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17384

DP/ID/SER.A/1176
28 March 1989
ORIGINAL: ENGLISH

MICROPROCESSOR APPLICATION ENGINEERING PROGRAMME

DP/IND/84/030

INDIA

Technical report: Review of hardware and software projects at various centres. Impart training to centres and industries on design methodology*

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

Based on the work of Eric J. Wightman, expert in microprocessor hardware and software development

Backstopping officer: V. Smirnov, Engineering Industries Branch

United Nations Industrial Development Organization
Vienna

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* This document has not been edited.

Review of Hardware and Software Projects at various Centres. Impart training to Centres and Industries on Design Methodology.

ABSTRACT

This report describes follow up actions recommended in Technical Report DP/IND/84/030/11-05/31.9.E-March 1988 for the introduction of microprocessors to improve productivity at the Integral Coach Factory, Madras. In addition, following a review of the proposals with the Indian Railway Board on December 17 1988, it was requested that consideration should also be given to engine manufacture.

The programme of work covered seven major areas of activity, from component manufacture to assembly. The activities described in this report were discussed and agreed with the appropriate Directors of the Indian Railway Board and included the following:

- Review of manufacturing facilities since last mission in December 1988.
- Assessment of resources required to implement proposals for productivity improvement in three specific areas.
- Formulation of Specifications of Requirements
- Proposals for development programme

Recommendations are included for follow up actions, highlighting known constraints which may require particular attention by M.A.E.P.

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ABSTRACT

LIST OF APPENDICES

1. INTRODUCTION

The objectives of the mission as detailed in Job Description DP/IND/84/030/11-05/J13315 included the following tasks for the Expert:

1.1 Investigate currently available tool identification, management and storage systems (in U.K.)

1.2 Provide recommendations for establishing tool management and storage system at the Integral Coach Factory in Madras.

1.3 Assist in compiling design specifications for the following projects:

- Machine tool status and condition monitoring system
- Automation of manual machines
- Automation of tool management and storage system
- Digital read-out for manual machines
- Automatic check out equipment for bogie testing
- Component gauging

1.4 Assist in establishing a service centre for cnc electronic equipment.

1.5 The Expert was also expected to prepare a final report, setting out the findings of the mission and recommendations to the Government on future actions which might be taken.

1.6 The programme of work was carried out during the period 9th January to 16 March 1989, as detailed in Appendix I "Itinery", including one day briefing in Vienna on 17 January, one day debriefing in Vienna on 15 March and associated travel time to New Delhi. In addition one week preparatory work was carried out in U.K. before departure.

1.7 This report describes the main activities carried out at the request of the chief project co-ordinator, visits to ICF Madras,Diesel Locomotive Works, Varanasi and M.A.E.P. Centre Lucknow, together with presentation seminars on the proposed development programme and various follow up actions arising from previous missions.The author was based in the Delhi M.A.E.P Centre for the initial period of this particular mission. Conclusions relating to these activities are listed at the end of the report.

2. RECOMMENDATIONS

These recommendations relate primarily to projects requested by the Indian Railway Board, with additional projects identified during this mission.

2.1 Effort is now required to locate suitable indigenous suppliers of electronic equipment for partially automating manual machine tools, to implement the development programme drawn up for projects requested by the Indian Railway Board. Emphasis will be required on project management to co-ordinate the work of M.A.E.P., ICF Madras and RDSO Lucknow.

2.2 It is proposed that consideration is given to a project for the application of electronic component gauging for machined components at the Diesel Engine Works, Varanasi.

2.3 It is recommended that as part of a longer term strategy for development of improved suspension systems for rail coaches using microprocessor based active elements, consideration be given to an M.A.E.P./UNDP project, for which UNIDO "Preparatory Assistance" is proposed as a first step.

2.4 Experience of poor service back-up from suppliers of cnc machine tools at ICF Madras, coupled with premature breakdowns on newly delivered machines during the last twelve months, enforces the recommendations made in Technical Report of 8th April 1988, for indigenous service facilities to be set up at ICF Madras, with capability for repairs down to component level. It was recommended that this facility should be developed in colaboration with M.A.E.P./UNDP as a priority, to enable specialist international assistance to be sought. This cnc service centre was seen to be a pre-requisite to the introduction of further microprocessor based equipments in manufacturing and the need is now even greater.

2.5 It is recommended that a UNIDO expert visits RDSO Lucknow/ICF Madras at three monthly intervals for a period of one month at a time, to provide continued technical and project management support for the three M.A.E.P./ICF projects now being actioned at the request of the Indian Railway Board.

3. ACTIVITIES OF THE EXPERT DURING HIS MISSION.

Following a briefing from the Chief Project co-ordinator Dr.Krishna Kant a number of activities were planned in order to implement the required objectives of the mission. A change of emphasis requested by the Indian Railway board was communicated by letter dated 24-1-89 and received by the author on 7th February. This is included (Appendix IA) in Appendix I "Itinery" and short lists three projects as a priority, namely, digital readout system, partial automation of manual machines and bogie test rig, for ICF Madras. The three activities comprising the mission were therefore:

- Prepare notes on "state of the art" tool management systems.
- Visits to M.A.E.P. Centre Lucknow, Varanasi and ICF Madras.
- Formulation of development programmes.

In addition, various miscellaneous activities in the application of advanced manufacturing technology for small and medium scale industry were carried out at the request of Mr.G.S.Varadan, Chief Project Co-ordinator, AAPPP.

The author also attended a "tri-partite project progress review" at UNDP on Monday 13th March, reported elsewhere.

3.1 Tool Management Systems

Preparatory work prior to the mission included discussions with two major suppliers of tool management systems in U.K., Sandvik Coromant and ISIS Informatics Limited. Tool management systems are largely dependent on software which is designed to support the kitting of all tools, fixtures , part programmes, gauges etc., ready for use as a complete prepared kit for each job. The location of each tool part is tracked in real time by recording every physical transaction:

- Issue to and return from particular machines
- Build and strip tool assemblies
- Build and breakdown kits
- Re-service tools
- Recalibrate gauges

Facilities offered by the two vendors were comparable but whereas the Sandvik system was designed to run exclusively on IBM System 36 mini-computer, the ISIS system was offered on a choice of Xenix5 (DRS300) or in limited form on MSDOS. Thus the ISIS system could be networked into other computer based production management systems with DOS via SCO Xenix-net, IBM via SCO unipath SNA-3270, in particular ICL DRS300 windowing access to

the OMAC system, of particular relevance to the existing ICL installation at Madras. A summary of the main features of tool management software is included in Appendix II "Notes on Tool Management Software", detailed specifications being presented to ICF management during a visit by the author during 15th to 24th February.

3.2 Visits to M.A.E.P. centre at R.D.S.O. Lucknow

The visits to Lucknow encompassed two activities:

- Review of on-going M.A.E.P. projects and participation in Technical Policy Advisory Committee (T.P.A.C.)

- Explore possibilities of implementing proposals for improving quality and productivity of rail coach manufacture, based on ICF Madras, proposals.

