presentation pertains to the activities of the Team, activities of the Bicycle R.D. Centre carried out with assistance of the consultants of the Team as well as other matters important for clear understanding of the Project outputs.

This report has been based on all the earlier ones prepared and duly submitted to UNIDO, Vienna, Austria and namely:

- six scheduled Interim Reports,
  - two additional Mission Reports,
- taking also into consideration:
- the project document,
  - ad hoc reports prepared for the tripartite review meetings held during implementation of the Contract,
  - minutes of the above tripartite review meetings.



This FINAL REPORT includes information on:

- objectives, inputs, achievements and outputs of the Project,
- activities carried out by the team of consultants and their utilization,
- proposals for future works and activities to be undertaken by the Bicycle R.D. Centre,
- conclusions and recommendations drawn as a result of observations and experience gained during the Project activities.

Annexes related to discussions and statements in the report are duly enclosed herewith.

The guidelines for the preparation of Documentary Outputs (Technical Reports, etc.) presented in the Chief Technical Adviser's Manual (UNIDO/Rev. 4) have been utilized and followed to the extent applicable.

## II. BASIC INFORMATION ON THE PROJECT

### A. Project Background

The bicycle industry in India was started in 1938/1939 and has developed as a matter of necessity to provide cheap and reasonable means of transport to the millions of rural and urban population. The main type of bicycle produced is the roadster model, most suitable for a common man. Other models for sport, leisure and health purposes are produced in limited quantities or are not produced as yet. India now ranks as the fourth largest producer of bicycles in the world, however the demand continues to be so large that the industry is still not in position to cope with it.

Gradual saturation of the domestic market for the classical roadster model and the need to expand the export potential is compelling the Indian bicycle industry to undertake complex modernization so that it could meet effectively the internal and export market demands of new types of bicycles and components of highest quality by increasing productivity and by upgrading production techniques.

In view of the above brief consideration, the State Government of Punjab has taken action to set up a Research and Development Centre in Ludhiana where most of the Indian bicycle industry is concentrated.

A bicycle Research and Development Centre has been established as a UNDP/UNIDO assisted institution-building Project, to provide facilities for increasing and diversifying production, economising the use of raw materials, increasing the life span of a bicycle, improving safety measures and upgrading the quality to aim at complying with international standards.

The project was approved on 4-th March 1981, became operational in August 1981 and started functioning in June 1983.

### B. Immediate Objectives and Comments on Their Achievement

The immediate objectives as originally envisaged in the Project Document are listed below with presentation of comments on their achievement:

1. Developing techniques for product design, jig, fixture, tooling designs and know-how, including process charts and raw materials specification for material handling machines, such as semi-automatic or automatic transfer lines for production and assembly, gauging and inspection systems, providing complete drawing and design facilities for products, jigs, fixtures and tooling.

- The Project has established a design office for the new designs of bicycles and bicycle components, jigs, fixtures, press tools and specialized equipment. New designs of products and toolings are being worked out by the Centre and supplied to the industry. The work is of progressive as well as of continuous nature. The Project is capable of providing these services to meet requirements of the industry.

2. Developing of prototype special purpose machines and equipment in conformity with the level of skills available to the industry.

- The Project has set up a special purpose machinery equipment development section including facilities for designing, manufacturing and testing. These activities have already been started. Two SPMs - one for brazing and one for heat treatment have been already manufactured. Fabrication of some other SPMs is progressing.

3. Providing common facilities for production of required jigs-fixtures-tooling, special purpose machines, semi-automatic and automatic equipment as well as required gauges.

- The tool production workshop, equipped with precision machine tools for the manufacture of jigs, fixtures, press tools, gauges, special tools and special purpose machines has been established.

- Ample services in respect of the above are being

provided to the industry.

4. Providing common facilities for testing of bicycles and components including material testing and calibration of gauges, keeping in view the safety standards adopted in the developed countries.

Following laboratories have already been set up in the Centre:

- Performance evaluating laboratory,
- Metrology (standards room),
- Spectroscopic laboratory,
- Chemical analysis laboratory,
- Mechanical (metallurgical) laboratory.

For the bicycle and bicycle components testing, the Centre has developed (designed and fabricated) almost all equipment required for testing according to the Indian Standards in force.

Other laboratories are equipped with basic modern testing instrumentation of high accuracy allowing for:

- inspection and precise measurement of highly accurate products,
- testing of raw materials in respect of properties as well as of chemical composition.

Purchase of some additional testing equipment is under progress.

5. Identifying latest trends in bicycle design and styling as well as developing complete package technology for their production.

- The Project has established a system for identifying the latest trends (styling of bicycle design suitable for Indian market and export) by:

- procuring samples of bicycles and bicycle components from abroad,
- collecting specialized world literature,
- attending exhibitions in India and abroad,
- participation in ISO meetings.

The Project has already initiated development of new designs of bicycles and bicycle components and has completed design

drawings of a few new bicycle models.

Complete know-how for manufacturing - including processing techniques, selection of materials, required equipment and machinery etc. - is being worked out by the Centre's consultancy cell for transfer to the industry.

6. Improving quality of the present model of bicycle viz. roadster, as regards its reliability and durability.

- All the activities related to the improvement of present models are available in the different cells of the Centre, i.e. in the:

- design office
- consultancy
- testing laboratory
- prototype manufacturing.

A complex programme for improvement of present bicycle models has been started.

7. Acting as a channel for dissemination of research results of the applied research organizations, such as Mechanical Engineering Research and Development Organization (MERADO), Central Mechanical Engineering Research Institute (CMERI) and National Metallurgical Laboratory (NML) for improved production techniques and cold forging, induction brazing fusion welding, butting of frame tubes, tapering of fork tubes, and seat stays, improvement in electroplating and heat treatment processes.

- A system for cooperation with other Indian R.D. Institutes and for coordination of the research and development activities has been set up in the Centre. The Project has also made available, through the foreign experts, results of R.D. works undertaken abroad.

8. Acting as an approved agency for inspection and quality control of products for exports.

- This objective is achieved to some considerable extent, however the final task of getting authorization for certification of products for export is still pending. Reason for partial achievement of this objective is the fact that most of Indian export agencies have their own inspection

and quality control systems, generally acceptable both to the exporters and importers.

However, preliminary action for the Centre to be incorporated in the all-India certification system for exports have been started under the Project. The Bicycle R.D. Centre is capable to perform this activity.

9. Providing training in related fields of engineering and management.

- Regular training courses are yet to commence. A working group has been formed to indentify the subjects and fields for training in accordance with the requirements of the Industry and of the Project Document. Preliminary programme has been set up for conducting short term courses. For this purpose some classes have been given by UNIDO experts on technical subjects for the Project professionals. Technical training programmes in form of seminars, workshops and lectures have been organized for the industry.

10. Providing library of technical literature and documentation on bicycle industry as well as other relevant information.

- A library has been established in the project and is having a number of technical handbooks, industrial standards from national and international institutions, international commercial and scientific journals and world-wide literature on bicycles and associated production machinery. The facility is adequately used by the bicycle industry. Assumptions for a complete information systems have been worked out and taken as basis for further development of this activity. More journals, books and standards are being acquired for the Project library.

C. International Expert Activities

With concurrence of the Project Authorities, TKP CONSULTANTS Limited, Warsaw, Poland were appointed for conducting international expert activities and assisting in the placement of trainees abroad. The Contract No 84/110 between UNIDO and TKP CONSULTANTS Ltd. was signed on 27 January 1985. The Contract stipulated for the Project running for a period of two years.

Among others, the Contract envisaged 45 man-months experts services (41 in the Project Area and 4 at Home Office in Poland) as follows:

Field of specialization	Period of assignment months	Project Area months	Home Office months
- Team Leader and Technical Adviser on Bicycles	24	22	+ 2
- Consultant in Cold Forging and Forming	6	5	+ 1
- Consultant in Brazing and Heat Treatment	6	5	+ 1
- Consultant in Production Technology	8	8	-
- Team Adviser	1	1	-

The Team Leader and the Team Adviser arrived in India on 26th June 1985. The five-months gap between signing of the Contract and the arrival of the first team of Consultants, was mainly due to the time required to complete procedural formalities for the issuance of special entry permits for the Restricted Area in Punjab as also due to the need for clarification on the privileges for the subcontract personnel. Ultimately the experts agreed to arrive in India in spite of absence of a decision on privileges, which have been guaranteed in the Contract with UNIDO.





D. National Staff

Against the originally envisaged requirement of 141 staff members on the Project, there were in all 73 members of the national staff in position, assigned to the Project IND/79/028 - Bicycle R.D. Centre, as well as to the sister Project IND/79/027 - Sewing Machine R. D. Centre operating on the same premises and using the same facilities. The National Projects Coordinator-cum-Deputy General Manager has been in charge of both the Projects during the entire Project duration. The post of General Manager for both the Projects was advertised earlier but a suitable candidate has not been found. Industrial Adviser -cum- Additional Director of Industries, Punjab State Govt. was acting as the General Manager of the Centres. The bicycle Project was headed by the Project Officer who remained with the Project till July 1986. The post is vacant at present.

It was the responsibility of the Project Authorities to ensure availability of the local Project personnel in adequate number and of appropriate skills, to safeguard a proper and timely performance of the tasks by the Bicycle R.D. Centre with the assistance of the UNIDO-subcontracted team. For this purpose and in accordance with the conditions set forth in clause 3.01 of the said Contract, TKP Consultants Ltd. was committed to specify, within one month after the Team Leader's first arrival in the Project Area, numbers and categories of personnel required. Accordingly, in a letter dated 26 July 1985 the Team Leader advised the Project Authorities on required personnel, with special indication of posts envisaged to act as the counterpart staff of the foreign experts. Clear identification of assignment of the personnel to the bicycle Project or to the sewing machine Project in some technical cells as for instance design and testing was also recommended, whereas common utilization of the staff for both the Projects in case of other cells e.g. administration, accountancy, consultancy, library, standards room and supporting cells was considered advisable.

The Project Management made efforts to increase the

national staff, so that considerable improvement in this respect has gradually been achieved. The state of employment of the national staff at the completion of activities of the Team Leader in the Project Area was as presented in the Annex No. 1 to this Final Report. There were 86 persons in position on the Project, out of which 16 were senior technical officers, 39 technicians and operators and 31 members of the supporting staff. Some of the a/m persons were also working for the sister Project - the SMR.D. Centre. Recruitment of further 11 senior technical officers and technicians was under way.

Filling the post of the Project Officer should be considered a high priority.

#### E. Buildings

As against an original plan, a common building is at present used for the BR.D. Centre and the SMR.D. Centre. Operational buildings (presently used for both the Projects) and the administrative block of the sewing machine Project have been completed. Construction of the administrative building of the bicycle Project has been taken up, similarly as that of the laboratories extension and extension of workshop for precision machines. Construction of a bicycle testing track is to commence shortly.

#### F. Machinery Equipment

1. All equipment planned to be supplied as UNDP input, except the induction brazing machine, has been received by the Centre prior to arrival of the team, commissioned and put into effective use. The a/m missing machine had been ordered earlier, but due to certain technical difficulties concerning application of induction brazing for locally designed bicycle models, the order was cancelled. Now the Centre plans to develop and to build a prototype induction brazing machine for bicycle frames on its own whereas purchase from abroad of a medium frequency generator is necessary for this purpose. List of UNDP-supplied Machinery Equipment is enclosed as

Annex No. 2 to this Final Report.

2. Majority of the indigenous machinery and equipment planned to be supplied as Government input has already been purchased, commissioned and put into operation. List of Indigenous Machinery & Equipment is enclosed as Annex No. 3 to this Final Report.

### G. Fellowship Training

In addition to a two-months orientation tours for the Executive Director and representatives of the bicycle manufacturers, which tours have been completed prior to team s arrival in the Project Area, the Project Document stipulates training of seven fellows for a total of 19 man-months.

After joint consideration, a resolution was taken up at the Tripartite Review Meeting on 14 October 1985, according to which the previous number of fellowship holders i.e. the number of technical areas being initially seven (7) has been increased to nine (9).

According to clause 3 "Fellowship Training" of the Annex D "TERMS OF REFERENCE" to the Contract between UNIDO and TKP Consultants Ltd., the fellowship training was to be arranged for a maximum of 20 man-months in the Bicycle Factory ROMET at Bydgoszcz, Poland.

