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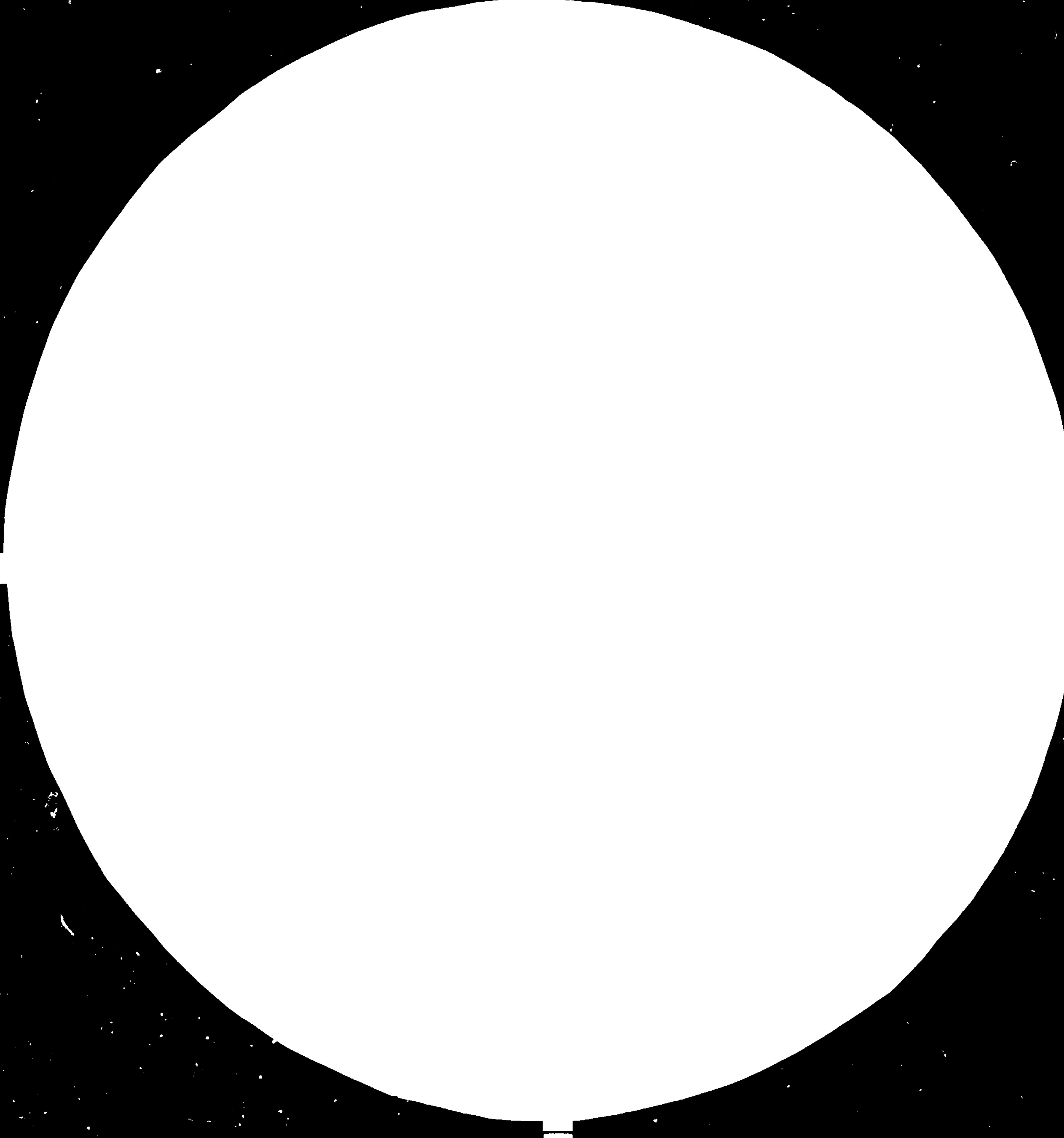