3.2.1 Technical Policy Advisory Committee.

Since inception the M.A.E.P. Centre (MAEC) has now reached the stage where a working infrastructure exists, training programmes have been undertaken and a number of significant projects implemented, some to a creditable stage of completion. A detailed report of progress to 31-12-88 is included in Appendix III for completeness. Two major issues were raised, to be the subject of follow up action by the Chief Project Co-ordinator, Dr. Krishna Kant, who was regretfully unable to attend the meeting because of a family bereavement:

(i) Poor availability of transducers/sensors. This is explained in Section 9 of Appendix III and further reported ad nauseam by the author following previous missions. A central M.A.E.P. facility is proposed.

(ii) Lack of autonomy in decision making. Although projects are funded by M.A.E.P., local administration procedures are required to follow custom and practice for the site. These are not necessarily compatible with the pace of microelectronic technological development and a review is recommended. This problem is also discussed in Section 9 of Appendix III.

3.2.2 Proposals for Quality & Productivity Improvement in Rail Coach Manufacture.

The author discussed the seven projects arising from the study carried out at ICF Madras with the following executives of RDSO:

- Mr. D.N.Singh - Director General RDSO
- Dr. Anantha Narayana - Director General(Research)
- Dr. K.Raghunathan - Director(Research)
- Mr. P.N.Garg - Director(Testing)
- Dr. A.Chakrabarti - Director(Engine Development)
- Dr. Somendra Nath Chakravarty - Addl. Director(Metallurgy)

M&C Directorate

- Mr. Masihuzzaman - Director (Motive Power)
- Mr. G.N.Asthana, Depy.Dir for K.B.Wadhwa-Director(Carriage)

The discussions were arranged by Mr. Deshdeepak,Chief Project Co-ordinator MAEC and Mr. V.V.Singh, Deputy.(Ref.Appendix I).

Two projects emerged of particular relevance and interest to RDSO for implementation, namely coach bogie testing and component gauging fixtures, the former being the subject of priority consideration by the Indian Railway Board:

3.2.2(i) Coach Bogie Testing - Active Suspension System

A review of the requirements for coach bogie testing resulted in proposals for an active suspension system for rail coaches, of which the bogie testing facility would be a sub-system by-product.

As a result of preparatory work carried out in U K.by the author prior to this mission, described subsequently to RDSO, details of developments in microprocessor controlled suspension system simulation were obtained which confirmed the potential of the proposed bogie testing rig for ICF Madras (if proceeded with),to enable an active suspension system to be developed in which the conventional springs and dashpot dampers could be replaced by microprocessor controlled electro-hydraulic actuators. This would result in major potential improvements to the quality of ride, greater tolerance of track irregularities and potential for achieving higher average speeds of trains in service.

Arising from these discussions with executives of RDSO,the author was requested by Dr.Anantha Narayana, Director General (Research) to compile notes on these proposals for further consideration at RDSO on Wednesday 8th February, with the objective of formulating a major project for funding by UNIDO/UNDP. These notes are included in Appendix IV.

Subsequent to a meeting of ten executives of RDSO chaired by Dr. Ananthanarayana on 8th February, during which the author presented the above Proposals, it was agreed to formulate a submission to be forwarded to UNIDO via D.O.E.,for "Preparatory Assistance" in defining a suitable project. This was subsequently compiled and discussed with the author on Monday 13th February, prior to transmission to Delhi for action.

3.2.2(ii) Component Gauging

It was recommended by Mr. Masihuzzaman, Director(Motive Power) that the author should visit the Diesel Locomotive Works at Varanasi and this was subsequently arranged for 10th February and reported in "Notes on Visit" in Appendix V.

3.2 Visit to ICF Madras.

The visit was arranged to follow up the request of the Indian Railway Board to implement three specific projects:

- Digital Readout for manual machine tools.

- Partial Automation of machine tools.

- Bogie Testing.

Following the visit and meetings held with ICF management, a progress report was compiled setting out a plan of action, including outline specifications for selected machines. This report is included in Appendix VI and emphasises the role of project management to co-ordinate the role of M.A.E.P. with ICF and potential suppliers of equipment.

A visit was made to the Appropriate Automation Promotion Programme (AAPP) Centre at CEERI Madras Centre at the suggestion of Mr. Varadan, Additional Secretary (AAPP). before leaving Delhi for Madras. The Centre has capability for development of process instrumentation, including printed circuits and sensors. The scope of projects is to be extended to formally embark on a programme of indigenous sensor development. In the long term this should assist in resolving many of the problems experienced on M.A.E.P. projects to date and described extensively in previous reports.

One project of particular relevance to ICF was a data acquisition system developed for monitoring various stages of pulp handling for paper manufacture and displaying detailed data, on command, on a visual display screen. This system could be adapted for the machine tool monitoring system proposed for ICF machine shops. Facilities are available for climatic testing to simulate the working environment at ICF.

4. CONCLUSIONS

The following conclusions were drawn from the activities of this mission:-

4.1 Three projects requested by the Indian Railway Board for ICF Madras have been actioned in terms of compiling outline specifications and implementation plans.

4.2 Two new projects, namely an active suspension system for rail coaches and component gauging for diesel engine manufacture have beeen identified and preparatory work carried out to enable project approval to be considered.

4.3 The main problems of implementing any of the proposed projects are not so much technical as administrative - the large geographical distances in India separating the specialised indigenous technical resources in localities such as Pune, Bangalore and Bombay, cpable of being applied to each project, make fast response difficult. Thus strict adherance to project time scales is prejudiced from the outset.

4.4 Capability exists in AAPP centre at Madras for complementary resources for design and manufacture of electronic equipment, which if harnessed, could make a substantial contribution to the detailed implementation of ICF projects.

4.5 Experience of service problems with the introduction of computer numerical machine tools at both Patiala and ICF Madras, endorse the recommendations made in proposals dated February and included in Technical REport of 8th April 1988, for setting up a service centre for cnc electronic equipment. It was proposed that the centre should have indigenous capability for diagnosing faults and carrying out repairs down to component level. Experience to date, of non co-operation from suppliers to supply technical data and spares, enforces this need and M.A.E.P. specialist assistance would contribute greatly in this area. A formal invitation to provide this assistance is awaited from the Railway Board.