Proposals as to the technical areas for the fellowship training as well as detailed programmes for the particular areas have been worked out by the Team Leader, discussed with the Project Coordinator and finally approved by the Project Authorities. The technical areas of and the programmes for the fellowship training were presented in the appendices Nos. 4 5 to the 2nd Interim report.

The proposed technical areas and the training programmes within the areas themselves were worked out taking into consideration following factors:

- objectives of the Bicycle R.D. Centre,
- envisaged programme of the R.D. activities in the Centre,
- technical areas represented in the ROMET Factory.

Candidatures for the fellowship training were scrutinized and discussed between the Team Leader and the Project Management. The candidates were finally approved by all authorities concerned. It was, however, not possible to appoint candidates for all the areas.

Responding to an invitation of TKP Consultants Ltd., Mr. H.S. Bains, Industrial Adviser-cum-Additional Director of Industries, Punjab acting as General Manager of the Bicycle R. D. Centre visited Poland to finalize training programme of the respective Project personnel, in the period of 3rd to 16th June 1986.

Due to reasons known to the Project Management, the fellowship training programme has been split into two missions, whereby clubbing of two technical areas into one has been agreed during the Centre General Manager's visit to Poland.

Taking into consideration the adjustments of the initial fellowship training programme, the training has been finally set forth for the following eight technical areas:

1. First Mission:

- manufacturing know-how, related to application of special purpose machines,
- manufacturing know-how in heat treatment, metal finishing electroplating and electrostatic painting,
- standardization, quality promotion, product development and information service arrangements,
- manufacturing know-how, related to production and inspection tools.

2. Second Mission:

- design of bicycles and bicycles components,
- manufacturing know-how, related to brazing and welding,
- manufacturing know-how in cold forging and forming,
- quality inspection, testing and practice,

Fellowship training for the first group has been scheduled for the period from June to October 1986, however due to external reasons (passports nonavailability) this training started in September 1986.

- Mr. J.S. Randhawa, Project Co-ordinator-cum- D-ty General Manager completed the study tour during 17-09-86 to 25-09-86 in Fed. Rep. of Germany and the fellowship training from 26-09-86 to 21-11-86 in Poland.

- The following three persons received training in Poland from 21-09-86 to 03-12-86:

- Mr. B.S. Sangha           Asst. Manager
- Mr. H.R. Singh           Manager
- Mr. Harbans Singh.      Sr. Techn. Asst.

The following two persons started the training on 28.08.87 and completed it on 10.11.87:

- Mr. Harbajan Singh      Manager
- Mr. J.S. Khorana        Asst Manager

As it results from the aforesaid, two groups consisting together of 6 persons have been trained in the Bicycle Factory ROMET at Bydgoszcz up to the total of 10 1/2 months.

Clause 3.d. of the TERMS OF REFERENCE envisages completion of all fellowship trainings within 26 months after the 1st Team Leader's arrival in the Project Area, namely not later than 24th of August 1987. Notwithstanding the a/m stipulation, TKP Consultants Ltd. agreed (vide telex message dated 13.04.1988) to the management's of the R.DC proposal to accept the third and final batch of fellowship trainees, provided their training is completed till 30.08.1988.

At the moment of closing this Final Report, no reply has been received from the Indian Counterparts as to the names of trainees selected for the third batch and dates of their training proposed, hence the final arrangements in this respect are still to take place.

### III. TEAM'S ACTIVITIES AND UTILIZATION OF RESULTS

#### A. Team's Workplan

The general scope of activities and services expected to be performed and provided by the Contract 84/110 between UNIDO and TKP Consultants Ltd. is presented in the formal document "TERMS OF REFERENCE - R.D. CENTRE FOR BICYCLE INDUSTRY, LUHIANA, INDIA" dated 26th November 1984. This document forms the Annex D to the a/m Contract and is enclosed to this Final Report as Annex No.4.

The a/m document includes:

- background information with justification of setting up the Bicycle R.D. Centre,
- contractor's tasks with respect to the Technical Adviser-cum- Team Leader as well as to all other Consultants of the Team,
- information on the required fellowship training with indication of main goals of the training,
- requirements for the periodic reports (interim reports) to be submitted from the Project Area with administrative assistance of the local counterparts.

In accordance with requirements set in the said TERMS OF REFERENCE, mainly the clause 2a related to the tasks of the Technical Adviser on Bicycles - cum - Team Leader and also basing on the

- Project Document and on the
  - contemporary state of bicycle industry in India,
- as well as taking into consideration the specializations of all the team members, the Team Leader has worked out the Team's Workplan related to activities expected to be performed under the Contract 84/110. This workplan has been discussed with and approved by the National Project Management and finally enclosed to the 1st Interim Report as Annex No.5.

In addition to the general Team's Workplan the following planning has been done in the course of the Project duration:

- detailed tasks for the Consultant in Cold Forging and Forming and for the Consultant in Brazing and Heat Treatment

worked out by the Technical Adviser - cum - Team Leader and the Consultant in Production Technology, approved by the National Project Management were enclosed respectively to the 2nd and 3rd Interim Reports,

- detailed mission workplans worked out jointly with the National Project Management for each consultant after their arrival in the Project Area,
- periodic (yearly) workplans of the Centre in respect of subjects related to activities carried out under the Contract 84/110.

#### B. Substance and Methodology of Activities

In accordance with the proposed and approved methodology, the following activities have been conducted by or with assistance of the relevant Team members:

- visits to various bicycle and parts manufacturing units and R.D. institutions selected by the National Project Management,
- selection of subjects and components proposed for research and development,
- elaboration of papers on technical subjects from the accepted R.D. programme related to product design, various fields of production technology, quality control and testing procedures, standardization and information services,
- assistance in carrying out activities related to designing and manufacturing of prototypes, testing fixtures and special tools,
- assistance in performing laboratory investigation and production trials required for research and development purposes,
- working out suggestions for internal education programme related to the R.D. activities,
- assistance in elaboration of technical papers for internal and external lectures or delivering internal lectures on technical subjects,
- day-to-day consultancy on subjects related to various bicycle techniques,
- working out scheduled mission reports, i.e. final mission

reports and interim reports including findings and recommendations.

### C. Analytical Account of Activities in the Project Area

The Team's Workplan has been worked out having in view high degree of interrelation of tasks of the particular members of the team, so that most of the activities were oriented to support the main development programmes implemented by the Centre. Hence it has been considered most convenient to present the evaluation of the logically arranged activities with respect to the particular research and development fields with indication of the outputs already achieved. At the same time presentation provides clear picture of participation of each team member in the Centre activities.

#### 1. Appraisal of Actual State of the Bicycle Industry in India

Purpose of the investigation on the actual state of the Indian bicycle industry was to collect and evaluate information required by the foreign consultants for working out recommendations for the Project Authorities as to the selection of:

- technical fields and subjects to be included in the development programme of the Bicycle R.D. Centre,
- products for which improvement of design and/or processing techniques were found necessary,
- supporting activities for implementation of the accepted R.D. programme.

Results of the investigations were also utilized for setting up the Team's Workplan and other research activities.

The appraisal has been worked out basing on:

- reports and publications on the subject from various Indian organizations, available in the Bicycle R.D. Centre, as well as reports prepared by the consultancy cell of the Centre prior to arrival of the consultants,
- joint investigations carried out by the counterparts, the Team Leader and the Team consultants during visits to various



manufacturing units selected by the National Project Management.

Due to certain limitations of the local nature, only visits to manufacturing units located in Punjab, mainly Ludhiana area, have been arranged by the National Project Management. However, these units may be considered to a wide extent as representative in respect of the entire bicycle industry in India. It is also worth mentioning that when visiting manufacturers most of the attention has been paid to units belonging to the small and medium scale sector making bicycle components.

The number of the units visited by members of the team is as follows:

- Technical Adviser on Bicycles-cum-Team Leader - 30 units
- Consultant in Cold Forging Forming - 6 units
- Consultant in Brazing Heat Treatment - 11 units
- Consultant in Production Technology - 13 units

The general appraisal related to all fields associated with the bicycle industry was worked out by the Team Leader at the beginning of his 1st mission to the Project Area and is presented in the main body of the 1st Interim Report. Appraisals of some specific fields related basically to areas of production technology have been worked out by the relevant consultant during their mission and presented in the mission report (5-th A) and enclosed to the interim reports. A brief summary of the findings, conclusions and recommendations in this respect is now presented here as follows:

#### 1.1. Appraisal of Design-Related Aspects

- Bicycles and bicycle components are made in India in several industrial units of the organized sector (large scale sector) and in a great number of small scale sector units. Manufacturing of bicycles, mostly in knocked down condition (CKD), is concentrated in organized sector units. Majority of bicycle components, amounting to over 80%, is manufactured in units belonging to the small scale industry sector.

- Due to various reasons, as e.g. better financial possibilities for technical improvements (better creditworthiness) and for purchasing high quality raw materials as well as better access to international markets by large units, there is a considerable technical gap between units belonging to both the sectors. Due to this fact, the recommendations as to the areas for improvements and certain specific proposals in this respect include mainly suggestions suitable for the small scale sector. However, having in view the task of general modernization of the whole Indian bicycle industry, some proposals suitable for the large scale sector have been presented as well.

- As compared with the world trade, the export share of the Indian bicycle industry amounting to:

0.5 - 0.8 % in bicycles,

1.0 - 1.5 % in bicycle componets,

must be considered relatively low taking into account overall size of the Indian bicycle industry output. In this connection activities for export promotion have been recommended and included in the relevant programmes of the Team s Workplan.

- The Indian bicycle industry manufactures mostly the Roadster type bicycles of various sizes and components for the same. This bicycle model is well established in the Indian market as most suitable for the local road conditions, stringent requirements of use as locally encountered and also suitable as a mean of short-range personal and goods transportation, these being at present the wide spectrum of functions that the bicycle in India is expected to serve.

- Other types of bicycles manufactured in India in limited numbers include:

- Sports light Roadster (SLR) bicycles, production of which was started a few years ago as a reaction to the world trends of bringing down the bicycle weight, however design of these bicycles is far from the basic concept of so called light-weight bicycle, which is the most popular model in more advanced markets.

- Bicycle Moto-Cross (BMX) bicycle, design of which is close to the cheapest and simplest version available in the world market. The Indian BMX design needs improvements in strength and styling to be considered a product for export to advanced markets.

- High-riser bicycles for boys and girls - of typical design as used mainly in the USA, but not comparable in respect of styling and decorations.

- Exercise bicycles - of typical design, comparable to a simple home trainer.

- Folding bicycles - of typical design of those having been quite popular in the European market some years ago, but not comparable as regards styling, decorations and certain dimensional aspects.

In addition to the bicycle types mentioned above, the Indian bicycle industry also manufactures a man powered three-wheel bicycle carriage called "rickshaw", designed for transportation of persons and small loads, that despite all the technical and social progress achieved, still appears to be quite popular in South Asia. Some improvements in the rickshaw design have already been worked out in the Bicycle R.D. Centre in Ludhiana. Other types of bicycles popular abroad as for instance racing bicycle, light-weight bicycles, mini cycles (alternatively called "shopping bicycles"), mountain bicycles and fun bicycles of unconventional design are not manufactured in India yet, however a few prototypes of a skater-bike have already been designed and built in the Bicycle R.D. Centre.

Having in view deficiencies of the bicycles manufactured in India at present, expected future demand of the local market as well as export requirements - it was recommended to include following goals into the programme of the R.D. Centre:

- improvement of design of the roadster bicycle,
- development of new improved bicycle models including light-weight, BMX and folding types, cycles for boys, girls and children as well as shopping and exercise bicycles.

### 1.2. Appraisal of Processing Techniques

Technical level of the basic processing techniques in the bicycle industry units in India can be characterized as follows:

- Crank type presses of capacity ranging from 6 to 250 tons are used for plastic metal working. These presses are mostly single-action presses. Single-operation tooling is also generally applied. Use of cold forging technology is in initial stage. Investigation on application of multi-stage presses and progressive dies as well as of cold forging has been recommended.