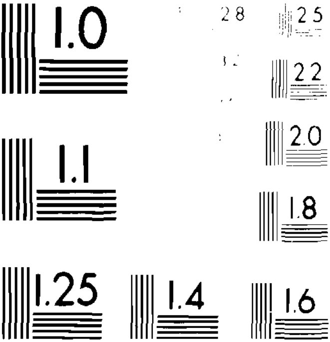

MICROCOPY RESOLUTION TEST CHART

Systems Project Management Limited

13607

Specification of Alternative Computer Based Systems to Support Production Planning and Control in Single-Piece and Small Batch Machine Parts Manufacturing on a Pilot Plant in Skoda, Plzen

Project DP/CZE/80/001

Synopsis

This report examines the currently implemented computerised batch production control system as developed by Skoda at their computer centre in Plzen, Czechoslovakia.

From this two alternative hardware systems are suggested to support the further development of this system for interactive running on a pilot scheme basis at one of, or a number of, Skoda's factories in the Plzen area.

This equipment will also be necessary for Skoda to fulfil its obligations to the Consultancy and Training Centre on Maintenance and Production Control Systems in Metallurgy and Engineering - the NTCTC.

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Appendices

Introduction

The initial draft of this report was written following a one month field investigation by a team of three SPM consultants at the Skoda Computer Centre in Plzen, and a number of meetings with INORGA staff in Prague.

The final text of the report was produced following meetings in Prague and Plzen with representatives of UNIDO, the Czechoslovakian Federal Ministry of Metallurgy and Heavy Engineering, INORGA, Skoda, and SPM.

A schedule of work in the production of this report is shown in Appendix G.

The author wishes to thank all concerned for the excellent help and co-operation given to the investigating team by the UNIDO, Federal Ministry of Metallurgy and Heavy Engineering, Skoda and INORGA specialists, and appreciation of the amount of effort they had to make to meet the tight deadlines for the enquiry.

Scope

Following briefings by INORGA and Skoda on previous UNIDO projects, and the proposed functions and timescales for the establishment of the Consultancy and Training Centre on Maintenance and Production Control Systems in Metallurgy and Engineering, the field investigation visited the proposed pilot plant in Plzen.

Several meetings were held with the Systems and Technical Group at Skoda and their current computing facilities were studied.

From information thus gathered an outline sizing of the pilot scheme was made in terms of computer and manpower resources. An attempt was also made to identify the hardware requirements for Skoda to provide an interface with the NTCTC.

Two configurations are detailed within this report. One configuration will meet the requirements of the Pilot Plant as seen, while the other is based on a more modest costing. This latter configuration will not cope with the proposed Pilot Plant and will require Skoda to identify a smaller plant to 'fit' within the capability of the configuration.

The report contains a description of the Pilot Plant; the program suites comprising the current production control system; strategies and full specifications of hardware, software and services to establish a pilot scheme. Also enclosed are projected performance figures for running the proposed Pilot Plant data on the current Skoda hardware and projected ideas on deployment of terminals within the Skoda plant.

General Conclusions

The Pilot Plant visited would provide an excellent opportunity for Skoda to introduce computerised production control into their operation, but the existing computer hardware is too overloaded to enable development of the present batch systems to fulfil this role.

A decision will need to be taken quickly on the enhancement hardware to enable Skoda meet the deadlines at least for their part in the NTCTC project.

There will be several benefits to Skoda, and the NTCTC resulting from the implementation of computerised production control. Firstly there is the potential to improve overall efficiency. It is anticipated that computerised control will bring about:

- an increase in production capacity loading by up to 10%
- a decrease in materials and spare parts stocks by up to 20%
- a notable improvement in product quality
- a notable enhancement of management capability of mid- and high-level decision makers at plant, corporation and central Government authority levels.

Secondly, it will enable the NTCTC to establish a centre of excellence on Production Control Technology which is relevant to the Czechoslovakian heavy engineering industry.

Pilot Scheme

In addition to the immediate requirement to provide a computerised Production Control System (PCS) to control the work in the selected Pilot Plant, the Skoda Production Control System must fulfil its part in a Nationwide Czechoslovakian Network of Metallurgical and Heavy Engineering Systems all linked to a central system in Prague. Diagrammatically this can be represented:

```
                Federal Ministry of Metallurgy
                    and Heavy Engineering.

                       INORGA Institute
                            Prague

                          IBM370/138
                              I
                              I
                              I 2 Km
                              I
Skoda                         I                East Slovakian
Plzen                         I                Iron Works(VSZ)
               100 Km       NTCTC     700 km
ICL1903T/Odra----------Data Bank----------IBM370/145
Enhancement                   I
                              I
Production                    I                Maintenance
Control                       I 8 Km           Management
                              I
                              I
            Research Institute of Technology and
             Economy in Mechanical Engineering
                           (VUSTE)

                           CAD/CAM
```

The central system is based at the INORGA Institute and will be used by the NTCTC to maintain a database of information relating to developments on the contributing systems.

Via links to the central system the NTCTC will be able to support its training and consultancy with its future clients.

Proposed Pilot Plant

Location

A Heavy Machinery plant - Zavod Tezke Strojirenstvi, comprising three separate workshops contained within one of Skoda's main Plzen factory complexes, has been selected as the pilot plant for the computerised production planning and control of single piece and and small batch machine parts manufacturing.

Range of Products

Two of these workshops are each established in adjacent buildings - one being concerned with heavy engineering orders, such as rolling mills, while the second handles lighter engineering work.

The third workshop comprises two adjacent buildings - the larger building being devoted to the manufacture of gearboxes and the smaller building to the assembly of textile machinery gearboxes and small gear production.

Layout

The three main buildings of all three workshops are similarly laid out - the equipment and machinery in each being of a size appropriate to the scale of its operation.

Overhead cranes and rail transport facilities are available for the material and parts movement, assembly, delivery and dispatch.

The unit involved in the manufacture of small gears etc. - being concerned with batch production of smaller parts, does not have, nor need, such equipment.

Each building is equipped with supporting tool and spares stores, and a number of shop floor administration units.

Machinery and Operation

Each workshop is equipped with numerous heavy to small drills, numerical control tools for precision manufacture and other equipment depending on its particular operation.

Large single parts under manufacture are labelled with their individual part number and assigned a card. This card contains details of the order number, and the various manufacturing processes required to produce the finished part. This card travels with the part around the workshop until the finished part is placed in a final assembly / dispatch area.

In the workshop concerned with the manufacture of small gearwheels etc., the layout and machinery are typically laid out for large batch production.

Sub-Contracts

A feature of all workshops is their participation in co-operative work with other workshops. In other words, parts are made as sub-contracted in, and out of, the workshop - the future computerised control system will have to cope with this type of operation.

Control

Some of the gear production is controlled by the use of computer produced Optical Character Readable cards; while all other production is controlled by conventional clerical methods.

Summary of Proposed Plant Production

Product Types

- Rolling Mills	75 % of production
- Gearboxes, Sugar Mills etc	25 % of production
Orders	1000 per annum
Parts	2000 per order maximum
Job Processes	2.5 per part average

Single Piece and Small Batch Production Control System

Overview

The computerised control of single piece and small batch manufacturing at the Skoda factory can be seen as four distinct sub-systems. These systems are partly implemented in batch mode and have the following general functions:

Sub-System 1 (Order Breakdown)

The function of this system is to break any given order down into its component parts which are then typed onto documents suitable for subsequent entry into the existing Skoda computing facility. This data is entered via an Optical Character Reader Device.

Sub-System 2 (Conversion of Orders Into Job Processes)

The function of this sub-system is to read the order data via the Optical Character Reader System; to validate and correct this data and ultimately to convert the order data into the detailed Job processes to be scheduled on the factory. The material requirements of the order are also produced by this sub-system.

Sub-System 3 (Order Scheduling / Factory Loadings)

This sub-system firstly schedules the detailed jobs within any Order to meet specified Order Completion dates, and subsequently loads these onto the required plant resources.

Sub-System 4 (Material Processing)

This system reads a file produced by Sub-System 2 which details the material requirements of individual orders. This system subsequently provides a magnetic tape file for Sub-System 3 which details materials delivered and available within the factory.

Sub-System 2 and 3 are now amplified to give a more detailed picture of their function and size.

Sub-System 2 (Orders To Job Processes)

Overview

Overall this Sub-System breaks down into three major suites:

- Order Entry and Validation
- Order Breakdown into Job Processes
- Production of Job Cards

In total, the entire Sub-System comprises some 211 individual Cobol programs and 238 systems utilities: sorts etc. The average program size is in the order of 32K words.

Performance

To process orders on current hardware for the proposed pilot plant - about 1000 orders per annum for rolling mills, gear boxes, cane sugar mills etc..The entire Sub-System could take, for some orders, approximately 24 hours of dedicated machine time from the time of order entry to the time of output of the final Job Cards for the order.

However, in normal use, this process is spread out over a period of 4 to 6 weeks depending on order size and other machine usage.

Data Volumes

The pilot plant orders can comprise from 20 up to 2,000 parts. For all orders in a year it represents 160,000 parts or 400,000 individual processes to be scheduled on the factory.

Sub-System 2 (Orders to Job Processes)

Order Entry and Validation Suite Overview

This, the first stage of the Sub-System, is responsible for the reading of orders - in the form of the complete parts lists created from documents submitted to an Optical Character Reader System.

The parts submitted are verified and entered onto a Parts Disc File for the order. Material requirements are output on Optical Character Reader documents which in turn are dispatched to Stores - who are responsible for their subsequent delivery to the production units concerned. Listings are produced to identify any errors with the data which are then cleared via corrections submitted through the Optical Character Reader System.

Finally, a tape file (a copy of the Parts Disc File) is produced together with various listings. This tape forms an input to the next suite.

Printer Volumes

There are some 93 Print Files produced by this suite of which 50% relate to auxiliary reports and error messages etc.

Parts Disc File

File Size	=	39 million words.
File Access	=	Indexed Sequential
Record Size	=	51 words
Record Key	=	Serial No.

where the serial number is derived from a look-up table of Serial Number vs Part Number.

Record Structure

Header

Serial No.
Order No.
Part No.
Weight
Quality of Material
Number of Materials in Batches
Number of Batches
Drawing Number
Part Name
Part Description
Additional Description

Batch Data:

Batch Description)	
Batch Number)	
Delivery Time)	
Number of Pieces)	up
Price)	to
Material Code)	3
Type of Units)	batches
Normal Material Value)	
Actual Material Value)	
Etc.,)	

Horn

Sub-System 2 (Orders to Job Processes)

Order to Processes Suite Overview

This suite serves two main purposes:

- Maintenance of a Master Parts Process File.

- Conversion of Parts into Individual Processes.

The total parts to be processed are provided by the first suite in this Sub-System (Orders Entry and Validation) and are matched against the Master Parts Process File on Drawing Number.

Successful matches are expanded and sent to a magnetic tape file. Mismatches are identified and a hard copy listing produced. Corrections are made via Optical Character Reader input and appropriate reruns made.

This procedure is repeated until an acceptable breakdown of Parts to Processes is achieved.

Listings are produced to show the final process structure of each part, and the file of processes is made available to the next suite.

Master Parts / Process File

This file is maintained within this suite via changes - or new product data, entered from documents read by the Optical Character Reader System.

The Structure of the File is:

File Size	=	56 million words	
File Access	=	Random	
Record Size	=	Variable Blocked	
Record Structure:		Header	26 words
		Operation	16 words
		Text	20 words
		+ other.	
Access	:	Records are located via a directory of disc location to Drawing Number.	

Sub-System 2 (Orders to Job Processes)

Job Cards Suite Overview

From the tape file produced in the previous suite - containing all processes connected with any given order, this suite sets up a corresponding disc file of Job processes with job times and rates added.

Optical Character Reader documents are produced for all jobs and a listing of all Job operations is made summarised against each part in the order.

Printer Volumes

In total the Job Card Suite and the Order to Process Suite produce over 75 different print files of which 50% are connected with auxiliary and error reports.

Job Card File

File Size	=	13 million words
File Access	=	Indexed Sequential
Record Size	=	22 words fixed
Record Key	=	Serial Number
		where serial number is derived from a look-up table of Order Number/Part Number against Serial Number.

Sub-System 3 (Order Scheduling / Factory Loadings)

Order Scheduling Suite

This suite requires two main inputs:

- File of Job Cards (Produced by Job Card Suite)
- Target Completion Date

The initiation of a run of this system does not necessarily follow immediately after the creation by the previous Sub-System 2 of the Job Card File.

In fact, it is understood that local statutory regulations require the Job Cards to be available - at the latest, 3 months before work is actually loaded onto the Plant. Once Skoda Management require an order to be scheduled they supply a target completion date for the order. Given this date, the system will begin to schedule all processes so as to meet the required date - the actual availability of plant and factory resources are not considered at this stage.

The resultant output of this system will be a hard copy printer listing showing the required completion of all process to meet the completion deadline and a similar file on disc. (Production Schedule File).

Production Schedule File

File Size	=	34 million words
	=	Approximately 1.5 Year Forecast.
File Access	=	Index Sequential
Record Size	=	Variable Length
Record Key	=	Order No/Part No/Batch No.

Record-Structure

Fixed Header (Part Description)
Variable - Process
Average record length 120 words.

Suite Run Time

On current equipment a typical run will take 60 minutes of dedicated machine time for processing about 40,000 records. This will make 1.3 disc reads per part and 1 disc write access per part.

Sub-System 3 (Order Scheduling / Factory Loadings)

Plant Loadings Suite

The main input to this suite is:

- Production Schedule File (From Order Scheduling)
- Available Pl[illegible]nt Capacity
- On-line Materials File (From Stores)
- Completed Job Cards (From Factory Plant)

The system produces two major outputs:

- 10 day shop floor loadings
- 4 month shop floor forecast.

Both these outputs are listed and the 10 day loadings retained on disc store.

Printer Volumes for Order Scheduling/Loadings

In total about 48 different print outputs are available of which 50% are connected with auxiliary and error reports.

Available Plant File

File Size	=	200 records
File Access	=	Indexed Sequential
Record Size	=	100 words
Record Key	=	Workshop Number/Work Place
Record Structure	:	Number of Men
		Number of Shifts
		Number of Overtime Hours
		Average Wages

Short Term Loading

File Size	=	200 Records
File Access	=	Index Sequential
Record Size	=	1000 words
Record Key	=	Workshop Number/Work Place
Record Structure	:	Number of Men
		Number of Shifts
		Number of Overtime Hours
		Average Wages
		(1 record per 10 calendar days)

Plant Loadings Suite Run Time

On current equipment a typical run will take up to six dedicated hours for 50,000 operations. Each operation will use 1 disc read and disc write.

Suitability of Current System

Introduction

It is presumed that for the Skoda system to provide a suitable interface to the NTCTC, it must be sufficiently equipped firstly to meet the production control requirements of the selected pilot plant.

In this respect there are several deficiences which make the current system inadequate for the daily, on-going, control of the proposed pilot plant. These have been observed by the Skoda EDP staff from their experience in running their system to control production in a locomotive plant - which incidentally provided the basis of the performance figures enclosed within this report.

In order to run the additional workload for the Pilot Plant a number of deficiences with the current system can be identified and detailed in 5 areas:

- The need for interactive terminals
- Current System Loadings
- Current System Age
- Need for Further PCS Application Development
- Need for Further EDP staff

These deficiences are now amplified.

Need for Interactive Terminals

Factory Data Collection

Since the current system has no network of terminals deployed within the factory, it has to rely on the return of completed job cards to be notified of any completed work. These cards are in fact used for payroll purposes and have to be processed in batch at fixed intervals of time to suit the payroll.

Hence when the information reaches the Production Control System it is too old to enable the system make realistic forecasts of shopfloor loadings.

Material Availability

This particular sub-system input to the proposed pilot scheme i.e. a magnetic tape file of material availability on the shop floor, suggests that - as with the job cards, the data provided will not be up to the minute. There is a need to provide this information by interactive terminal input.

Information Changes

The vast majority of input,changes or amendments to the system's data base are via an Optical Character Reader System. This may be acceptable in some circumstances for the input of large volumes of data, but is very cumbersome and slow for the correction of errors or the entry of small data volumes.

It is considered that this would become a major bottleneck in the daily running of a production control system and could be removed by the introduction of a terminal system.

Current System Loadings

Presently the Production Control System, as described above, runs on a near twin ICL-ODRA configuration. Full configuration specifications for this and other existing equipment are set out in appendix A.

Deficiences with this can be listed:

- the entire configuration is run operationally 24 hours per day for 7 days per week.

- the workload is mixed and the machines have no spare capacity to dedicate time to the running of the production control system - it must be multiprogrammed with other work.

- to produce the vital 10 day shop floor loadings forecast there is a requirement in the order of 6 hours dedicated machine time. Under current computer loadings only one run within any 10 day period is possible.

In effect the current system is fully utilised and cannot spare the capacity to allow the running or development of the PCS.

Current System Age

By the time the Production Control System goes live in 1986 some of the existing hardware will be over 10 years old. This will almost certainly create unwelcome problems of spare parts and support, and hence the reliability of the service that the EDP department can provide.

Modern equipment is required to enhance Skoda's computing facilities to avoid such potential problems and provide a full support to the Pilot Plant scheme.

Need for PCS Application Development

Order Breakdown to Parts

Currently this stage of the system is produced by conventional clerical methods. The total parts content of any order is eventually typed onto documents which are subsequently entered into the computer controlled stages via an Optical Character Reader System.

Computerisation of this stage could make significant savings and improve the general performance of the initial stages of the currently implemented system. This aspect would also be of interest to the NTCTC.

Need of Further EDP Staff

To implement the PCS for the selected Pilot Plant it is estimated that an additional 36 staff in various skill classes will be required. These are detailed in the section of the report concerned with the strategy to provide a full PCS for the selected Pilot Plant.

To enable the existing and future staff be effective in their particular role in running the PCS system, the additional training and consultancy services recommended within this report will be required.

Consequences

From the shopfloor and management point-of-view the availability of an accurate 10 day production schedule is paramount to the acceptability of the system as a means of production control. If anything it is important to aim to produce shorter - say a 5 day forecast, to optimise the use of the factory resources.

The use of the existing equipment would result in:

- Inaccurate and out-of-date short term forecasts
- No opportunity to make several re-runs of plant loadings just before issue of the final loadings. Thus the elimination of any errors of mis-recorded information or last minute shop floor changes, would not be possible
- Inability to accurately optimise the use of factory resources which could result in idle time and waste of plant and manpower.

Conclusion

It was considered that the existing equipment as in current use is - or would be, too old, too slow and overloaded to provide a suitable base for the projected pilot scheme.

Outline System Development Strategy

Objectives

It follows from the previous section of this report that a development strategy needs to be derived to overcome the deficiences inherent in the current system. This strategy must have realistic objectives and commitment by all concerned: Management, Pilot Plant, EDP Department, NTCTC etc..

The strategy must also take into account a number of factors which will affect the PCS at all stages of its implementation. These factors can be considered under the following headings:

- Systems Development
- Performance
- Connectivity
- Terminal Network

System Development Factors

It is noted that the implementation of the PCS will take a number of years and will be constrained by financial and other practical considerations. To this extent it is envisaged that the hardware to support the system will be installed and developed in distinct stages and should take advantage of the availability of existing peripherals, terminals and software applications. The possibility to replace such retained resources by new equipment in the future will also be required.

In this context the strategy should aim to use equipment which can provide:

- Compatibility with existing CPU's
- Peripheral switching with existing CPU's
- Systems and Applications Software compatibility with existing CPU's
- Portability of Applications Software
- Future replacement of any retained peripherals

Performance

The success of the PCS implementation at Skoda is dependent on the availability of a powerful central processor.

It can be seen from the summary of anticipated system loadings detailed in Appendix B that the critical Plant Loadings Suite would require 6 hours dedicated machine time on existing hardware.

Future equipment will be required to run this suite several times in any day and at the same time support the on-line systems of the PCS - in this way Skoda Management will have the opportunity to provide accurate and meaningful shop-floor loadings.

Connectivity

To allow for financial constraints it is appropriate that future hardware will be able to connect with:

- Existing Disc Backing Store
- