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RESTRICTED

DP/ID/
1986
English

15612

Appropriate Automation Promotion Programme
DP/IND/82/034
and
Microprocessor Application Engineering Programme
DP/IND/84/030

Technical Report

Prepared for the Government of India
by the United Nations Industrial Development
Organization, acting as executing agency for
the United Nations Development Programme

United Nations Industrial Development Organization
Viena

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1. Summary

In order to meet the objectives of the mission as defined in 2.1 to 2.3 here, the expert has

1. visited the AAPP-Project Centre in New Delhi
2. informed himself about the running Project activities within the Centre as well as within the others Project Centres
3. discussed the objectives of the new (national) Project INCOS and made himself acquaint with the state-of-the art and future actions within the project
4. delivered a series of lectures on model building and simulation of industrial processes for the people from the steel plants(s. Appendix A.1)

In order to meet the objectives of the mission as defined in 2.4 here, the expert has

1. visited the MAEP-Project Centre in New Delhi and Jabalpur
2. informed himself about the running Project activities
3. discussed the state-of-the art in procurement of equipment within the Project
4. compiled a survey list in this area in which the instruments already procured as well as ones to be procured are included as agreed with the Project Co-ordinator
5. delivered a lecture in the area of Local Area Networks for process data transmission

2. Objectives of the Mission

As per Job Description and according to the telegraphic instruction of UNIDO, the objectives of the expert mission have been:

2.1 Objectives concerning the AAPP-Project

- upprising on the training needs of the steel industry
- suggestion of the suitable hardware and software for augumentation of modeling, simulation and training environment of the Process Control Laboratory
- guidance of the Centre to evolve models and simulation of steel plants

2.2 Objectives concerning the MAEP-Project

- preparation of equipment requisition for Project Centres

3. Activities of the Expert During his Misseon

Here, the activities relative to both Projects should be stated.

3.1 Activities Concerning AAPP

During his visit to the New Delhi Project Centre the expert has carried out the following activities:

- lecturing in model building and simulation of industrial plants (as given in Appendix A.1 here) for people from the iron and steel industry, the future staff of INCOS-Project
- helping the AAPP-Project Centre in planing and carrying out of training and other educational activities in New Delhi as well as in the Bhilai-Plant for successfull development of INCOS-Project
- reviewing of proposed equipment for process simulation and Control Laboratory in Bhilai and New Delhi
- reviewing the detailed plans for the future education and training of Project staff
- discussing the on going work within the Project Centres and the most important difficulties to be overcomed
- advising the personnel of the Centre in problems solving and in planing of future activities

3.2 Activities concerning MAEP

In order to meet the objectives of the mission, as defined in 2.2 here, the expert has visited the Project Centre in New Delhi and in Jabalpur and has carried out the following activities:

- he informed himself about the running Project activities within the Centres and
- upprised the current status in procurement of equipment within the Project,
- delivered the lecture in the area of Local Area Networks for Process Data Transmission within the Distributed Computer Control Systems.

Especially in the Jabalpur Centre the expert

- discussed the current Project activities in the area of microcomputer application in agriculture and
- worked out a plan of possible future trainings and study tours of Project staff

4. Findings of the Expert

4.1 Findings Concerning AAPP

During his stay in New Delhi the expert has noticed the following:

- educational and training activities in the area of process automation for the people from the industry have been carried out as planed last year during the experts visit of New Delhi Centre
- the same holds for the hardware and software design for a series of small industrial automation projects in the area of railways, cement, fertilizer and steel plants
- special attention has been given to the project activities in the area of steel plant automation.Here, the Project centre has
  - organized an extensive educational and training course for the people from the steel industry, out of which the future staff of the INCOS-Project should be selected.
    The course has the duration of 4 weeks and includes
    - Numerical Methods
    - Matrix Algebra
    - Linear Programming

- Advanced Control
- System Modeling and Simulation
- Computer Communication
- Local Area Networks
- NEC Computer System
- Higher Level Computer Languages
- Microprocessors
- Personal Computers
- PERT and Flow sheat Technique

- the Project Centre has planed an educational and training centre within the BHILAI-Plant for future qualification of INCOS-Project staff.The planed centre will - in experts opinion - have the character of a higher school of automation.Such a school is in fact necessary not only for the young engineers in the steel industry but also in other industrial branches, like in the chemical, petrrochemical, cement and shugar industry and should be installed there.
- also the establishmennt of an Automation Laboratory was planed by the Centre in order to improve the quality in training of engineers in the field of process automation.The instalation of such a Laboratory has already been recomended by the expert in his Technical Report on AAPP, 1984(Appendix A.1 to A.3) and 1985(Appendix A.1 and A.2).There also was recomended that UNIDO increases its input for procurement additional laboratory instrumentation.
- it was further decided by the Centre to incorporate the activities of the MAEP-Project Centre in Ranchi into the AAPP-activities in order to efficiently support the progress of the INCOS-Project.This is what also has been recommended by the expert in his last Technical Report on AAPP, 1985 as Recommendation 7.2.In this way the INCOS-Project will benefit from the work on hardware and software development for data acquisition, graphical data representation and control whithin the steel plants that is being carried out in the Centre in Ranchi.This work is even Bhilai-Plant oriented(automation of a wire road mill).