- Depending on production rate and financial standing, following kinds of equipment are presently used for machining:

- simple single-operation machines,
- special purpose machines,
- semi-automatic machines,
- single-spindle automatic machines.

Methods of machining are of traditional nature.

Investigations on application feasibility of multi-operation and multi-purpose machines have been recommended.

- Preassembly operations (i.e. those for inseparable assembling), applied mainly for assembly of bicycle frames and front forks as well as for mechanical connection of various bicycle components were found at low mechanization level. Application of special-purpose assembling machines has been recommended whenever feasible.

- Main methods used for brazing bicycle components are:

- high brass- and high fuel-consuming dipbrazing in molten brass using oil-fired pot type furnaces (applicable mainly for brazing of frames),

- high fuel-consuming charge brazing in open type furnaces with oil burners (applied mainly for brazing of front forks),

Investigation on feasible application of modern brazing techniques as for instance torch brazing on automatic or semi-automatic brazing machines or lines as well as induction

brazing or resistance brazing has been recommended.

- Hand operated oxy-fuel-gas welding process is mostly used for welding of bicycle components as lugs, shells and front fork blades. In few cases shielded metal arc welding process is used for welding of frames and front forks of particular designs.

Investigation on feasible application of advanced welding techniques such as gas metal arc welding or gas tungsten arc welding as well as multispot and projection welding has been recommended.

- Various heat treatment methods, as for instance carbonitriding, cyaniding and carburizing are applied for case hardening of the bicycle components. The cyaniding process widely applied by small scale manufacturers represents an extremely low technology level characterised by:

- very poor working conditions,
- environment pollution,
- lack of effective temperature control,
- lack of control of salt bath carbon potential,
- poor quality.

Carbonitriding process is considered most satisfactory for case-hardening of bicycle components, but certain irregularities related to control of carbon and nitrogen potential in the atmospheres and the applied quenching techniques causing insufficient quality have been encountered in some cases.

Main Team's recommendations for improvement of heat treatment processes are as follows:

- application of carbonitriding process instead of cyaniding,
- application of proper equipment for effective carbon potential control,
- improvement of quenching techniques.
- Preparation of surface for painting is of traditional nature, typical for this kind of surface treatment. Pickling and phosphatizing technologies are mostly used.

Methods of painting applied include both dipping and electrostatic techniques. Because of relatively poor quality of the paint coatings, it was recommended to undertake a complex study on both pre-treatment and painting technologies and on quality of the paints as well, as soon as the required research facilities are available.

- Preparation of metal surfaces for electroplating, basically grinding and polishing operations, are carried out manually in most cases, with application of simple machinery whereby high environmental pollution takes place. Application of semi-automatic and automatic equipment (including processing lines wherever feasible), with stress on effective dedusting installations, has been recommended for grinding and polishing. Electroplating processes provide in most cases coatings of good quality and bright appearance. Various types of equipment used for electroplating are well mechanized or automatized in both industrial sectors units.

- Productwise, the technical level of processing techniques applied can be classified in following groups:

- high level: freewheels, hubs, rims, spokes, chains, bottom bracket fittings,

- medium level: frames, front forks, handle bars, head parts, mudguards, pedals, chainguards, saddles, brakes, bells,

- low level: cranks, chainwheels, luggage carriers, stands.

Detailed proposals for improvement of processing techniques applied in production of individual bicycle components are presented in most of the interim reports as well as in other elaborations prepared in the Project Area jointly with the national counterpart staff.

- The Bureau of Indian Standards (formerly the Indian Standard Institution) issued over 25 standards for bicycle components i.e. practically for all component parts from which the present Indian bicycles are made. A set of two standards for complete bicycles, based on the international standards issued by ISO, has been worked out and has become obligatory. The Bureau of Indian Standards acts as secretariat for the

Technical Committee TC-149 of the ISO and takes part in standardization of bicycles as regards parts interchangeability. One of the benefits of close cooperation with ISO is the continuous verification of the bicycle standards available with the Centre, which provides the local industry with an important tool for quality stimulation.

The Bureau of Indian Standards has also established a quality certification mark and a chain of quality Marking Centres.

The Project Team of experts recommended to establish close cooperation between the BIS and the Bicycle R.D. Centre with the purpose of:

- participation in future standardization of bicycles and components thereof,
- authorization of the Centre as an approved test house in respect of bicycles and bicycle parts.
- Quality of products manufactured by the Indian bicycle industry varies from maker to maker and from product to product, depending on different factors. Consequently, it was recommended to check the conformity of the Indian bicycle industry products with the requirements of Indian Standards, within a complex quality improvement programme to be taken up by the Bicycle R.D. Centre. Further investigation of the subject of quality, with the purpose to identify weak points in design, processing and testing, has also been recommended by the Team members in their reports.

## 2. Improvement of the Roadster Bicycle

Jointly prepared programme of activities for improvement of design and processing, hence also for quality upgrading of the already manufactured most popular Roadster type of bicycle, has been accomplished in the following ways and stages:

- During the first and partially second mission of the Team Leader, the Centre has completed working out of design drawings of all component parts (except drawings for rubber, plastic and standard components) applicable for the Roadster

bicycle. Within this activity the most suitable raw materials have been selected and the basic dimensions and all tolerances have been unified with the purpose to increase productivity, interchangeability and effectiveness of quality control procedures. Complete sets of drawings of the basic bicycle assemblies have already been passed to the industry.

- According to a request of the DEVELOPMENT COUNCIL ON BICYCLE PARTS INDUSTRY (DCBP), a working group consisting of representatives of the Centre and of the industry has prepared a complex elaboration of requirements in respect of raw materials, their grades and properties. These requirements have been worked out by the relevant cells of the Centre with assistance of the Team Leader and another expert and submitted to all respective authorities and organizations.

- Certain selected vital components have been tested for conformity with requirements of the Indian Standards.

- Most of the activities of the Team's consultants were related to investigations and to working out proposals for improvement of processing techniques applied for manufacture of Roadster bicycels. These activities and outputs are presented separately in the clause "Development of Processing Techniques".

- In addition to the above procedures, a special sub-programme for investigation and further research and development works have been discussed and their implementation started. This sub-programme includes searching possibilities for:

- wider application of plastics for certain components (e.g. mudguards, chainguards, etc.),
- modernization of design and styling of selected components (e.g. saddles, luggage carriers, central stands, etc.).



In accordance with this sub-programme, prototype parts are expected to be fabricated and tested. Execution of the sub-programme is in progress and is expected to be carried out within the Centres work plan 1987/1988.

- Basic problems related to design and processing of bicycle components have been discussed with the manufacturers within the day-to-day consultancy services, during meetings organized by the National Project Management.

### 3. Development of New Bicycle Models

Activities related to design development of new bicycle models have been carried out applying the following methodology:

- discussions and exchange of information on actual state of world technology in respect of design and processing techniques,
- working out basic design assumptions with indication of fundamental design concepts and parameters, accessories and styling,
- working out separate action plans with indication of all required development steps, scope of activities and personnel involved,
- working out required design drawings,
- discussion on procedures for fabrication of prototypes,
- day-to-day consultancy during fabrication of prototypes,
- discussion of testing assumptions,
- discussion on processing requirements of the new model components to be included in the mission work plans of the relevant consultants of the Project Team.

Activities of the Team Leader and the consultants consisted in preparation of basic assumptions and in assistance in carrying out these development steps which have been implemented during their stay in the Project Area, as discussed in the next report sections related to development of the particular bicycle models.

#### 3.1. Development of the Lightweight Bicycle

Due to reasons explained later in this section, development of the lightweight bicycle has been adopted as a separate programme of high implementation priority. Basic design concept of the lightweight bicycle has been worked out by the Team Leader at the very beginning of his first mission to the Project Area and presented in the First Interim Report. According to the first approach it was aimed at designing a lightweight bicycle of popular sports

version of a weight within the range of 11-13 kgs. For this version:

- availability of required raw materials - both: steel and light alloys (AL - alloys) has been investigated,
- design assumptions for lightweight components selected jointly in consultation with the DCBPI (handles with stems, chainwheels and cranks, caliper brakes) have been discussed and the design drawings worked out during the first Team Leader's mission.

In course of discussions with the Indian Planning Commission it was stressed that development of a lightweight bicycle of a weight within 8-9 kgs, i.e. a bicycle of racing category, is desired by the Government Authorities.

Consequently, the National Project Management, in consultation with the Team Leader, decided to:

- start as soon as possible parallel development of both versions of the lightweight bicycle on priority basis - with little adjustment of the weight ranges of both categories viz. 8-10 kgs and 10-13 kgs,
- undertake action for fabrication of a pre-prototype, based on application of imported components wherever necessary,
- adjust the earlier workplan of the Bicycle R.D. Centre, taking into consideration new priorities. In accordance with this decision, development of folding bicycle and of an exerciser has been phased out to a later period.

A set of technical and organizational documents, required for implementation of the revised lightweight bicycle development programme has been worked out jointly with the national staff. These documents are as follows:

- reviewed design specification for both versions of the lightweight bicycle with indication of components to be:
  - developed by the Centre in the 1st stage,
  - purchased from abroad in the 1st stage and developed by the Centre in future,
  - to be purchased from abroad but acquired in future, if possible, from local sources,

- to be purchased from abroad for pre-prototypes only.
- Weight comparison charts for both versions.
- Action plan for development of the lightweight bicycle of 8-10 kgs weight category.
- Assumptions for development of both versions of lightweight bicycles, with additional indication of components expected to be developed by other industrial or research organizations.
- Action plan for manufacture of pre-prototypes of the lightweight bicycles.
- Specification of imported components required for the pre-prototypes and research activities - with indication of suppliers and approximate costs.

The complete design drawings of the following components for the lightweight bicycles have been completed during the presence of the Team Leader in the Project Area:

- Light alloy chainwheels and cranks
  - with double chainwheel - 2 versions,
  - with triple chainwheel - 1 version.
- Rear derailleurs.
- Shifting levers for derailleurs.
- Bottom bracket fittings for cotterless cranks.
- Multi-sprocket freewheels.
- Light alloy caliper brakes - 2 versions.
- Light alloy brake levers.
- Light alloy handle bars & stems - 2 versions.
- Steering head fittings.
- Frame assembly.
- Front fork assembly.

The design assumptions for the remaining parts of the lightweight bicycles i.e. the front rear hubs, pedals, saddles, seat pillars and front derailleurs have been discussed and designing of them has started.

The Centre has carried out trial manufacture of light alloy hub body by pressure die casting.

All Team consultants worked jointly out the basic

processing assumptions for manufacture of selected components for the lightweight bicycle. This is more widely discussed in the section "Development of Processing Techniques".

Discussions have also started with some possible future manufacturers of the following components: chainwheels, cranks and caliper brake sets.

### 3.2. Development of Other Bicycles

Prior to starting development activities related to other bicycle models, their basic design principles have been reviewed. The following has also been agreed in respect of these bicycles:

- Whenever feasible, bicycle models that are not manufactured yet by the Indian industry should be considered for development by the R.D. Centre. With this objective in mind, welded structures of frames and front forks providing possibility of application of automatic or semi-automatic gas metal arc welding (MIG, TIG) have been developed in case of BMX, childrens and shopping bicycles. For the same purpose new components not applied in the present Roadster bicycle have been designed or used for some bicycle versions, these components being as follows:

- angular steering bearings,
  - one-piece crank with suitable fittings,
  - narrow roller chains 1/2 "x 3/32" for multispeed juvenile sports cycle,
  - Thompson type bottom bracket fittings,
  - disk type chain guards,
  - wide angle front, rear and spoke reflectors (imported),
  - self-adhesive transparent decals (stickers).
- Whenever possible raw materials available in India should be used, but in justified cases recommendations to develop new types of materials in India are expected.

The state of programme implementation for development of other bicycle models is as follows:

- Bicycle Moto Cross (BMX):

Basic design assumptions with foreign samples comparison completed. Design drawings for 3 versions completed. Action plan for implementation of the programme approved. Fabrication of prototypes under progress - close to completion.

- Children's bicycles:

Basic design assumptions completed. Design drawings for 2 versions completed. Fabrication of prototypes under preparation - not started yet.

- Shopping bicycles:

Basic design assumptions completed. Design drawings for 2 versions completed. Fabrication of prototypes under preparation - not started yet.