APPENDIX I

ITINERY - E.J.WIGHTMAN - 16 January to 16 March 1989

Date	Time	Activity
Mon 16 Jan	8.00a.m.	Depart U.K.for briefing.
	2.00p.m.	UNIDO Vienna.
Tue 17 Jan	10.00a.m.	Depart for India.
Wed 18 Jan	1.15a.m.	Arrive N.Delhi
	10.00a.m.	UNDP briefing
	10.30a.m.	MAEP Centre. Dr.Krishna Kant, Chief project Co-ordinator.
Thu 19 Jan	9.00a.m.	Prepare Lectures
Fri 20 Jan		
Mon 23 Jan	2.00p.m.	AAPP Mr.G.S.Varadan. Proposals for FMS Project.
Tue 24 Jan	9.00a.m.	MAEP Centre
Wed 25 Jan	9.00a.m.	MAEP Centre.Notes on Tool Management Software.
Thu 26 Jan		Republic Day National Holiday
Fri 27 Jan	9.00a.m.	M.A.E.P. Centre
Mon 30 Jan	6.45a.m.	Depart for Lucknow.
	2.00p.m.	Arrive Lucknow.
Tue 31 Jan	9.00a.m.	R.D.S.O.,M.A.E.P.Centre-Mr.V.V.Singh Deputy Co-ordinator M.A.E.P.
	10.00a.m.	Dr.K.Raghunathan,Director(Research) Mr.I.Hasan,Systems Analyst N.I.C.
	11.00a.m.	Mr.D.N.Singh,Director General R.D.S.O. Mr.Masihuzzaman,Director(Motive Power)
	12.00a.m.	Dr.A.Chakrabarti,Director(Engine Development Directorate).
	2.30p.m.	Mr.Masihuzzaman Mr.V.V.Singh.
	3.30p.m.	Mr.G.N.Asthana,Joint Director(Carriage) Mr.D.Rangarayan,ADE(Carriage) Mr.R.C.Bhalla,ADE(Carriage) Mr.Ramana Rao,CDA(Carriage)
Wed 1 Feb	10.00a.m.	Mr.Deshdeepak,Chief Project Co-ordinator M.A.E.P.
	10.30a.m.	Mr.P.N.Garg,Director(Testing)
	11.30a.m.	Dr.S.N.Chakravarty,Addl.Director Metallurgy,M&C Directorate
	2.30p.m.	M.A.E.P. Technical Advisory Committee
Thu 2 Feb	9.30a.m.	Mr.Deshdeepak M.A.E.P.
	10.30a.m.	Dr.Anantha Narayana,Director General Research,R.D.S.O. Mr.L.A.Gokhale,Director(Track) Dr.K.Raghunathan,Director(Research) Mr.Deshdeepak M.A.E.P.
	11.30a.m.	Mr.G.N.Asthana(for Mr.K.B.L.Wadhwa, Director,Carriage).
	3.00p.m.	Depart for Delhi
	9.15p.m.	Arrive hotel Delhi.
Fri 3 Feb	9.00a.m.	UNDP

	9.40a.m.	M.A.E.P Centre.Compile visit report.
Mon 6 Feb	9.00a.m.	M.A.E.P.Centre,Dr.Krishna Kant,Chief Project Co-ordinator.Review Lucknow visit
Tue 7 Feb	9.00a.m.	M.A.E.P.Centre.Compile proposals for new coach suspension project.
	9.30p.m	Depart for Lucknow.
Wed 8 Feb	7.30a.m.	Arrive Lucknow
	9.00a.m.	M.A.E.P. Centre
	10.00a.m.	Dr. Ananthanarayana + Executives (Meeting to review Proposals)
	12.00a.m.	Mr. V.P. Ojha, Director (Computing)
	2.30p.m.	Mr. A.B. Chatteri,Deputy Director (Fatigue Laboratory)
Thu 9 Feb	9.30a.m.	Mr. K.B.L.Wadhwa, Director Standards (Carriage)
	10.30a.m.	Dr. Ananthanarayana Dr. K. Raghunathan Mr. K.B.L.Wadhwa Mr. C.N. Sastry,Director Standards (Wagon)& UNDP regional liason officer
	10.00p.m.	Depart for Varanasi
Fri 10 Feb	6.45a.m.	Arrive Varanasi
	9.30a.m.	Mr. R.C. Sethi, General Manager
	11.00a.m.	Mr. Dass, Superintendant(Production) Tour of Works.
Sun 12 Feb	10.00a.m.	Depart for Lucknow
	5.00p.m.	Arrive Lucknow
Mon 13 Feb	9.00a.m.	M.A.E.C. Compile report.
	2.00p.m.	Mr. Pratap Srivastava, Joint Director (Motive Power).Review of Varanasi visit.
	3.30p.m.	Dr. Ananthanarayana Dr.K. Raghunathan Mr.L.A. Gokhale Mr.K.B.L. Wadhwa Meeting to review application for UNIDO "Preparatory Assistance"
	10.00p.m.	Depart for Delhi
Tue 14 Feb	7.40a.m.	Arrive Delhi
	9.15a.m.	UNDP
	10.30a.m.	M.A.E.P. Centre. Review visits to Lucknow and Varanasi with Dr.Krishna Kant, Chief Project Co-ordinator.
Wed 15 Feb	4.30a.m.	Depart for Madras.
	10.10a.m.	Arrive Madras
	3.00p.m.	ICF Mr.Mallya,Production Planning(Shell)
	3.30p.m.	Mr.B.Rangarajan CME
	4.00p.m.	Mr. R.Subramanian D/CME
Thu 16 Feb	9.00a.m.	Mr. N.L.Madhusudan D/CME (Maintainence) Mr. Mallya
	2.30p.m.	Mr. B.Rangarajan Mr. R.Chandrasekharan D/CEE (Projects) Mr. S.Sankaralingam D/CEE (Design) Mr. N.L.Madhusudan Mr. Mallya,to discuss project strategy.
	4.30p.m.	Technical Library

Fri 17 Feb	9.30a.m.	Mr. Madhusudan Mr. Mallya Mr. Chandrasekharan Mr. Sankaralingam Tour of laboratories
	11.00a.m.	Mr. Madhusudan Mr. Mallya. Preparation of project proposals.
	3.00p.m.	Compile requirements for service centre
Mon 20 Feb	9.30a.m.	Mr. Madhusudan Mr. Mallya Review proposals for service centre.
Tue 21 Feb	9.30a.m.	Prepare progress report for subject three projects.
Wed 22 Feb	10.00a.m.	Dr. P.E.Saankaranarayanan,Project Co-ordinator AAPP Centre, Madras. Mr. Madhusudan, Mr. Mallya.
	2.30p.m.	ICF. Compile final report.
Thu 23 Feb	9.30a.m.	ICF.
	11.00a.m.	Mr. B.Rangarajan CME. Mr. Madhusudan Mr. Mallya Progress review.
	4.00p.m.	Mr. Satish Bahl, General Manager Mr. B.Rangarajan. Review of projects and approval of final report for submission to Railway Board.
Fri 24 Feb	4.00a.m.	Depart hotel for Delhi.
	10.00a.m.	Arrive Delhi.
	11.30a.m.	UNDP
	2.00p.m.	M.A.E.P. Centre. Compile visit report.
Mon 27 Feb	9.00a.m.	M.A.E.P. Centre. Dr. Krishna Kant. Review of Railway Projects at Lucknow and ICF Madras.
Tue 28 Feb	9.00a.m.	UNDP
to	9.45a.m.	M.A.E.P. Centre.
Thu 2 Mar(inc)	9.00a.m.	Draft technical report
Fri 3 Mar	9.00a.m.	M.A.E.P. Centre.
	2.oop.m.	Dr. Krishna Kant, project review.
Mon 6 Mar	9.00a.m.	M.A.E.P.Centre.
to		
Wed 8 Mar(inc)	9.00a.m.	M.A.E.P.Centre.
	3.00p.m.	Mr. Varadan.Factory Automation.
Thu 9 Mar	9.00a.m.	M.A.E.P.Centre.
Fri 10 Mar(inc)	9.00a.m.	M.A.E.P.Centre.Review technical report.
Mon 13 Mar	9.00a.m.	M.A.E.P.Centre.
	11.00a.m.	UNDP.Tri-partite Project Progress Review.(UNDP,UNIDO,D.O.E.)
Tue 14 Mar	12.00a.m.	Depart hotel for airport
	2.55a.m.	Leave Delhi for Vienna
	11.00a.m.	Arrive Vienna.
Wed 15 Mar	9.00a.m.	UNIDO de-briefing.
Thu 16 Mar	12.30p.m.	Depart for U.K.

APPENDIX IA

भारत सरकार GOVERNMENT OF INDIA
रेल मंत्रालय MINISTRY OF RAILWAYS
(रेलवे बोर्ड Railway Board)

No. 89/M(W)/964/14 रेल भवन, नई दिल्ली-110001, दिनांक 19
Rail Bhavan, New Delhi-110001, dated 24-1-89

Dr. Krishan Kant,
Chief Coordinator(MAEP),
Government of India,
Department of Electronics - CCI Wing,
National Informatics Centre,
'A' Block, CGC Complex,
Lodi Road, New Delhi - 110003.

Sub:- Micro-processor application in ICF/Madras.

Ref:- Your letter No. DOE/CCI/MAEP/KK/88 dt. 3.12.1988 addressed to PS to Member Mechanical/Railway Board.

The report enclosed with Secretary, DOE's letter No.Secy(E)/88/1441 dt. 29.3.1988 to Member Mechanical, Railway Board, has been studied with considerable interest. Following further discussions held with you and Mr. Wightman in December '88, it hasbeen decided to undertake pilot projects in the following three areas in ICF/Madras:-

1. Automation of 3 to 4 manual machines at ICF.
2. Digital read-outs on 5 to 6 machines in ICF.
3. Automatic check out equipment for bogie testing at ICF.

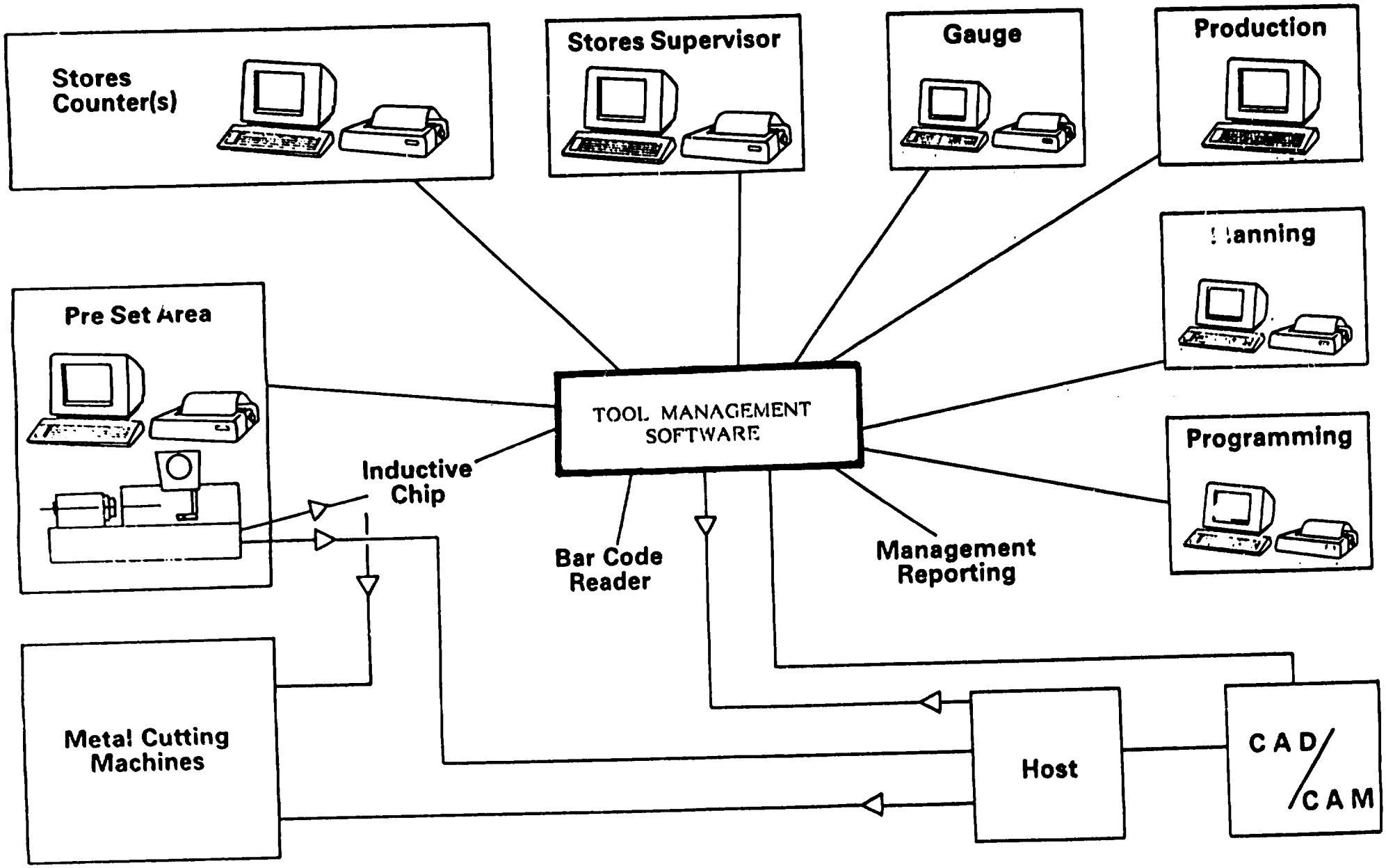
A decision on other projectsidentified in the report mentioned above would be taken at a later date after the results of the pilot projects in the above areas are evaluated. It is our understanding that Railways will not be required to bear any financial burden or enter into future commitments, for the execution of these pilot projects.

You may now contact CME/ICF/Southern Railway who is being suitably advised. This office may be kept apprised of the anticipated time frame for completion of the projects and the progress from month-to-month.

(V.S. BHATNAGAR)
Executive Director Mech. Engg.(W),
Railway Board.

APPENDIX II

NOTES ON TOOL MANAGEMENT SOFTWARE


Stores Counter(s)
Stores Supervisor
Gauge
Production
Planning
Pre Set Area
TOOL MANAGEMENT SOFTWARE
Inductive Chip
Bar Code Reader
Management Reporting
Programming
Metal Cutting Machines
Host
CAD/CAM

TOOLWARE SYSTEM SPECIFICATIONS

BASIC REPORTING FUNCTIONS

TOOL STATUS - reports summary information and all known locations both in the crib and on the shop floor, by tracking categaries of the specified tool.

JOB STATUS - reports tools currently charged to a specified Job Number by tracking categaries.

USER STATUS - reports all tools currently charged to a specified employee by tracking categaries.

MACHINE STATUS - reports all tools currently charged to a specified machine by tracking inputs.

STOCK MAP (LOCATION STATUS)- reports for a primary (new) location all tools currently assigned to that location. Summary report prints all primary (new) and tools assigned to the location.

TOOL LIST - reports by tool number its assigned location.

RECORDER REPORT - lists all tools that have met or are below, their set minimum inventory quantity.

OUTDATED REPORT - reports all tools that have had no activity or use since a specified date and the last date of their use.

OVERSTOCKED REPORT - reports all tools that are currently over the specified maximum inventory quantity.

ON ORDER REPORT - reports all tool numbers that have been placed on order by the TOOL ORDER command.

SCRAPPED TOOL REPORT - reports all tools that have been scrapped by the tracking categaries and date scrapped.

REWORK INVENTORY - reports all tools currently in the rework departments.

REWORK HISTORY - reports all tools by tracking categaries and date that tools have been in the rework departments.

AUXILIARY TOOL REPORT - allows a list of tools to be printed by their auxiliary ID or by their ID and any combination of the two dimension classifiers.

ACTIVE INVENTORY REPORT - prints all tools currently checked out of their crib location by date and tracking categaries. (open transaction).

ITEM ACTIVITY REPORT - prints out by tool number the YTD,MTD and LM activity for each tool.

TOTAL INVENTORY REPORT - prints total inventory summary for all tool items.

KIT AVAILABILITY REPORT - prints the status of tools required for a specified KIT and any shortage of tools.

WHERE USED REPORT - for a specified tool or kit this report lists all kits which use this tool or kit.

DAILY TRANSACTIONS

DAILY TRANSACTION REPORT FILE

Purpose: To provide a list of all transactions that have been made in the Toolware system. This file is constructed in a format that lists all Adds, Deletions, withdraws, Returns, Scraps, Reworks, or any option package transactions that effect the inventory status of tools, gauges, fixtures and other items defined.

Daily Transaction Report File Features

1) Daily Audit Trail - The Daily Transaction Report File can be printed on request. The report will indicate the type of transactions, where, who, when, how many and any other information that is pertinent to the transaction.

2) Command is executed from the supervisors menu as DX. Allows the supervisor to display the contents of the file on the screen, print the file on the system report printer, or purge the contents of the file prior to a specified date.

The information detail under daily transaction is formatted ASCII so that the information may be dumped into other systems or software where data (or some of it) also resides. This allows use with MRP, Costing or Purchasing functions.

In addition to the visible output from the Daily Transaction File, the cost information is also held. Simple manipulation of Daily Transaction using standard UNIX scripts can generate much useful management reporting in a manner tailored for each user. These reports can be customer built. A typical report could give information such as (for a given period) most scrapped, most used, highest value of scrap, most re-worked, etc. Downloading the information to other data bases managers such as D Base II or Informix will further enhance the ability to manipulate the information.

TOOLWARE OPTIONS

RESERVE/TRANSFER

Purpose: To reserve tools in advance of use in order to ensure availability. To transfer tools and kits from pre-set to the shop floor. To transfer tools on the shop floor directly to other areas onthe shop floor. This option works in conjunction with all Toolware functions. Specific functions are:

1) Reserve Tool(s) - Tools, Kits, etc., can be reserved in advance of need by assignment to a specific machine, job and/or user. Reserved tools cannot be issued to another rquester unless reassigned by a supervisor.

2) Transfer to - allows the direct transfer of tools and kits between machines, jobs, or users, without returning to the tool crib. This feature can also allow the transfer of tools or kits from a present area or rework department directly to the shop floor.

3) Reserved Tools Report - Prints all tools on reserve status, quantity reserved, quantity used to-date, machine, job, user and date reserved. Report can be viewed on the screen or printed. Report can be sorted by tool number, date reserved, machine, job, user or any combination.

REFERENCE FILES OPTION

This option allows Toolware users to maintain a list of machine locations, job number descriptions, vendor addresses, user names, and other detailed information regarding machines, jobs, users, kits tools etc. The purpose of this option is:

1) To provide a refernce of the machine number to its description and location.

2) To provide a refernce between the vendor number and the vendor company name and address. The option also allows a re-order report to be generated and sorted by vendor (using the VR Vendor Recorder Report function).

3) To provide a user file which can display information regarding the user.

4) To provide reference of the job number to its name and description.

5) To provide a Refernce Data file for information or additional instructions when insufficient space exists with standard Toolware screens.

GAUGE FIXTURE CONTROL

Purpose: To provide inventory and control information about gauges, fixtures and inspection tools (items). This option works in conjunction with the standard software, but with expanded features pertinent to gauges, fixtures and inspection tools.

The use of Gauge/Fixture Control package is not limited to these items. The package can be used for any item that requires a discreet (serialised) identity and/or must be inspected at various item or usage intervals. Typical examples are: foundry patterns, dies, templates and qualified tooling.

Specific features of the Gauge/Fixture (Inspection) Control package are:

1) CALIBRATION REPORTING - The system will monitor the time or usage since the last calibration or from the first usage date and compare the activity to establish calibration periods that have been pre-set in the Toolware system. When these time periods or usage points have been met, the system will report the items to be calibrated.

2) SERIAL NUMBERING - A suffix may be added to the item number that serialises each individual inspection tool where more than one of the same item exists. When withdrawing an inspection tool for use on the shop floor only the inspection tool need be entered. The Toolware system will issue the first available item and report the serial number selected. On return of the inspection tool, the serial number will be compared to ensure that the correct item is being returned.

3) LOCATION AND TRACKING - The inspection tools are inventories by their assigned storage location and can be tracked by the machine, job and user.

4) VALID ISSUE - When an inspection tool is being withdrawn, Toolware will verify that the item is not due for calibration. In the event that all items are due for calibration, the system will allow the issue of the best case item and warn the attendant that the item is out of calibration.

TOOLWARE UTILITY COMMANDS

A system administrator menu is supplied with the following features:

Backup data to disc or tape
Format floppy disc or tape
Backup Toolware programmes
Make passwords (not MSDOS)
Create new users
Send mail (messages to other (not MSDOS) user
Reload data
Reload programmes and enhancements
Help facilities

APPENDIX III

PROGRESS REPORT OF MAEC / RDSO
by
DESH DEEPAK
Project Coordinator

1.0 INTRODUCTION

MAEC/RDSO has been set up to impart training to Railway personnel in microprocessors, to introduce this technology for improving working of railways and to provide inhouse facility for undertaking development of new equipments using this technology. MAEC/RDSO since its inception has continuously striven to attain these objectives and it gives me immense pleasure to report some of the significant achievements of MAEC/RDSO as on 31.12.1985.

2.0 LAB

MAEC/RDSO has got a well equipped lab for developing prototypes of microprocessor-based equipments. Following facilities have been created -

1. One MDS manufactured in India which allows software development in assembly language of 8085 processor.
2. One IBM P.C. based MDS which allows use of any programming language.
3. One Intel system.
4. Modular hardware for 8-bit processor (8085)
5. Modular hardware for 16-bit processor (8088)
6. Complete setup of test equipments for lab simulation and testing, such as function generator, oscilloscopes, strip chart recorder, etc.
7. Training kits for training and learning.

A large number of courses are organised in a year.Training consists of theoretical exposure and hands-on exposure on training kits.

3.0 TRAINING

MAEC has trained following number of personnels in railways so far.

From Railways - 46
From RDSO - 139

This training has led to appreciation of technology in all facets of railway working. Last year following special training programmes were held-

1. Training of IRSE probationers in Indian Railway Institute of Civil Engineering (IRICEN).
2. Training of Senior IRSE officers in IRICEN.
3. Extensive field training of staff assigned to operate microprocessor-based systems.

Training implemented on such a large scale has already started yeilding dividends.

4.0 AREA OF ACTIVITY

The projects undertaken by MAEC/RDSO for percolation of this technogoly cover broadly following areas of railway working-

1.Track recording and monitoring systems.
2.Track construction and quality control systems.
3.Data acquisition and processing systems for R&D.
4.Miscellaneous

Microprocessor can be and are being used now almost in all facets of railway working.MAEC/RDSO's thrust in above areas have yielded good dividends and helped to concentrate so that technology advantages are completely available in one of the most costly asset's construction and maintenance that is PERMANENT WAY which plays an important role in safety and reliability of operation.
Various projects are described in paragraphs that follow.

5.0 TRACK RECORDING AND MONITORING SYSTEMS

One big area where Microprocessor can be used to tremendous advantage is the track recording and maintenance planning to economise on inputs and to ensure safe operation. The significance of this technology increases with increase in speed and traffic density. Following projects have been undertaken in this area-

5.1 B.G. Track Recording Car

This system was initially developed in collaboration with DOE. It was introduced in field and several modifications have become necessary to tune the system to Indian enviroment and to meet requirements of our staff. The system has now been modified as field requirement and is now in regular service.

5.2 M.G.Track Recording Car

The car has been instrumented and is undergoing field trials. We hope to complete this development by end of June 1989. It will be a major achievement of MAEC/RDSO which when completed will save over Rs 8 cores in foreign exchange.

5.3 Alignment Recording System For Mechanical Amsler Cars

The existing Amsler car do not have alignment recording system. A microprocessor based system is being developed.The prototype have been developed and field trials started. Once completed it will enhance capability of existing Amsler cards.

5.4 High Speed Track Recording Car

It is proposed to develop a high speed track recording car for speeds of 160 kmph and above for the proposed high speed routes of Indian Railways. This track recording car will be totally different from the existing development and will require a 16 bit system with a numeric coprocessor, and semi conductor mass data storage system. Hardware for the proposed system has been finalized and tenders are being invited.

5.5 Ride Quality Meter

This system has been developed in collaboration with DOE. The protype has been validated. The commercial system integrating the digital system, transducers and amplifiers has been developed and is under field trials.

5.6 Vibration Cum Speedometer

This system has been developed in collaboration with DOE. The commercial system integrating the digital system amplifiers and transducers has been manufactured and is under field trials. This development has helped Indian Railway to avoid import of speedometersfor locos thus saving enormus amount in foreign exchange.

6.0 TRACK CONSTRUCTION AND QUALITY CONTROL SYSTEMS

Second area where microprocessor can be used to tremendous advantages is the quality control in track construction and maintenance. The importance of this technology has increased with higher speeds and higher axle loads. Railways have identified 5 missions and microprocessor in this area has become extremely important in achieving each of the five missions. Following projects have been undertaken in this area.

6.1 Curve Realignment Calculator

This has been developed by RDSO as a dedicated system which works in interactive mode with the user for solving the problem of realignment of curves. A large number of systems are already in use on Zonal Railways and has found wide appreciation and application.

6.2 Weld Recorder

This device is being developed in collaboration with MAEP/New Delhi. This device acts as a supervisory control on the quality of flash butt welds, in the welding plant.The control is essential for safety of running trains. A Prototype has already been validated and a commercial system is under manufacture. There is considerable pressure from the zonal railways to quickly implement this system on all the Flash Butt Welding Plants. We hope to achieve this by end of 1989. This shall result in yet considerable savings in foreign exchange.

6.3 Weld Geometry Monitor

This device is being developed for improving the geometry of flash butt welds which will ultimately help in routine working. The device will act as intelligent monitor and will display the geometry to the operator working on straightning machine. The transducers for this device are being procured. The system design has been completed. Digital hardware has been procured and software is under preparation.

6.4 Corrugation measurement system

Indian Railways are procuring grinding machine for removal of corrugation from the rail head. It is proposed to develop a corrugation measuring system which will also evalute the results in realtime and help to find out the locations needing the grinding. This is still under design stage.

6.5 Track Maintenance System

It is proposed to develop a complete track maintenance system for track maintenance planning and quality control on track maintenance operations by creating a data base using track recording car results and other inputs. It is proposed to develop the system on an IBM PC and ultimately integrate it with high speed track recording car for on line analysis and preparing work sheets.

7.0 DATA ACQUISITION AND PROCESSING SYSTEMS FOR R & D

Considerable amount of R&D work is essential for assessment of vehicles for their speed potential and for design of rolling stocks and track. Large quantity of data generated in these trails was so far analysed manually. It is proposed to develop data acquistion and analysis systems so that much more complex analysis can be performed and relatively in small time.

7.1 Measuring Wheel Analyser

This equipment is meant for capturing load data from measuring wheels and analyse the same in real time for producing records of vertical and lateral forces and their statistics. We have procured the hardware and software is under development. The system will go for trials once the locomotive is allotted. This shall replace the existing imported system presently lying out of order.

7.2 Continuous Force Measuring System

In order to measure the forces coming on the track at a particular locati under different vehicles and in different states of maintenance, it is essential to develop a system which can on its own record the data for a very long time without external interruption. It is proposed to develop a continuous forces measuring system using microprocessor to achieve this objective. The transducers for this will be a measuring rail or a measuring sleeper which are under development. The measuring ra..

has already been developed and is waiting for insersion at site. The digital system is under development.

8.0 MISCELLANEOUS

Projects of miscellaneous nature requiring improvements to existing systems also become essential. A few projects of this nature have also come up.

8.1 Ultrasonic Rail Flaw Detection

It is proposed to automate this technology so that defective welds are not ommitted due to operator's fatigue. This system is being developed.

8.2 Component Inspection In PRC Plants

MAEC has been asked to develop an inspection system for pre-stressed concrete plants so that 100% inspection is feasible. This project will be taken up shortly.

9.0 PROBLEMS

One of the most serious problem that is being faced by MAEC Centre is poor availability of transducers for various projects. Indigenous availability of almost all types of transducers is nil. In certain cases, if the transducers are being manufactured indigenously, the quality of transducers and amplifiers is extremely poor. This is the reason as to why the track recording car project even though completed conceptually is suffering tremendously in field application. This centre is of the opinion that microprocessor application programme will be a failure in the long run unless availability of reliable transducers and amplifiers for different applications is ensured indigenously. It is suggested that MAEP should take up this issue and should try to create enough indigenous capability for transducers. The problem with imported systems is that there are no facilities for subsequent repairs and no organisation is keen or able to maintain them.

The second major problem being faced by the centre is lack of autonomy in decision making. As per the existing memorandum of understanding the project coordinator is governed by the rules of present organisation. Naturally with this stipulation the growth of the centre can not be faster than what is possible in a particular administrative set up. More autonomy to project coordinator in procurement and establish matters is essential. If necessary Project Coordinator can work under Chief Project Coordinator, MAEP and these tow aspects can be looked after by MAEP itself instead of the rules of concerned organisation.

10.0 CONCLUSIONS

Concluding bout the performance of MAEC/L aknow, it can be stated that Centre has succeeded in creating awareness of this technology on Indian Railways. It has also succeeded in undertaking a large number of projects and in solving many issues hitherto unsolved. It has also succeeded in generating thinking in administration about large number of projects using microprocessors to increase efficiency.

APPENDIX IV

MICROPROCESSOR APPLICATION ENGINEERING PROGRAMME

PROPOSALS FOR ACTIVE SUSPENSION SYSTEM FOR RAIL COACHES

Notes for Discussion at RDSO Lucknow on Wednesday 8th February

ABSTRACT

This paper has been prepared for discussion purposes between M.A.E.P. and RDSO Lucknow, concerning proposals for the indigenous development of a new active suspension system for rail coaches.

The subject matter includes reference to the rationale, scope, project definition, feasibility, development cost plan, financial aspects and actions which may need to be considered for UNIDO/UNDP funding.

CONTENTS

1. RATIONALE

Following a study initiated by M.A.E.P. at ICF Madras in March 1988, a number of areas for the application of microprocessors for improving quality and productivity of rail coach manufacture were identified. One important requirement was for testing bogies and an outline proposal was made for development of a test rig capable of simulating track conditions dynamically. Such a rig, if available, would also enable advanced active suspension systems to be developed, using microprocessors for controlling the level of the coach.

Subsequent to this proposal, developments in U.K. in the application of computer technology to motor vehicle suspension systems, in which conventional springs and dampers have been replaced by hydraulic actuators under complete control of an on board microprocessor, have been announced. It is therefore relevant to take stock of these developments to determine how a project may now be structured for exploiting latest technology for achieving higher standards of comfort and higher average train speeds using existing tracks with known irregularities.

Work to date in M.A.E.P. has centered on instrumentation projects for determining track deficiencies and ride quality, to assist maintenance. This work is of paramount importance and value because it can provide the necessary input data for the design of the proposed new suspension system.

Accordingly these notes have been compiled, taking account of the infrastructure of M.A.E.P. and the on-going programme of work on track maintenance in RDSO. If the project is to proceed it is realised that it will become multi-disciplinary embracing coach design, suspension system dynamics, high performance electro-hydraulic servos, computer simulation, vehicle attitude sensing systems and microprocessor control.

In order to design a meaningful programme which will culminate in a prototype coach in say, 2-3 years, it will be necessary to avoid embarking on programmes of fundamental research as far as possible and to apply known international state of the art knowledge and components. To this end it may be desirable to define a project which would qualify for UNIDO/UNDP funding, in order that access may be gained to overseas developments. These notes have therefore been compiled to list some of the known areas which would require to be included in such a project.

2. INTRODUCTION

For purposes of implementing a multi-discipline project described in the above "Rationale", a number of stages have been identified, each of which requires to be the subject of individuals study. They include, but are not restricted to:

- Scope, Project Definition
- Feasibility
- Development Cost Programme
- Financial Aspects
- Actions

Activities comprising these headings are described separately with a concluding section listing the actions required to take the project to the next stage. It is envisaged that the initiative for starting the project and negotiating funding with UNIDO/UNDP will rest with M.A.E.P./D.O.E but that implementation of the project, if approved, will be managed by RDSO with specialist input from M.A.E.P./D.O.E on microprocessor aspects.

3. SCOPE - PROJECT DEFINITION

The scope of the proposed project includes all necessary activities to result in the design and development of a self powered coach incorporating an active suspension system, during an initial programme of 2-3 years. Known problems of current rail tracks in service are:

- Undulating track caused by varying degrees of subsidence and condition of sleeper beds, resulting in swaying motion of the coach and in extreme cases, derailment.

- Short term disturbances caused by corrugations of the rail head, resulting in vibration and noise in the suspension system and discomfort to the passenger.

Current suspension systems based on conventional springs and dashpot dampers have limited capability for dealing with the extremes of the above problems. For example, if the springs are softened to give a comfortable ride the swaying of the coach may become uncontrollable. If the springs are too hard, vibration becomes noticeable to the passenger. The proposed microprocessor controlled active suspension system stabilises the coach to a known datum irrespective of undulations in the track and can result in higher train speeds on existing track irregularities.

Activities comprising the project definition, pre-feasibility study include:

- **Survey of known related technologies in U.K. and Germany for example. Consideration of joint ventures.**

- **Assessment of sub-systems necessary to comprise the total project,e.g.**

  Hydraulic and electric power supplies

  Attitude sensing and control systems

  High performance electro-hydraulic servo systems and components

  Microprocessor packaging and cabling

  Computer simulation of three dimensional motion in real time

- **Test Equipment,e.g.**

  Coach test rig

  Bogie test rig

  Hydraulic power packs

  Transfer function analysers

  Multi-channel electronic measurement, recording and analysis of displacement, velocity and acceleration

- **Reliability, fail safe features, environmental protection**

4. FEASIBILITY

This will require a task force consisting of multi-discipline specialists in each of the above fields to compile a study report which will effectively design the project strategy. It is proposed that this should be completed in three months and when completed will include:

- Design Specifications for all sub-systems

- Facility Requirements

- Manpower Requirements

- Cost Estimates

5. DEVELOPMENT COST PROGRAMME

Arising from the above feasibility study, sufficient data should become available to draw up a programme with stages of progress and expenditure defined. By involving the task force who will ultimately become accountable for implementing the project, a realistic programme should result.

Activities will include:

- Milestone Events
- Human/Material Resources required
- Stages of Development and associated conditions for achievement
- Field Trials

6. FINANCE

Reference has been made to the desirability of UNIDO/UNDP funding. The purpose of this is threefold:

- Access to international organisations for knowledge and training facilities
- Access to international markets for specialised components
- Supply of Experts to contribute to problem solving and assist in the direction of the project

7. ACTIONS

In the first instance, several important actions immediately become apparent if RDSO wishes to proceed:

7.1 RDSO formally request M.A.E.P./D.O.E. to initiate the project.

7.2 RDSO and M.A.E.P. to nominate senior executives to start the project.

7.3 RDSO and M.A.E.P.to review current projects and activities, including overseas fellowships, with a view to harnessing as many inputs from on-going projects as possible.

7.4 M.A.E.P./D.O.E. to formally request UNIDO for "Preparatory Assistance" in defining the project, to speed up the processes of project definition and approval.

7.5 D.O.E. to authorise short term funding to enable the first preparatory steps to be taken in formulating requirements.

APPENDIX V

NOTES ON VISIT TO VARANASI - DIESEL LOCOMOTIVE WORKS, Fri 10/2/89

1. OBJECTIVE

The visit was arranged at the suggestion of Mr. Masihuzzaman, Director Std. (Motive Power) RDSO to explore the possibilities of the application of microprocessors to improve quality and productivity of diesel engine manufacture.

2. PERSONS SEEN

Mr. R.C.Sethi, General Manager
Mr. Dass, Works Superintendant.

3. ACTIONS ARISING

A tour of the works was made. The workshop makes complete diesel locomotives including engines and associated major machined components. Current production output is 150 engines per year with plans to increase this number to 180 to cope with increased demand for export.

It was concluded that in the short term, intermediate inspection of major items such as connecting rods and camshafts could be speeded up by the use of gauging fixtures using electronic probes and inspection carried out alongside the machine tool,as an alternative to the present time consuming manual inspection process necessitating transport of the components to an inspection room.

Mr. Dass agreed to compile specifications of requirements and a list of other potential areas for component gauging, for consideration by Mr. Sethi and possible approach to M.A.E.C. at Lucknow for assistance on probes. Mr. Dass would arrange for the mechanical design and manufacture of the gauges, M.A.E.C. Lucknow to provide the necessary electronic probes.

Dr. Krishna Kant, Chief Project Co-ordinator M.A.E.P. would be approached by the author to write confirming the offer of assistance and if possible to arrange a visit to Varanasi to discuss arrangements with Mr. Sethi.

Problems of manufacture at the component plant machine shop at Patiala were described by Mr. Sethi, notably breakdowns and service problems of nine different types of cnc machine tools currently in use. M.A.E.P. may be able to assist in the future. Ideally the request for setting up of an M.A.E.P. centre at Patiala for the service of cnc equipment, including indigenous substitution of circuit cards, for all railway machine shops is indicated, subject to main railway board approval. Mr. Sethi to contact Member(Mechanical) cocerning a possible visit.

APPENDIX VI

MICROPROCESSOR APPLICATION ENGINEERING PROGRAMME

PROGRESS REPORT

ICF Projects requested by Railway Board

Ref. Letter No.89/M(W)/964/14,24 January 1989

1. INTRODUCTION.

The three Projects requested by the Railway Board for action were listed among seven potential areas where microprocessors may be applied to improve quality and productivity of coach manufacture at ICF, as described in proposals compiled in February 1988 and to which detailed reference should be made. The Projects requird to be formally actioned are:

- Digital readout for manual machine tools
- Partial automation of manual machines
- Bogie testing

The current status of each of these projects is reviewed following detailed consultation with ICF management between 15th and 24th February 1989. Factors which were considered are appended to this report.

2. DIGITAL READOUT

Since proposing this equipment a number of commercially available systems have been offered for sale in India. Examples are:

- Anilam Electronics Europe Ltd., marketed through Kirloskar Electric.
- Ferranti Metrology Systems, Marketed by Heatly and Gresham.
- Heidenhain
  Dr. Joannes Heidenhain GMBH
  Postfach, 1260, D8225, Traunreut, West Germany.

From consideration of machines at ICF, a sample of each category was selected:

Centre Lathe (Appendix I)

Vertical Turret Lathe (Appendix II)

Press Brake (Appendix III)

Specifications for each of these machines are apppended, to be used for quotation purposes. Since the main areas for uncertainty at Madras are:

- Unreliability of mains supply

- High ambient temperature and humidity

It is proposed to evaluate sample equipment by M.A.E.P Centre RDSO Lucknow and to introduce whatever modifications are necessary to overcome operational limitations, before retrofitting the equipment.

3. PARTIAL AUTOMATION OF MANUAL MACHINES

Three types of machines have been selected for this activity:

- Vertical Milling Machine (Appendix IV)

- "ELHA" Pedestal Drill (Appendix V)

- Centre Lathe (Appendix I)

Discussions have already taken place with CMTI at Bangalore in February 1988 where capability for this work exists and further negotiation is required to obtain a quotation in collaboration with M.A.E.P. Lucknow. Abridged specifications are appended to this report.
In addition, two other companies are known to possess capability for this work and should be approached:

- Mysore Kirloskar - Bangalore
- Technofore - Pune.

4. BOGIE TESTING

The author acquainted ICF Management of the outcome of discussions at RDSO Lucknow, concerning the design of a production test rig from which it was agreed that a specification of requirements could be made available but RDSO were reluctant to proceed until the outcome of a broader study on bogie suspension systems had been carried out, in order to make the optimum use of design resources. RDSO to advise on the outcome of the proposed study.

5. IMPLEMENTATION

Discussions have been held with Chief Project Co-ordinator, M.A.E.C.,RDSO Lucknow, with a view to implementing the above projects in collaboration with ICF Madras. It was agreed that RDSO would take the initiative in liason with ICF to begin work and locate suitable suppliers.

6. TIME SCALES

The time scale for sourcing and proving suitable equipment for digital readout and partial automation is typically nine months and a meaningful programme can be designed once reliable sub-contractors have been located. A provisional programme is appended to these notes.

NOTE:- Appendices referred to in the above text, are retained by ICI and M.A.E.P.

PROJECT IMPLEMENTATION

ACTION PLAN

UNDP/DOE/MAEP/RDSO		ICF/RLY.BOARD
Prog.Project Report by UNIDO Expert to Dr.Krishna Kant, DOE	Copy DOE	CME/ICF letter
Study & Approval of Report by DOE		EDME/PU
Establish contact and action plan with MAEP centre at RDSO	Copy of letter to Rly.Board	
Contact probable suppliers and get Budgetary Quotations		Clearance for Project by Rly.Board
Review and accept the quotations		
Bring the suppliers to ICF to prepare detailed specification and get quotation		
Decide on the suppliers to place the order		
Receipt of supply		
MAEP to evaluate the equipment for Temp./ Humidity	Submit progress Report to Rly. Board	
Installation Programme		
Evaluation at ICF		

FACTORS TO BE CONSIDERED IN PARTIAL AUTOMATION

1. SLIDEWAYS

These may require stripping, re-grinding and protecting with telescopic covers.

2. LEAD SCREWS

These may require replacing with ball screws, possibly by re-designing mountings.

3. AXIS DRIVES

These will consist of either:

- Stepper motors
- d.c. motors
- a.c. motors

Experience to date shows that stepper motors with encoders for closed loop control or a.c. drive motors with encoders, are more reliable than d.c. drives.

4. MEASURING SYSTEM

This will consist of either linear scales or rotary shaft encoders for measuring slide position. In the case of digital readout systems, a stored programme feature enables a number of finished dimensions to be stored, for example stepped diameters on a turned part, or hole co-ordinates on a drilling machine. The operator selects the appropriate dimensions and turns the handwheel to position the cutting tool, until zero is reached. This has been shown in practice to yield more accurate, repeatable results than count up until a number is rreached - the latter method introducing a greater risk of error.

5. CONTROL UNIT

This will incorporate a manual data entry facility for loading part programmes.

6. AXIS DRIVE AMPLIFIERS

These will probably require a separate rack and power supply from the control unit package.

7. MAIN SPINDLE DRIVE

Modern systems use a large variable speed d.c. or a.c. drive, the latter being preferable, but tending to cost 50% more than a comparable d.c. drive. Some retrofit systems do not replace the main spindle drive, but retain the existing manual gearbox. Commands for speed selection are displayed to the operator on the controlmboard panel.

8. MANUAL DATA INPUT.

This facility enables the operator to create a part programme on the machine as an alternative to preparation of a part programme off line and storing it on paper or magnetic tape. For the latter event a tape reader is required on the machine but this can be portable and plugged in when required.