4.2 Findings concerning MAEP

The time spend in New Delhi was used to discuss with the Project Co-ordinator the activities of the Centres in Pune, Bangalore and Jabalpur, especially in the view of the necessary equipment to be procured.

As already pointed out in the Technical Report on MAEP, 1985 these Project Centres have had - in different degrees - some serious initial difficulties that have delayed the efficient start of the work on Project.In the mean time , some of the difficulties have been removed, especially in the Project Centre in Bangalore, but only partially in the Centres in Pune and Jabalpur.

As reported to the expert, the Project Centre in Jabalpur has two essential problems that have to be solved as soon as possible:

- a vehicle should be made available to the Centre for transport of relatively expensive UNIDO instruments to the field for measurements, and
- the Centre should be provided by a direct communication facility(e.g. by a telephon) in order to be able to communicate with the Project Co-ordinator in New Delhi as well as with other institutions.

Beside this, the Centre in Jabalpur has some serious staff recruitment difficulties:as being situated within the Faculty of Agriculture in the central area of the country with relatively poor electronic industry in the vicinity, the Centre has difficulties to find the suitable engineers as Project Assistents etc.At the moment, a new trial was made to recruit the necessary staff as planed within the Project.

However, disregard the problems stated above, the Centre has many excellent senior scientists in the area of agricultural instrumentation and the agricultural engineering. The planed Project activities, as discussed during the visit in Jabalpur, seem to be of essential importancy for the Indian agriculture, two of which should particularly be mentioned here:

- supervision of humidity state of fields and prediction of optimum irigation time
- determination the most suitable grain species for a given soil by field data acquisition and analysis

4.3 Procurement of Equipment

As regard the situation in the field of procurement of equipment for MAEP Project Centres, the following is to be stated:

4.3.1 Project Centre in New Delhi

- already procured	US$ 20, 000.-
- Function Generator	
- Osciloscopes	
to be procured until end of June '86	130, 000.-
- HP-2250A Measurement and Control Unit and accessories	

4.3.2 Project Centre in Bangalore

- already procured	-
- to be procured until end of June'86	120, 000.-
- Microcomputer Development System and Accessories	

4.3.3 Project Centre in Pune

- already procured	130, 000.-
- Microprocessor Development System	
- Logic Analyser	

4.3.4 Project Centre in Jabalpur

- already Procured	34, 000.-
- Digital Moisture Meter	
- Infrared Thermometer	
- Portable Photosynthesis System	
- order placed to UNIDO	
- Infrared Analyser	40, 000.-
- Infrared Sensor	2, 000.-
- to be procured in September '86	
- Test Measuring Instruments	
- different Accessories	

4.3.5 Project Centre in Ranchi

- order placed to UNIDO	133, 000.-
- Microprocessor Development System and Accessories	
- Single Board Computer with Interface Modules	
- ISBC Units	
to be ordered in September '86	
- some additional Video Equipment	

4.3.6 Summary of Procurement

- already procured	US$ 359, 000.-
- to be procured in June '86	250, 000.-
- left for September '86	100, 000.-
- total	US$ 709, 000.-

5. Summary of Findings

5.1 Findings Concerning the AAPP

1. The activities within the Project Centres in New Delhi, Trivandrum and Ahmedabad are progressing as planed.
2. Recent Project activities in New Delhi are extensively INCOS-oriented.
3. Working programme of the MAEP-Project in Ranchi has been formulated to meet the needs of INCOS-Project.
4. Beside the INCOS-oriented activities, the Project Centre in New Delhi is also involved in other projects of different industrial branches (cement, fertilizer, etc).
5. The general trend towards the model building and systems simulation is obvious.The activities in this area will even encrease in the future.
6. The planed educational and training programme in automation engineering as well as instalation of the planed Automation Laboratory for people from the steel industry is a trend which will continue and will be increased in the future.
7. The Project Centre in New Delhi has thus far not used the full possibilities for training the Project personnel abroad as planed within the Project.
8. The trend is noticable to use the Motorola 68 000 computers for solving the automation problems within the Project.

5.2 Findings Concerning the MAEP

1. The initial difficulties within the individual Project Centres have been partially, but not completely removed.
2. The possibilities for training the Project staff abroad have poorely been used, with the exception of the Project Centre in Ranchi.
3. Procurement of equipment lags behind the planned one.This concerns especially the Centres in Delhi and Bangalore.
4. Special attention should still be given to the Project Centre in Jabalpur concerning the development and training programme.
5. Also here, e.g. within the MAEP-Project the trend is obvious towards the more frequent use of Motorola 68 000 Computer as a suitable microcomputer for solving the automation problems.
6. Less activity has been noticed within the Project in the sense of model building and systems simulation.

6. Summary of Recommendations

6.1 Recommendations Concerning the AAPP

1. The efforts in model building and simulation of industrial plants in different industrial areas should be promoted in the future.This was also recommended by the expert in his last Technical Report and has been followed by Project Centres.Here, the cement, fertilizer and chemical industry should be included, as well as power plant engineering.
2. Project Centre in New Delhi, Ranchi and Trivandrum should continue their activities concerning the automation in the steel industry and should closer co-operate in this area, as already recommended by the expert in his last Report.
3. The National Project Co-ordinator should apply for additional UNIDO-inputs for supplementary personnel and instrumentation resources for carrying out the Project activities in the area of steel plant automation and in connection with the INCOS-Project.
4. After stabilizing the additional activities in this area, the Project Centre in New Delhi should try to organize similar activities for other potential industries like the cement, fertilizer and chemical industry.Here, the Centre should also try to initiate big national automation projects like in the steel industry.
5. The special course in automation engineering, and particularly the course part concerning the model building and system simulation as held in New Delhi for the INCOS-staff should also be organized for the people from other industrial branches, especially after the planed Automation Laboratory has been installed in New Delhi.
6. The training possibilities for the Project staff should be used.However, the staff should not be send to the computer vendors for training abroad.
7. The trend to apply the Motorola 68 000 System more freqently in the future should be followed as intensive as possible. This is the general, world-wide trend in this area.

6.2 Recommendations Concerning the MAEP

1. Special attention should be given by the Project Co-ordinator to the Centres in Pune and Jabalpur due to the initial difficulties.
2. The Project Centre in Jabalpur should be provided by the necessary transport and communication facilities as stated in 4.2 here.
3. The Project activities within the Jabalpur-Centre as planed there should be fully supported as being important for Indian agriculture.
4. The Centre in Jabalpur should be supported in establishing the technical connections to similar development centres abroad.
4. The Project staff should be sent abroad for training as soon as possible.This concerns nearly all Project Centres.
5. Also the Project Co-ordinators should plan and realise their study tours as soon as possible.
6. More model building and system simulation activities should be organized within the Project for Project staff.The Project can here profit from the AAPP.
7. The procurement of equipment should be finalized within the Project Centres.
8. The 2 terms should be respected as agreed upon during the stay of the expert in New Delhi:
   - untill the end of June the equipment should be ordered for not less than US$ 250,000.-
   - untill the end of September 1986 additional equipment should be ordered for not less than US$ 100,000.-

APPENDIX A.1 Content of the Course on Model Building and Simulation of Industrial Plants

1. Introduction and Explanation of Terms
   - What is a mathematical model of a plant
   - Why do we need the model building
   - How the mathematical model is integrated into the modern computer-based plant control system
   - what are the prerequisites for successful model building of a plant
     - engineering knowledge
     - plant instrumentation
     - plant measurement data
     - system identification and parameter estimation methods
   - Systems Classification:linear, non-linear, lumped and distributed parameter, continuous, sampled, deterministic, stochastic
   - Model classification:physical, mathematical, static, dynamic, linearized, adaptive, reference, predictive
   - Classification of Parameter Estimation Methods
2. Model Building Approaches
   - Theoretical Systems Analysis:balance-equations for flow, energy, momentum;transport equations for mass, and heat transfer;heat exchanging processes (convection, conduction, radiation);dynamics of exothermic and endothermic reactions
   - modeling of a chemical reactor·reactor geometry(tubular, stirred-tank and mixing reactor), boundary conditions, initial values; input, output, internal and control variables;reactor parameters
3. Systems Identification Procedures
   - Design of identification experiments:building of (input, output, generalized) error equation, choise of input signal, selection of optimal sampling rate, determination of shortest length of the identification time, choise of adequate performance index, measurement noise suppression, selection of the best parameter estimation method
   - Model verification, validitation and improvement

4. Parameter Estimation Methods

   - Least-Squares Methods:problem formulation, derivation of sampled parametric model, error equation, penalty function, minimization method in parameter space, derivation of recursive version of LSM-Algorithms, improved LSM-Variants
   - Software implementation problems:modularization, user interaction interface, program initialization, documentation of estimation results.

5. Advanced Process Control Techniques

   - Static and dynamic optimal control, set-point and mo--based predictive control, direct digital control, adaptive and self-tuning control, state-feedback and feed-forward control, multilevel hierarchical control
   - Some exampels:optimal winding of strip, optimal reheating of slabs

6. Model-Based Automation of Steel Plants:State-of-the Art and Future Trends

   - Automation objectives, means, tools and methods
   - Automation systems:system structures (dedicated, decentralized, centralized, distributed, hierarchical)
   - Approaches:Partial, total and integrated automation
   - Automation of: process, plant, factory, enterprise
   - Economic and social aspects
   - Future trends:hardware, software, methods

7. Case Study 1:Modeling and Optimal Control of Basic Oxygen Steel Furnace

   - Process dynamics, endpoint carbon-temperature relation, on-line carbon estimation, calculation of optimal control temperature, some implementation problems, economic benefits

8. Case Study 2:Modeling and Rolling of Slabs

   - description of rolling process, modeling of hot strip rolling, direct measurement and model-based reconstruction of process variables, control objectives, optimal and adaptive control strategies, some practical results

9. Modeling and Optimal Control of Soaking Pit

   - Basic relations, optimal firing strategy, optimal ingot scheduling