- Shopping bicycles:

Basic design assumptions with foreign samples comparison chart completed. Design drawings for 1 version completed.

- Juvenile bicycles:

Basic design assumptions completed. Working out of design drawings started and expected to be completed within the Centres workplan for 1987.

- Folding bicycle:

Basic design assumptions completed. Following the decision to allocate priority for the lightweight bicycles, further development steps of the folding bicycles are not included in the Centres workplan for 1987.

- Exerciser:

No development steps undertaken due to priority set for lightweight bicycles - as above.

#### 4. Development of Processing Techniques

Activities of all consultants of the Project Team related to production technology can be classified into two basic groups as follows:

- activities for improvement of the present processing techniques with the purpose to:
- increase the quality level,

- reduce manufacturing costs,
- increase productivity,
- provide better working conditions,
- reduce the environment pollution, as basing on the appraisal given above, these tasks have been found of first priority.
- activities for development of new processing techniques required in connection with the implementation of research and development programmes for new bicycle models.

Having in view the financial limitations existing in the small scale sector for which most of the activities of the Bicycle R.O. Centre have been oriented, it was agreed that proposals for low cost development should be of first priority. However, technical level suitable for bigger manufacturing units, was expected to be taken care of simultaneously, as far as possible.

Joint activities related to development of processing techniques were carried out applying the following methodology:

- selection of components and of technological processes requiring or recommended for improvement,
- working out proposals for improvement in the form of:
  - technical and design assumptions for application of special purpose machines and specialized equipment,
  - technological assumptions for application of new processing techniques,
  - complex reports on improvement and/or application of updated specialized technologies,
- selection of proposals for immediate practical development and application in trial production,
- assistance in development and fabrication of research and trial stands, experimental equipment and tooling,
- assistance in carrying out trials and evaluation of results.

Technical papers and reports on proposed development as well as associated activities have been presented and widely

discussed in the scheduled Interim Reports and in the separate Mission Reports worked out by the Team Leader and the consultants. Some of the papers were enclosed to these reports.

Main subjects to which the a/m technical papers and the activities are related, are briefly presented in this Final Report. Comments on practical application of several proposals are included as well.

#### 4.1. Proposals

- Application of special tooling, special purpose machines, special equipment and processing lines for:
  - automatic cutting, semi-automatic grinding and polishing, semi-automatic bulging and knurling of handlebar tubes,
  - thread rolling of front fork columns,
  - automatic bending of saddle and luggage carrier components,
  - semi-automatic punching of spoke and valve holes in rims,
  - mechanized, semi-automatic and automatic polishing of handlebars, mudguards, rims and chainwheels,
  - automatic shot blasting of frames and front forks,
  - semi-automatic assembling of bicycle frames,
  - semi-automatic fixing of brass charges to tubes,
  - automatic machining of cranks,
  - mechanized blanking of various bicycle components,
  - automatic welding of frame subassemblies.
- Application of:
  - multistage presses for forming of chainwheels, spoke hub cups etc.,
  - progressive dies for blanking and forming of hub parts,
  - Application of cold forming technology for the following bicycle components:  
made of steel:
    - on presses: hub cone, expander cone, bottom bracket axle, bottom bracket, cup, pedal cone,
    - on horizontal multistation press: pedal axle, cotter pin,
    - on processing lines: cranks.



- Application of hot forging, machining and heat treatment of components made of Al-alloys for the lightweight bicycle, as follows:

cranks, chainwheels, handlebars, handlebar stems, seat posts and brake calipers,

- Modernization of various heat treatment processes by improvement of present or application of new processing techniques related to:

- controlled atmosphere carburizing,

- nitriding,

- controlled atmosphere carbonitriding,

- standard case-hardening processes for bicycle industry,

- calculation of hardenability of steel components,

- spectroscopic examination of carbon potential and carbon distribution in carburized layer,

- application of liquid fuel endothermic generator,

- application of fluidized bed furnace.

- Modernization of brazing and welding techniques by possible application of:

- resistance brazing of front forks,

- induction brazing of frames,

- liquid petroleum gas metal arc welding,

- gas tungsten arc welding.

- Application of various handling containers for workshop transportation of bicycle components.

- Economical effectiveness of production processes - methodology and principles of evaluation.

- Principles of effluent treatment, including oil recovery system.

Note: Theoretical principles, processing parameters, basic characteristic data on machines equipment, recommendations for materials, basic calculations, etc. as applicable, are presented in the proposals.

#### 4.2. Practical Application

Initial trial applications of certain proposed technological improvements or new processing techniques have already been started in the Centre, and namely:

- Within the cold forging programme and with assistance of the relevant consultant, the Centre has designed and fabricated special tooling for cold forging of hub cone and bottom bracket axle. Practical trials have been carried out.

- Within the programme for application of Special Purpose Machines and with assistance of the designed relevant consultant the Centre has designed and started fabrication of:

- semi-automatic assembly table for bicycle frames,

- semi-automatic equipment for fixing brass charges to tubes.

The fabrication was very close to completion at the departure of the Team Leader.

- Basing on the design assumptions and with assistance of the respective consultants, the Centre has designed and fabricated a resistance brazing equipment for front forks. Practical trials have been carried out and equipment has been offered to the industry.

- Basing on the design assumptions and with assistance of the relevant consultant the Centre has designed and fabricated a fluidized bed furnace. Initial trials have been started but further research activities have been recommended.

It is worth mentioning that the activities related to assistance in fabrication of prototypes of some SPMS and special research equipment were not included in the Terms of Reference, vide Annex No. 4 to this Final Report. However it has been agreed, that these additional activities were desired by the National Project Management for consolidation of the Project achievements, so they were included into the Team's workplan and implemented as far as described in this Final Report.

### 5. Development of Research Facilities in the Centre

The basic condition for successful performance of the various research activities related to upgrading of the Indian bicycle industry, is availability of well organized technological and testing laboratories, equipped with suitable scientific instrumentation.

As it is commonly accepted, the basic objectives of such laboratories are as follows:

- supporting the investigations of problems raised by the industrial units, their evaluation in form of expertise reports with suggestions for improvements,
- carrying out research works with the purpose to develop improved processing techniques, advanced technological and testing equipment and finally to present the positively implemented result to the industry,
- performance of various quality research and acceptance tests,
- theoretical and practical training of works engineers.

As mentioned earlier, some well equipped laboratories were available on the arrival of the Team Leader in the Project Area, but these laboratories were in principle oriented to perform measurements, chemical and spectroscopic analyses as well as testing of bicycle components.

Basing on discussions as well as on written proposals worked out jointly, the requirements for additional testing equipment for these laboratories have been identified and finally presented to the authorities concerned at the Tripartite Review Meeting and to the Centre's Governing Council - in both cases with TeamLeader's recommendations.

Purchase procedures for missing equipment of high priority as for instance:

- universal tensile testing machine,
- brakes performance testing equipment,
- photometric test equipment,

as well as construction of bicycle testing tracks and extension of the existing laboratories are in progress.

Organization of technological laboratories has been initiated and basic concepts have been discussed. Proposals and recommendations in this respect have been presented in the following papers:

- "Comments on Lay-Out and Equipment for the Workshops Expected to be Organised in the Bicycle R.D. Centre within its Extension Plans" prepared by the Team Leader. This paper also includes requirements for additional equipment for the Products Prototype Workshop,

- "Suggestions for Organization and Activity of the BRDC Heat Treatment Research Training Laboratory" and "Suggestions for Organization and Activity of the BR.DC Brazing and Welding Laboratory" worked out by the Consultant in Brazing and Heat Treatment.

- "Agenda for the Meeting on Organization of Cold Forging Pilot Production Section" containing proposals for scope of activities, equipment and manpower - worked out jointly by the Team Leader and the Consultant in Cold Forging and Forming.

The National Project Management, the Team Leader and the relevant consultants have jointly presented their opinion according to which the Bicycle R.D. Centre is capable to develop (design, fabricate and implement) some of the technological research equipment. Design assumptions for such equipment, as for instance the above mentioned fluidized bed furnace, liquid endothermic generator, resistance brazing machine and induction brazing machine, have been worked out by the members of the Project Team. For a part of this equipment certain components have to be imported, as not being available locally.

#### 6. Samples of Bicycles and Bicycle Components

In most of the research institutions working on development of new consumer products, one of the objectives is to collect foreign made samples, the purpose of this action being:

- to present the foreign made samples to the manufacturers who consider starting production thereof,
- to conduct comparative tests in respect of functioning, durability, fatigue etc.,
- to utilize foreign made components for fabrication of prototypes, especially of the products where application of these foreign components during regular production process is envisaged.

In accordance with the Team's Workplan, the Technical Adviser on Bicycles-cum-Team Leader was expected to present proposals in this respect and to work out specifications for the required foreign made samples of bicycles and bicycle components.

At the arrival of the Team Leader in the Project Area some foreign made samples provided with the assistance of UNDP/UNIDOWere already available in the Bicycle R.D. Centre.

As the stock of samples already available was considered insufficient, this subject was jointly raised at the Tripartite Review Meeting where additional funds were allocated for purchasing of further samples.

In accordance with specifications worked out by the Team Leader and in response to his request, the Project Contractor, i.e. the TKP CONSULTANTS Ltd., Warsaw, Poland, with assistance of the UNDP Office, New Delhi, India has arranged for a free of charge supply of the following foreign made samples of various bicycles and bicycle components:

BICYCLES;

- 2 sports bicycles of 10 speed category,
- 1 BMX bicycle,
- 1 unisex bicycle of touring category,
- 1 folding bicycle,
- 1 exerciser - of popular home-trainer version,
- 1 touring type bicycle,
- 1 children s bicycle.

BICYCLE COMPONENTS;

- 2 saddles for BMX bicycles,

- 2 pairs of grips for BMX bicycles,
- 2 sets of pads (body protective elements) for BMX bicycles,
- 4 sets of tyres and tubes size 20"x 2.125" for BMX bicycles,
- 4 sets of tyres and tubes (sizes 24"x 1 /8 and 26"x 1 /8) for touring type bicycles,
- 2 sets of 1 piece cranks with Thompson type BB fittings,
- 3 single speed coaster brake hubs,
- 4 bells,
- 4 saddles - two for touring bicycles and two for sports bicycles.

The Team Leader worked out and submitted to the National Project Management for further action, a recommended list of further samples to be acquired with indication of models, manufacturers and countries of origin, making also use of new catalogues and information on novelties shown during recent international fairs and exhibitions.

In addition to the general requirements for foreign made samples, there has also been a demand for purchase of different foreign bicycle component for the prototype bicycles to be made within the above mentioned lightweight bicycle development programme. The Team Leader has worked out a list of required components with their technical specification. Some of the samples have been collected during the study tour of the Centre Acting General Manager to the International Motorcycle and Bicycle Exhibition in Cologne, Federal Republic of Germany.

Purchase of the foreign made samples of bicycles and bicycle components is under continuous processing by the Bicycle R D Centre.

#### 7. Standardization, Quality Promotion and Certification

During the period of the Team Leader s missions to the Project Area, the National Project Management kept on initiating various activities related to standardization, quality promotion and certification. The R. O. Centre has

also close working relations with the Bureau of Indian Standards (former Indian Standards Institution). The Team Leader participated in practically all these activities and especially in activities related to the following fields:

#### 7.1. Development of Testing Programmes and Testing Equipment

Within the work programme on this subject, the Team Leader has carried out detailed investigations on requirements for tests and testing equipment basing on Indian standards, international standards issued by ISO as well as some other national standards, and namely:

- Federal Register, USA,
- DIN, Federal Republic of Germany,
- BSI, United Kingdom,
- JIS, Japan.

Written recommendations based on these investigations contain proposals on which testing equipment should be developed or purchased as soon as possible and which equipment may be considered optional, to be acquired later.

Basing on these recommendations an internal document on testing of bicycles and bicycle components has been worked out by the Centre.

Thirty five (35) test rigs acc. to Indian Standards have been designed in the design cell of the Bicycle R.D. Centre, out of which thirty four (34) have been fabricated for the use in the own testing laboratory.

Some of the test rigs have been manufactured upon orders from the industry and already delivered to the manufacturers. This Centre's activity is of a continuous and expanding nature. It should be considered important for upgrading quality, as only some of the Quality Marking Centres organized by the Bureau of Indian Standards have few test rigs required by the Indian standards. It should also be mentioned that testing equipment appears very seldom in the industrial units.

### 7.2. Participation in Standardization of Products

Activities within the above mentioned scope was related basically to:

- working out comments on various standardization documents,
- working out procedures and carrying out tests including evaluation results.

Some of the standardization documents on which the comments have been prepared following the request from the ISO Technical Committee TC 149, as for instance:

- French proposal for safety requirements for BMX bicycles,
  - draft proposal ISO/DP/8098 worked out as Document N280 "Cycles-Safety Requirement for Bicycles for Children",
- were strictly interrelated with the new products development programme implemented by the Centre.

A number of other standardization documents for which the comments were requested, as for instance the document:

- Bicycle Lighting Systems, Additional Requirements for Rechargeable Systems,

were of more general nature, however are also important in view of future works to be carried out in the Centre.

A considerable number of practical tests has been carried out in the Centre, some of them on request of the Bureau of Indian Standards - within the national and international standardization programme - and some of them on request from the industry - within their own research and development programmes.

### 7.3. Participation in Product Certification

Team Leader's task "Consultation in Organization of Product Certification System was strictly related to one of the objectives of the Bicycle R.D. Centre, i.e. - "Acting as approved agency for inspection and quality control of products for exports".

All the activities discussed under the above clauses 7.1 and 7.2 should be considered as preparatory for achieving of the final task and namely the product certification which



however, still needs some formal steps to be taken.

This objective of the Centre was discussed during a Tripartite Review Meeting. It was concluded at this occasion that most exporters have their own inspection and quality control systems, generally acceptable also to importers, however small-scale manufacturers might be interested in the Centre's inspection and quality control activities, what in fact has already been proved in several cases.

Concerning products designed for domestic market, participation of the Bicycle R.D. Centre in the product certification system will depend on two factors and namely:

- extent to which the Centre shall participate in the inspection and quality control activities,
- approval of the Bureau of Indian Standards to grant the respective authorisation to the Bicycle R.D. Centre.

This subject has been taken up by the National Project Management. Discussions have started with the Bureau of Indian Standards - being at present the only organization authorized for quality marking of products in India.

The capability of the Centre to act as a competent institution in this respect has been presented by the Team Leader in the seminar organized by the Centre for the local industrialists and for the Bureau of Indian Standards. Respective publication has been presented jointly with the national staff.

It is very likely that the Centre will be authorised in the near future to carry out qualification tests within the routine procedure of the products certification system. So far a proposal to work out in the Centre a Bicycle Compliance Test Manual has been discussed with the national staff.

#### 7.4. Other Comments

One of the objectives of the Centre is to develop new products of quality being in conformity with requirements of the international standards. Access to and making use of the information on the world progress in this respect is an

important condition for assuring proper level of research and development works carried out by the Centre. Therefore it was recommended to take steps to provide possibility for the staff members to participate in the meeting of the ISO Technical Committee TC-149. This committee is now expected to start standardization of fatigue tests and formulation of requirements for bicycles models that are not manufactured in India, which activities are particularly suitable for research institutes.

## 8. Information Service

Access to as much as possible technical, statistical, economical and other information on the national and international state of design, manufacture and quality of bicycles and bicycles components is a precondition for the Centre national staff in keeping path with the world trends as well as for the local industrialists in development and application of improved techniques. Organization of the Information Service was therefore included in the Project Document as one the Project's objectives. As mentioned elsewhere in this Final Report a complex information service was not available in the Centre on the arrival of the Tea Leader in the Project Area, except for the library that was found quite well equipped.

The National Project Management and the Team Leader started early discussions on this subject, so responding to these tasks the Team Leader worked out a document: "Basic Assumptions for Organization of the Information Service in the Bicycle R.D. Centre in Ludhiana". This document was enclosed as Appendix No. 1 to the 2nd Interim Report. The purpose of this elaboration was to present the basic assumptions for said activity with indication of the proposed objectives, main organizational guidelines, the required inputs and manpower as well as some other aspects considered useful.

The proposed Information Service Section of the Centre is planned to be located in the Administrative Building being under construction now. A separate auditorium is also planned for this purpose.

During running of the Project the following activities were carried out by the Information Service in temporary premises:

### 8.1. Seminars, Workshops and Lectures

A specification of seminars, workshops and lectures organized in the Bicycle R.D. Centre is presented in the Annex

No. 6.

Consultant in Production Technology assisted in preparation of papers for the following lectures:

- pneumatically controlled bicycle frame assembly fixture
- application of multiplunger press for manufacture of bicycle parts like chain wheels, hub flanges, etc.,
- automatic tube cutting machine with grinding and polishing attachment,
- automatic spoke hole and valve hole punching machine for bicycle rims,
- automatic rim and mudguard polishing machine,
- internal factory transportation systems,
- utilisation of SPM in bicycle industry

Consultant in Cold Forging and Forming assisted in preparation of papers for the following lectures:

- principles of cold forging and stamping. Advantages, needs and limitations of stamping and cold forging technology,
- application of cold forging technology for selected bicycle parts,
- requirement of raw material for cold forging and stamping,
- application of stamping technology to selected bicycle parts
- typical toolings and special devices for cold forging and stamping,

Team Leader prepared and delivered the following lectures:

- various types of light weight materials used for different bicycle components and its advantage over conventional materials,
- contribution and role of the Bicycle R.D. Centre for standardization, certification and quality promotion,
- tasks ahead - recommendation for future works related to production technology,
- tasks ahead - recommendation for future works related to design and testing,
- application of microphotography.

### 8.2. Exhibitions and Displays

The Project has established a product display room where all foreign made indigenous bicycles and bicycle components are permanently displayed.

The Project has also arranged 3 ad hoc exhibitions of foreign made bicycles, bicycle components and specialized publications on various occasions. One of these exhibitions was organized jointly with participation of Trade Authority and local exporters.

### 9. Day-to-Day Consultancy

The day-to-day consultancy provided by the Team Leader and the Consultants can be classified as follows:

- consultancy for the National Project Management,
- consultancy for the counterpart staff,
- consultancy for manufacturers of bicycles and bicycle components.

The consultancy provided for the National Project Management related mainly to the following subjects:

- organization schemes,
- workplans,
- research and development programmes,
- additional equipment,
- lay-outs of laboratories and workshops,
- manpower,
- selection of candidates for fellowship training abroad,
- organization of workshops, seminars and exhibitions,
- protection against environmental pollution.

The consultancy provided for the counterpart engineers from the Bicycle R.D. Centre related mainly to the following subjects:

- selection of materials for bicycle light weight, cold forged and heat treated components,
- selection of tolerances in design,
- testing procedures and evaluation of results,
- design of test rigs,

- modern methods in plastic working,
- various improvements of production technology,
- mechanization of assembly works,
- modernization of metal finishing technology,
- internal transportation systems,
- fabrication of prototypes of SPM,
- processing data on preparation of tools for cold forging,
- upgrading of carbonitriding and nitriding processes,
- fabrication of prototypes;
- fluidized bed furnace,
- liquid fluid endothermic generator,
- application of gas metal arc welding processes,
- design of welding machines.

Some of these subjects have also been discussed with the manufacturers.

The consultancy provided for manufacturers of bicycles and bicycle components was related mainly to following subjects:

- selection of materials,
- various design of bicycle components,
- processing of bicycle components,
- principles of melt forging technology,
- correction of concept of tooling for cold forging,
- hardenability of steel components.

The day-to-day consultancy with manufacturers of bicycles and bicycle components was arranged by the National Project Management directly or with participation of engineers from the extension - consultancy cell of the Bicycle R.D. Centre.

## 10. Training Activities

### 10.1. Internal Training

In addition to the day-to-day consultancy provided to the counterpart staff, more regular training activities were also arranged by the National Project Management.

The Consultancy in Cold Forging and Forming carried out regular training of the cold forging group consisting of the

counterpart staff engineers. The training covered the following subjects:

- brief theory of plastic working processes,
- raw material selection and requirements,
- calculation formulas for processing limitation,
- calculation of inner pressure in dies and stresses acting on punches,
- tool designing, tool materials and accuracy, heat treatment and quality requirements,
- calculation of compound (prestressed) dies,
- types of machinery, calculation of maximum admissible loads,
- aspects of component designing related to shape requirements of individual operations,
- evaluation of pilot production results.

The Team Leader conducted regular classes on following subjects:

- introduction - role of bicycle in human life,
- classification of various groups of bicycles,
- characteristic data of various groups of bicycles.
- principles of designing bicycle frames,
- principles of processing bicycle frames,
- new materials in frame building,
- standardization and testing of bicycle frames,
- considerations on theory of steering and equilibrium in cycling,
- principles of design, processing and testing of bicycle front forks.

#### 10.2. Training Courses

In accordance with the objectives set in the Project Document, the Bicycle R.D. Centre is expected to hold regular training courses for personnel from the industrial units.

For this purpose working out of a complex training programme was necessary. Starting of short training courses was required and was considered possible.

According to a request of the National Project Management, the Team Leader has prepared subject proposals for short training courses which could be held in the Bicycle R D Centre by its own engineering staff, and namely:

- Testing and inspection of bicycle components as per national and international standards.
- Application and maintenance of electronic systems and instruments used in production equipment.
- Indian Standards related to engineering drawings - reading of blueprints.
- Engineering materials used in design of bicycle components - their properties and testing.
- Designing principles of bicycles and bicycle components - standardization, unification, patent investigations and CAD application.
- Quality control systems, quality promotion, principles and practical application of statistical quality control (SQC). quality motivation systems.
- Metrology and engineering inspection, new trends (stage I - basic, stage II - advanced).
- Design and manufacture of inspection gauges.
- Design and manufacture of press tools (stage I - basic, stage II - advanced).
- Packing and handling systems, quality acceptance procedures and documents related to export activities in the bicycle industry.

The above mentioned subjects have been thoroughly discussed with the relevant officers from the Bicycle R D Centre and the National Project Management, so that a basis for implementing the above mentioned courses has been created.

#### 11. Reporting

As stipulated in the enclosed Terms of Reference and following an additional working understanding between UNIDO, Vienna and TKP CONSULTANTS Ltd., Warsaw the following interim



and mission reports have been submitted by TKP CONSULTANTS Ltd. to UNIDO for approval and distribution to the authorities concerned in accordance with the routine procedure:

- Six interim reports prepared by the Team Leader only or with participation of the relevant Consultant. To these interim reports were also enclosed:
  - the mission report on first mission of the Consultant in Production Technology,
  - the mission report on the single stage mission of the Consultant in Cold Forging and Forming, worked out by the relevant consultants.
- Separate additional mission reports were worked out as follows:
  - numbered 5A, by the Consultant in Brazing and Heat Treatment on his single stage mission,
  - numbered 6A, by the Consultant in Production Technology on his second mission.

These were all reports scheduled or expected to be submitted from the Project Area.

The more important documents, information and findings presented in the interim and mission reports are as follows:

- Team's workplan related to the tasks of the Team Leader and to each consultant,
- subsequent evaluation of the team's work progress with enclosed examples of technical elaborations,
- fellowship training programme with detailed programmes for each technical area,
- general information on the bicycle industry in India, related to product design, production technology with findings and recommendations to be utilized in the Centres workplans,
- appraisal of the actual state of local industry with findings and recommendations in respect of production technology - including the mission reports with enclosed selected technical elaborations,

- detailed tasks for the consultants:
- in Cold Forging and Forming,
- in Forming and Heat Treatment,
- appraisal of the actual state of local bicycle industry with findings and recommendations in respect of cold forging and forming technology - including the final mission report with selected technical elaborations,
- appraisal of the actual state of local bicycle industry with findings and recommendations in respect of brazing and heat treatment - including the final mission report with selected technical elaborations,
- assumptions for organization of the Information Service in the Bicycle R.D. Centre.

Recommendations presented in the Interim Reports and in the Mission Reports have been related to following subjects:

- development of product design,
- development of production technology,
- cooperation with Bureau of Indian Standards and the International Standards Organization,
  - testing of products from bicycle industry according to prevailing standards,
- organization of Information Service,
- cooperation with other R.D. institutions,
- investigation on latest bicycle models introduced into the Indian market,
- organization of study tours and visits to national and international exhibitions,
  - organization of the development programmes and activities related to implementation of new products, new processing methods and selected Special Purpose Machines,
  - studies and investigations on expected future development of products related to bicycle industry,
- implementation of the fellowship training programme,
- organization of a trial section for implementation of cold forging techniques developed by the Centre,
- organization of further continuous training of the cold

forging group,

- continuation of development of cold forging technology in respect of bicycle components,
- visits to large-scale units,
- preparatory activities for the second mission of the Consultant in Production Technology,
- preparatory activities for the arrival of the Consultant in Brazing and Heat Treatment for his single stage mission,
- organization of purchase of foreign made samples of bicycles and bicycle components,
- investigation on Product Certification System,
- organization of treatment, brazing and welding laboratories,
- research works related to heat treatment, brazing and welding
  - assistance to the Centre in modernization of small scale production shops,
  - purchase of additional testing equipment,
  - adoption of a suitable system for financing standardization activities of the Centre from central funds, etc.,
  - continuation of research and application activities related to brazing of bicycle components,
  - research and application works in the field of automatic welding,
  - mechanization of manual works,
  - research and application works on production technology especially related to bicycle lightweight components made of aluminium alloys.

The recommendations have been made use of by the National Project Management to the expected applicable extent.

D. Activities at the Home Office

In accordance with Clause 2.03 "Contractors Personnel" of the Contract No. 84/110, TKP CONSULTANTS Ltd. was expected to provide also 4 man-months of expert services at the Home Office as follows:

- M.L. REICH Team Leader 2 man-months
- B.M. KIRYLUK Consultant in Cold Forging and Forming 1 man-month
- J.M. GRZYB Consultant in Brazing and Heat Treatment 1 man-month

Activities of the Team Leader and the Consultants, carried out at the Home Office in Poland were strictly related to other activities performed in the Project Area and may be characterized as follows:

1. Prior to arrival in the Project Area of the Consultant in Cold Forging and Forming as well as the Consultant in Brazing and Heat Treatment, detailed tasks for their missions have been worked out by the Team Leader and the Consultant in Production Technology. After approval by the National Project Management, these tasks were submitted via TKP CONSULTANTS Ltd., Warsaw to the Consultants concerned. This has allowed the Consultants to get acquainted with the basic problems to be worked on during their missions to the Project Area and to undertake required preparatory works during the period of Home Office activities set in the Contract. These works were related mainly to collection of various technical data, publications and information as well as to working out some introductory papers on the subjects approved for research.

2. During his first mission to the Project Area, the Technical Adviser cum Team Leader has investigated the technical fields related to his tasks laid down in the Teams Workplan for his second mission with the aim to identify problems that required additional activities at the Home Office. The Team Leader has taken up these activities, adjoining his home leave in 1986. Within this period the Team Leader has also assisted the acting General Manager of the

Bicycle R.O. Centre during his visit to Poland, when consultations on conditions, programmes and modifications of the fellowship training at the ROMET Bicycle Factory have taken place.

In accordance with the Team's Workplan, a part of data required for preparation of this Final Report has been collected by the Team Leader during his second mission to the Project Area. Some of these data have been utilized during joint preparation of the Draft Terminal Report for the Tripartite Review Meeting.

This Final Report was expected to be worked out within a 3 months period after completion by the Team Leader of his second mission. The remaining period stipulated in the Contract for activities at the Home Office, was devoted to working out of this Final Report.

#### IV. PROPOSALS FOR FUTURE WORKS

From the discussions presented in the various sections of this Final Report, it is evident that despite of some limitations occurring during the life of the present Project, as for instance acting in a disturbed area that also caused certain delay in starting the activities, the Centre has achieved the immediate objectives, planned inputs as well as the expected outputs in most of the cases, exceeding them in certain cases. However it can also be seen that certain activities, especially those related to:

- implementation on the complete fellowship training programme,
- manufacture of a research equipment for induction brazing of frames,
- purchase of additional testing equipment,
- consolidation of Centre's experience gained during presently reported Project were not possible to be completed within the stipulated Project duration i.e. up to June 1987.

From the Project Document it is also evident that the development objectives of the Project are quite far-sighted and thus of a long term nature. The final Project results in respect of the development objectives can not be considered achieved yet. This subject was discussed widely with the representatives of the small scale bicycle industry that mainly benefited from the Centre's activity as well as with representatives of government authorities and other official institutions. It has been jointly concluded that a follow up actions for:

- full utilization of the present achievements of the project,
- better consolidation of the activities resulting from high requirements stipulated in the Project Document and
- consequently extension of the Project duration by at least 6 months are justified and desired.

Furthermore, it is worth mentioning that during drafting the Project Document IND/79/028 and approval thereof, the

state of art and levels of development as prevalent up to the end of seventies were taken into consideration. Major changes have taken place since early eighties in the world bicycle industry, so that a lot of new research programmes should be undertaken to minimize the existing technological gap between the present standard of the local bicycle industry and the world standard of the same.

Having in mind needs of the industry, the National Project Management was of the opinion that Second Phase of this Project should follow. Both the above mentioned subjects, i.e. extension of the present Project and establishing of its Second Phase were presented and discussed at the Terminal Tripartite Review Meeting held in June 1987. The same view was shared by the participants of the Meeting, who recommended the necessary action to be taken. Initial proposals for subjects within the follow up activities have been worked out jointly by the National Project Management and the experts from the Project Team and presented in the following documents:

- Draft Proposal for UNDP/UNIDO assisted follow up services and expertise for the Bicycle Research and Development Centre in Ludhiana,
- Draft Report for Tripartite Review Meeting - scheduled for 12 June 1987.

The proposed subjects with brief description and justification thereof are now presented in this Final Report.

A. Proposed Subjects for Future Activities

1. Continuation of activities related to development of new bicycles and bicycle components, including:

- completion of design drawings,
- purchase of required materials, locally and foreign made components,
- fabrication of prototypes,
- testing of prototypes,
- working out of full package of processing data, tools and gauges,
- working out of feasibility studies for potential manufacturers, concerning production and/or development processes.
- assistance in implementation of the processes with the industry.

Within the new products development programme, development of the lightweight bicycle should be continued on priority basis. The procedures for the above steps of development have already been discussed jointly with national counterpart staff and agreed by the National Project Management.

2. Within the above lightweight bicycle programme it is required to work out and present to the industry the project assumptions for a small scale unit for manufacture of lightweight and racing bicycles of capacity 10 thousand per year - based on designs developed already by the Centre.

These project assumptions should include:

- feasibility study,
- production programme,
- production profile,
- production - processing assumptions,
- equipment list,
- space (area) calculation,
- calculation of required manpower,
- consumption of power, water, technical gases, compressed air etc.,
- organizational scheme,



- proposed lay out.

Forming a small scale unit for manufacture of the lightweight bicycle should be interesting to industrial investors. Possibility of organization of such a unit as pilot one by the Centre itself, should also be taken into consideration.

3. Continuation of research and development works in the areas of cold forging, brazing, welding as well as on the specialized elaborations worked out by the relevant consultant during their missions to the Project Area. For this purpose, organization of well equipped specialized technological laboratories as already initiated by the Centre, is a precondition for effectiveness of the research works. Some of the research prototype equipment required for the a/m laboratories can be developed in the Centre, most probably with some foreign input. Preliminary development of the following prototype equipment has been jointly discussed:

- medium frequency induction brazing machine for frames,
- fluidized bed furnace,
- endothermic generator for generation of controlled atmosphere for heat treatment processes,
- automatic welding equipment.

As already mentioned, basic design assumptions for this equipment have already been worked out by the respective consultants. The development programmes for this equipment should include:

- organizational data,
- indication of standard components to be purchased and scope of components and works to be manufactured and performed in the Centre,
- indication of research and trial precedures.

4. Working out and implementing new research and development programmes in the areas of electroplating, electrostatic painting and pollution control. Research works on effluent treatment are urgently needed by the small scale industry. Low cost solutions should be preferred. Similarly as in the

item 3 above for carrying out these research works, additional specialized laboratories are necessary.

5. Expansion of the Centre testing activities by introduction of:

- durability and fatigue tests,
- reliability investigations,
- testing of non-metal materials, like rubber and plastics.

Requirements for specialized equipment for the durability and fatigue tests as well as for the reliability investigations and also the required testing procedures, can be worked out basing on the experience gained by the national counterpart staff during the fellowship training in Poland. Testing equipment for non-metal materials should be selected basing on the relevant standards and technical publications.

6. Expansion of activities related to development of Special Purpose Machines. For this purpose a complex development programme should be adopted, including:

- dissemination of proposals worked out by the Consultant in Production Technology,
- fabrication of prototype SPM ordered by industrialists or selected by the Centre for demonstration.

7. Preparatory works for establishing of a low cost automation and control laboratory in the area of pneumatic and hydraulic systems, including

- working out organizational data,
- selection of research, trial and testing equipment,
- elaboration of assumptions for exemplary control systems.

The Centre has already fabricated testing rigs, some of which are suitable to be equipped with pneumatic or hydraulic loading and control systems. The Centre started also manufacture of SPM where application of pneumatic and hydraulic driving and control systems is a common practice. A low cost automation laboratory would effectively support these activities.

8. Special research and development programme for application of investment casting in manufacture of certain bicycle and

sewing machine components would be useful for the industry, however organization of the required facilities and working out the research procedures would need a very specialized expertise and assistance.

For justification of this proposed activity it is worth mentioning that certain bicycle components as for instance best quality lugs and shells are produced by the leading world manufacturers with application of this technology.

9. Application of computer aided design (CAD) systems including automatic drafting equipment (plotter) and of personal computers for engineering calculations is recommended.

In future, after acquiring wider experience by the Centre in utilization of computerised systems, research work on application of computer aided management (CAM) systems may be taken up with the purpose to meet the future plans of the industrial units in this area.

10. With reference to the preparatory activities for establishing an effective and subject-wise acceptable training system, it has been considered useful to establish a complex training programme in the areas of engineering and management.

This complex programme should include:

- organizational assumptions,
- selection of short and medium term courses,
- elaboration of programmes,
- setting of requirements for:
  - didactic aids,
  - lecturers,

and could be implemented parallelly with completion of the premises, thus providing reasonable coordination of all the related activities.

11. Working out of a complex action programme in respect of bicycle and cycling promotion activities, including:

- selection of activities,
- identification of required inputs,

- working out organizational schemes,
- working out action plan and a draft promotion programme.

A lot of similar activities are carried out by various foreign institutions, as for instance the Japanese Bicycle Promotion Institute that initiates various actions, events, publications, competitions, etc. for promotion of bicycles.

Since there is a visible trend to utilize the bicycle in India also for sport and leisure, it seems reasonable to start similar promotion activities, whereby the Bicycle R.D. Centre may play an important role.

12. Working out a pre-feasibility study on required technical and commercial activities in Indian bicycle industry for expanding export to developed countries.

This is proposed to have in view the present and future plans related to expansion of exports from India and the need to extend the actual export-oriented activities of the Centre by strengthening the research works in cooperation with various development and trading authorities concerned.

It has been agreed that the proposed pre-feasibility study should consist of the following:

12.1. Marketing Study - including:

- Evaluation of statistical data.
- Identification of trade systems applicable on various markets for bicycles and bicycle components.
- Investigation on export potential of the Indian Bicycle Industry with reference to:
  - local trends and procedures,
  - gaps in world markets,
  - international competition.
- Working out suggestions on the most feasible systems for export of the bicycle industry products.
- Working out suggestions on required marketing activities for promotion of the export production and sale.

12.2. Investigation and working out suggestions on:

- expected development trends of new designs and styling taking into account export requirements,

- required cooperation of Indian Bicycle Industry with world manufacturers,
- way and systems of increasing productivity,
- identification of limitations for cost reduction.

12.3. Investigation and working out suggestions related to quality aspects on the world markets - including the following subjects:

- legal aspects of quality and safety requirements prevailing on the principal foreign markets,
- proposals for legal and other activities required for development of quality to the internationally required level,
- comparison between Indian standards and the Indian quality certification system and relevant systems adopted in principal developed countries - proposals for improvements.

12.4. Other aspects related to export economy - including investigation and working out suggestions related to the following systems of:

- packing,
- handling,
- shipment

12.5. Working out proposals for complex programme of activities for export promotion.

All proposals presented in this Section A of the Chapter IV have been worked jointly or at least discussed with the National Project Management. However they can not be considered finalized, since more ideas on future works are expected to emerge after completion of all the fellowship trainings.

### B. Proposals for UNDP/UNIDO Assistance

Having in view the development objectives set in the Project Document and the above proposals, it was jointly concluded that for their full completion some follow-up action with moral and financial support from the Government and UNDP/UNIDO is required.

For this purpose

- extension of the present Project,
  - establishing of a Second Phase of this Project,
- have been considered advisable.

Further assistance of UNDP/UNIDO in various forms, as for instance:

- providing expert services,
  - arranging study tours to various international organizations and international exhibitions,
  - providing additional equipment, especially:
    - additional testing equipment,
    - specialized equipment for information service,
    - specialized equipment for computer aided activities,
    - arranging of additional fellowship training,
- has been envisaged.

Proposals on the required scope of the UNDP/UNIDO additional support and assistance should be worked out and applied for the National Project Management according to the routine procedures.

## V. CONCLUSIONS

The following conclusions can be drawn from the experience gained during the mission to the Project Area and from the findings presented in this Final Report:

1. The development and immediate objectives as originally envisaged in the Project Document are still relevant and it can be assessed from the already achieved results, that fulfillment of these objectives would lead to attainment of the expected outputs.
2. The evaluation of the Project status and progress is an evidence that immediate objectives of the Project, the planned inputs as well as the expected outputs have been achieved in most cases and in some cases even exceeded. As discussed in the main body of this report as to certain objectives, inputs and outputs, there is still more financial support from the Government and possibly also from UNDP/UNIDO required for their consolidation. Accordingly, extension of the life of the Project is considered advisable and justified.
3. The development objectives of the Bicycle R.D. Centre are quite farsighted and thus of a long term nature. In the light of research activities being run by the Centre, it has been concluded that these development objectives can be attained only during a period reaching beyond life of the present Project and that further assistance of UNDP/UNIDO in various forms could be very useful for acceleration of achievements of the final national development tasks. As a consequence, a Second Phase of this Project is considered advisable.
4. The Centre with the existing national staff and the available facilities and equipment is capable to perform most of the activities already initiated. However in view of the expected future research and development programmes and the expected requirements to carry out additional activities asked for by the bicycle industry, appointment of the already advertised new research personnel, including the Project Officer and further extension of presently available

facilities, including additional scientific instrumentation and testing equipment, have been recommended.

5. Despite efforts of the National Project Management and recommendations presented in the Interim Reports by the Team Leader, the accepted fellowship training programme could not be completed within the present life of the Project. It has been jointly accepted that the fellowship training should be completed as soon as possible.

6. The activities of Contractor's experts carried out in the Project Area and at the Home Office are considered consistent with the expectations and conditions presented in THE TERMS OF REFERENCE and oriented for achievement of the development objectives of the Bicycle R.D. Centre. The Interim Reports were prepared in the Project Area in accordance with the requirements set in the TERMS OF REFERENCE. The recommendations presented in the Interim Reports have been made use of to the contemporarily applicable extent.



## VI. RECOMMENDATIONS

With reference to findings contained in the consecutive Interim Reports and also in the main body of this Final Report as well taking into consideration various opinions arrived at the Tripartite Review Meetings held during the assignments of the Contractor's experts the following general recommendations are presented:

1. Having in view the already presented requirement for the Bicycle R.D. Centre of various follow-up and new activities with the purpose to meet the extended needs and demands of the Indian bicycle industry, it is advisable to work out a modified research and development programme for the next 3 years (1988-90), with indication of:

- expected activities,
- required additional inputs,
- quantified outputs.

2. For preparation of the said future research and development programme for the Centre, the proposals worked out by the Contractor's experts during their mission to the Project Area should be utilized, whereby certain in-depth consultations can prove necessary. The above mentioned proposals for future works are presented in various technical papers, interim reports and mission reports as well as contained in Chapter IV of this Final Report. Out of the Project outputs, especially those related to the following subjects should be of interest:

- export promotion of Indian bicycles and components including organization of separate products prototype workshops and of research stands for durability and fatigue tests,
- upgrading of processing techniques including fabrication of prototype Special Purpose Machines organization of specialized technological laboratories and fabrication of selected technological research equipment,
- purchase of additional scientific instrumentation and testing equipment,

- application of CAD (computer aided design) and CAM (computer aided management) systems,
- participation in ISO activities,
- extension of the information service,
- implementation of an extended training programme,
- initiation of bicycle and cycling promotion activities,

3. Because of the anticipated complex nature of the future research and development activities as well as the expected interrelation of the Centre's programme with activities of other scientific institutions and organizations, additional assistance of UNDP/UNIDO within the proposed Second Phase of this Project is recommended. Experience attained the Bicycle R.D. Centre during present Project duration should be utilized for preparation of the Project Document for the Second Phase.

4. As to the present phase of the Project, it is advisable to complete the fellowship training programme as soon as possible, but not later than till the end of August 1988. Maximum cooperation of all parties concerned for achieving this goal would be appreciated.

ANNEX No. 1

NATIONAL STAFF IN BICYCLE R.D.CENTRE (on 25 June 1987)

Post	Name/title	Number
1	2	3
A. General Manager	- in charge Mr.H.S. Bains Industrial Adviser-cum- Additional Director of Industries, Punjab	1
B. D-ty Gen. Manager	- Mr. J.S. Randhawa, acting also as Projects Co-ordinator for both Projects	1
C. Project Officer	- vacant	-
D. Managers:		
- Engineering Services	- Mr. Harbhajan Singh	1
- Consultancy Extens.	- Mr. H.R. Singh	1
- Common Facility	- vacant	-
E. Asstt. Managers:		
- Process Engineering Quality Control	- Mr. J.S. Khorana	1
- Laborat. Testing	- Mr. B.S. Sangha	1
- Electronics	- Mr. O.P. Aggarwal	1
- Co-ordination	- Mr. A.K. Garg	1
- Techn. Inquiries	- Mr. K.S. Grewal	1
- Consultancy - Extens.	- vacant	-
- Design	- vacant	-
- Store, Purchase Offic.	- Mr. A.S. Sidhu	1
	Singh, Mohinder Pal Singh, Shamsher Singh, Surinder Pal Singh, Bachitter Singh,	6
G. Sr. Techn. Asstt.	- Mr.Mr. Harbans Singh, Y.A. Khari (two vacant)	2

1	2	3
H. Extension Asstt.	- Mr.Mr. Tejinder Singh, Swaran Singh	2
I. Techn. Draftsmen	- Mr.Mr. A.K. Sharma, Jasbir Singh, Rajinder Singh, Jaspal Singh, Jagbal Singh, Zora Singh	6
K. Operators	Mr.Mr. Gurdip Singh, Sasendranath, Mohinder Singh, Jagdish Singh, Atma Singh, Pritam Chand, Rajinder Singh, Raj Kumar, Narinder Singh, Pal Singh, Om Prakash, Sat Pal, Rattan Kumar	13
L. Fitters	- Mr.Mr. Subash Chander, Sam Singh, Sarav Mitter, Gurmail Singh	4
M. Technicians Laborat./ Standards Room	- Mr.Mr. Tejinder Singh, Vishwa Nat Bhatt, Harjinder Pal Singh, Sunil Paul, Surinder Pal	5
N. Other Technical Staff	- Mr.Mr. Balbir Singh, Jaswinder Singh, Jasbir Singh, Gurnam Singh, Ranjit Singh, Sanjiv Kumar, Kirpal Singh	7
O. Admin. Acc Personnel:		
- Acc.-cum-Admin.Offic.	- Mr. Dilbagh Singh	1
- Accountants, Clerks; Stenographers, Typists-	in total	12
- Store Purchase Staff	- in total	3
- Security Staff	- in total	7
P. Others:		
- Peons, Sweepers, Mali	- in total	8
<b>Total</b>		<b>86</b>

ANNEX No. 2UNDP MACHINERY, EQUIPMENT

Sr.No.	Description	Remarks
1.	Jig boring machine	commissioned and in operation
2.	Base mounted Schaublin lead screw lathe	"
3.	Optical profile grinding machine	"
4.	Universal copy milling machine, Deckel	"
5.	Sakamura cold bolt former	commis. and being demonstr
6.	Circulon vibrator	commis. and in operation
7.	Wheel building machine	commis. and being demonstr
8.	Wheel trueing machine	"
9.	Universal measuring microscope	commissioned and being put into operation
10.	3-dimensional measuring marking machine	"
11.	Profile projector	"
12.	Inspection and measuring instruments for metrological laboratory	"
13.	Vacuum emission spectrometer	not yet commissioned
14.	Induction brazing machine	order cancelled

ANNEX No. 3INDIGENOUS MACHINERY, EQUIPMENT

Sr.No.	Description	Remarks
1.	Universal milling machine	in operation
2.	Radial drilling machine	"
3.	Centre lathe NH 26	"
4.	Internal cylindrical grinder	"
5.	Ram turret type milling machine	"
6.	Surface grinder	"
7.	Hydraulic cylindrical grinder	"
8.	Power press 60 tons	"
9.	Bench drilling machine	"
10.	Hydraulic press 10 tons	"
11.	Power hacksaw	"
12.	Universal drafting machine	"
13.	Ammonia printing machine	"
14.	Air compressor	"
15.	Welding rectifier	"
16.	Flexible shaft grinder	"
17.	MIG welding set	"
18.	Flexible shaft grinder	"
19.	Metallurgical specimen cut off machine	"
20.	Single disc polishing machine	"
21.	Bench grinder	"
22.	Electric brazing torch	"
23.	Workshop instruments and tools	"

TERMS OF REFERENCE

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DP/IND/79/028

RESEARCH AND DEVELOPMENT CENTRE FOR  
BICYCLE INDUSTRY  
LUDHIANA, INDIA

1. BACKGROUND INFORMATION

While some manufacturing units in India produce the complete bicycle with all its components, most of the bicycles are produced and assembled in a disaggregated, small-scale sector. The technology for producing bicycles needs extensive modernization in design, production methods and production processes and controls - especially for such items as frames, hubs, cranks and sprockets. Upgrading is needed as rapidly as possible in order to put the country in a position to respond to the market demand.

In view of this, the following are required:

- new functional and style-conscious designs;
- proto-type production models;
- quality control and quality auditing policies and procedures;
- standards;
- improved interchangeable manufacture.

It has been decided to set up a Bicycle Research and Development Centre in Ludhiana to provide technical assistance to the bicycle industry in the country.

This centre would perform the following functions:

- a) Train individuals from the bicycle industry in relevant and current design and manufacturing technology. Much of this training would be the "hands-on" variety.

- b) Acquire representative current manufacturing equipment in order to demonstrate the latest technology to the industry.
- c) Provide design and manufacturing consulting services to the bicycle industry.
- d) Establish a technical information service.

2. CONTRACTOR'S TASKS

The Contractor would be required to provide a total of 40 man months of expert services in Ludhiana in 4 principal technical areas:

Technical Advisor on Bicycles (also project leader)	- 22 m/m
Consultant in Cold Forging and Forming	- 5 m/m
Consultant in Brazing and Heat Treatment	- 5 m/m
Consultant in Production Technology	- 8 m/m

A description of the duties to be performed by each of these individuals is as follows:

a) Technical Advisor on Bicycles

Working in close co-operation with the project director and counterpart personnel, the expert will specifically be expected to:

- Appraise the actual state of local bicycle industry, its production programme and market requirements;
- Work out programme of the team's work;
- Assist the centre to develop new designs for bicycles and bicycle components;
- Provide consultation on production and manufacturing processes, quality control, assembly and finishing operations related to bicycle manufacturing;



- Conduct training courses related to the areas mentioned above.

The expert will also be expected to prepare a final report, setting out the findings of the mission and recommendations to the Government on further action which might be taken.

b) Consultant in Cold Forging and Forming

The expert in close co-operation with the project director and counterpart staff is expected to:

- provide consulting services to the centre relative to cold forging, forming and allied operations;
- provide consulting advice concerning process specifications and production equipment for cold forging, forming and allied processes;
- conduct training sessions relative to the items mentioned above;
- prepare periodic and final reports setting out his findings, conclusions and recommendations.

c) Consultant in Brazing and Heat Treatment

The expert in close co-operation with the project director and counterpart staff is expected to:

- provide consultation to the centre in brazing, related metals, joining processes and heat treatment;
- provide consulting advice concerning specifications and production equipment for brazing and heat treatment;
- conduct training sessions relative to the items mentioned above;

- prepare periodic and final reports setting out his findings, conclusions and recommendations.

d) Consultant in Production Technology

The expert in close co-operation with the project director and counterpart staff is expected to:

- appraise the actual state of local bicycle industry in respect of production technology;
- set detailed tasks for the consultants as per items b) and c) above;
- provide advice to the centre concerning the appropriate manufacturing metalworking technology; this includes methods and processes for producing bicycles;
- provide consulting advice concerning metalworking equipment, equipment specifications and process specifications;
- conduct training sessions relative to the items mentioned above;
- prepare periodic and final reports setting out his findings, conclusions and recommendations;
- all the periodic reports should be prepared in English in ten (10) copies and the final reports in English in twenty (20) copies.

3. FELLOWSHIP TRAINING

- a) The Contractor will arrange for a maximum of 20 man months of fellowship training in bicycle factory ROMET, BYDGOSZCZ in Poland;

- b) The exact number of fellowship holders and technical areas covered by the fellowship will be established jointly by the Contractor's Team Leader and the National Project Manager (counterpart);
- c) The programme for these fellowships including the names of the fellowship holders, the technical areas of the fellowships, starting dates and duration of each fellowship will be determined as part of the 2nd interim report prepared by the Contractor's Team Leader 7 months after the Team Leader arrives at the project site;
- d) All fellowships are to be scheduled such that they are completed within 26 months of the Contractor's Team Leader's arrival at the project site;
- e) UNIDO will bear all expenses related to the travel of the fellowship holders from India to the factory in Poland and return, local travel between the fellowship holders' residence in Poland and the bicycle factory, and board, lodging and pocket money. At its discretion UNIDO may negotiate with the Contractor to provide local board, lodging, transportation and spending money in return for a fixed fee.

#### 1. INTERIM REPORTS

The Team Leader shall be responsible for the following periodic reports (interim report) to be submitted from the Project Area with administrative assistance of the local counterparts:

1st Interim Report - of Team Leader's appraisal of the actual state of the local bicycle industry, its production programme and market requirement with Team's workplan attached - to be presented in 4 months after the Team Leader's first arrival in the Project Area.

2nd Interim Report - on Team's work progress and particularly on appraisal of the actual state of the local bicycle industry in respect of production technology and setting detailed tasks for the

Consultants in cold forging and forming as well as programme of fellowships as per item 3.c) of this Annex D - to be presented approx. 7 months after the Team Leader's first arrival in the Project Area.

4th Interim Report - on Team's work progress - also setting detailed tasks for the Consultant in brazing and heat treatment - to be presented on commencement of home leave by the Team Leader, which is planned to take place approx. 11 months after the Team Leader's arrival in the Project Area. This 4th Interim Report shall also constitute a closing report on the first stage mission of the Consultant in production technology.

5th Interim Report - on Team's work progress - to be presented approx. 14 months after the Team Leader's first arrival in the Project Area. This 5th Interim Report shall also constitute a final report on the mission of the Consultant in cold forging and forming.

5th Interim Report - on Team's work progress - to be presented on completion of the mission of the Consultant in brazing and heat treatment, which is planned to take place approx. 19 months after the Team Leader's first arrival in the Project Area. This 5th Interim Report shall also constitute a final report on the mission of the Consultant in brazing and heat treatment.

6th Interim Report - on Team's work progress - to be presented on completion of the second stage of the Consultant in production technology, which is planned to take place approx. 23 months after the Team Leader's first arrival in the Project Area. This 6th Interim Report shall also constitute the final report on mission of the Consultant in production technology.

TEAM'S WORKPLAN

Specification

Specification	1985						1986						1987											
	V - IX			X - XII			I - III			IV - VI			VII - IX			X - XII			I - III			IV - VI		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
I. TEAM LEADER - M.L. REICH	-----																							
1. Appraisal of actual state of bicycle industry in India and working out of Team's Workplan.	-----																							
2. Consultation in working out requirements for additional equipment for - prototype workshop - bicycle testing room	-----			-----																				
3. Consultation in designing additional testing equipment.				-----			-----																	
4. Assistance in working out basic assumptions for new designs.				-----			-----																	
5. Working out of specification for foreign made bicycle components required for the R&D design programme.				-----																				
6. Consultation in development of Roadster bicycle, manufactured at present.				-----			-----																	

# Specification

Specification	1985						1986						1987											
	V - IX			X - XII			I - III			IV - VI			VII - IX			X - XII			I - III			IV - VI		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Assistance in designing new bicycle models.																								
- Lightweight Bicycle ✓																								
- BMX Bicycle ✓																								
- Folding Bicycle ✓																								
- Bicycle for boys and girls ✓																								
- Childrens Bicycle ✓																								
- Shopping Bicycle ✓																								
- Exerciser -																								
2. Consultation in organizing of :																								
- Patent investigations																								
- standardization service																								
- information service																								
- product certification system																								
3. Working out of recommendations for future works.																								
4. Participation in training courses on subject of design, quality control and standardization (every second month).																								
5. Working out of the Draft Final Report.																								

# Specification

	1985						1986						1987											
	VII - IX		X - XII		I - III		IV - VI		VII - IX		X - XII		I - III		IV - VI									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<p><u>CONSULTANT IN COLD FORGING AND COLD FORMING - B.M. KIRYLUK</u></p> <p>1. Exploration of possibility of introducing cold forging and cold forming technology for :</p> <p>A. Steel parts :                      free wheel parts, B.B. axle, B.B. Cups, pedal axle, hub cones, hub nuts, hub flanges, handle lugs, chain rollers.</p> <p>B. Light alloy parts :                      handle bars, caliper brakes, chainwheels, cranks, hubs, rims.</p> <p>2. Consultation on processing procedures for selected bicycle components - in respect of cold forging and forging-with indication of machines, tools and recommended materials.</p> <p>3. Day-to-day consultancy in designing of forging and forming tools.</p> <p>4. Participation in training courses on the subject of cold forging and</p>																								

# Specification

Specification	1985						1986						1987											
	X - IX		X - XII		I - III		IV - VI		VII - IX		X - XII		I - III		IV - VI									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
forming (every second month).																								
<b>II. CONSULTANT IN BRAZING AND HEAT TREATMENT - J.M. GRZYB</b> 1. Study on present brazing processes and working out suggestions for application of most suitable brazing methods with indication of equipment and procedures. 2. Study on present heat treatment processes and working out suggestions for improvement of heat treatment methods with indication of equipment and procedures. 3. Consultation in selection of materials most suitable for selected bicycle parts in respect of heat treatment and quality requirements. 4. Participation in training courses on the subject of brazing and heat treatment (every second month).																								
<b>IV. CONSULTANT ON PRODUCTION TECHNOLOGY - P.A. ZALENSKI</b> 1. Appraisal of the state of technology of local bicycle industry.																								



# Specification

Specification	1985						1986						1987											
	V - IX		X - XII		I - III		IV - VI		VII - IX		X - XII		I - III		IV - VI									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2. Selection of units of the small scale industry for close cooperation and selection of parts to be worked on.						┌───┐																		
3. Consultation in working out recommendations as to changes in processing procedures for the selected parts, with indication of machines, tools and gauges.						┌───┐															┌───┐			
4. Study and consultation on mechanization of handworks.																					┌───┐			
5. Day-to-day consultancy on production technology.						┌───┐															┌───┐			
6. Participation in training courses on production technology (every second month)						┌───┐															┌───┐			
7. Setting of detailed tasks for the other consultants.						┌───┐																		

ANNEX No. 6

TECHNICAL LECTURES SEMINARS

1. A seminar on gas brazing was organized for the industry with the help of M/s ELGA of West Germany on 9 July 85. The representatives of the industry were shown technical film and slides on the gas brazing process. The process itself and its advantages were also explained. 10 representatives of the industry plus 15 staff members attended the seminar.

2. A technical lecture on the application of electronics in special purpose machines, tools and measuring instruments incorporating:

- Digital read out systems.
- Programmable D.R.O.
- CNC systems.
- Digital measuring instruments,

was organized on 16 July 85 with the help of M/s Kirloskar Electric Co. Ltd., Bangalore. Participants were shown technical films and demonstration elucidating the operation and various advantages of the systems. 72 persons representing the local bicycle and sewing machine industries as well as the Centre attended the programme.

3. Workshop on Upgrading of Production Technology by Application of Special Purpose Machines in Bicycle Industry  
The workshop was conducted on 21 - 22 March 86. Following papers were presented by the officials of the Centre:

- Pneumatically Controlled Bicycle Frame Assembly Fixtures.
- Application of Multiplunger Press for Manufacture of Bicycle Parts like Chainwheel, Hub Flanges etc.

- Automatic Tube Cutting Machine with Grinding and Polishing Attachments.
- Automatic Machine for Spoke and Valve Holes Punching in Bicycle Rims.
- Automatic rim and Mudguard Polishing Machine.

Participants were explained the advantages of these machines, their cost, operation and production capacities etc. The workshop was well attended by the representatives of local industry.

#### 4. Workshop on Promotion and Application of Cold Forging/Forming Technology in Bicycle Industry

The workshop was conducted on 24 - 25 March 86. Following papers were presented by the officials of the Centre:

- Principles of Cold Forging and Stamping. Advantages, Application Range and Limitations of Cold Forging and Stamping Technology.
- Application of Cold Forging Technology for Selected Bicycle Parts.
- Requirement of Raw Materials for Cold Forging and Stamping.
- Application of Stamping Technology to Selected Bicycle Parts.
- Typical Tooling and Special Devices for Cold Forging and Stamping.

The participants were instructed on principles and advantages of cold forging and stamping, the process and material savings in manufacturing bicycle components etc. The workshop was well attended by representatives of the industry.

5. A Seminar on application of lightweight materials in bicycle design for export promotion was conducted on 24 May 86. The following lectures were held:

- Various types of lightweight materials used in the world for different bicycle components and their advantages over conventional raw materials.
- Chemical composition, physical mechanical properties of the lightweight material used in the world.

6. A symposium-cum-workshop on MIG and MAG welding was organized in collaboration with M/s Peico Electronics Electricals Ltd., Welding Div. (M/s Philips) on 30 July 86. The application of MIG and MAG welding in bicycle industry was explained to the participants. Advantages of this welding technique alongwith the operation of the machines were also elucidated with the help of slides. The workshop was organized under the technology upgrading programme.

7. A seminar on upgrading technology through testing, standardization and IS certification was organized on 21 March 87, with cooperation of Bureau of Indian Standards. The participants were explained the procedures and benefits of obtaining the IS certification. The seminar was organized with an aim to motivate the small scale industrial units to upgrade quality in order to obtain Indian Standard mark. The seminar was attended by 50 representatives of industrial units.

8. A seminar of application of electrostatic powder coating (painting) was organized for bicycle manufacturers on 8 April 87. The participants were explained the process itself, and its numerous advantages over the conventional painting methods. The lecture was delivered by Dr. Sampooan Singh, Director, Wolfson Electrostatic Advisory Unit of Southampton

University, U.K. The seminar was attended by 57 representatives of the industry and staff of the Centre.

9. A workshop on upgrading production technology by application of new processing techniques was organized on 2 June 87, for the bicycle manufacturers and the Centre staff. Following lectures were held:

- Utilization of Special Purpose Machines in Bicycle Industry.
- Tasks Ahead - Recommendations for Future Works Related to Production Technology.

10. A workshop on upgrading technology for export promotion was organized on 23 June 87 for the bicycle manufacturers and the Centre staff. Following lectures were conducted:

- Tasks Ahead - Recommendations for Future Works Related to Design and Testing,
- Application of Micro-photography.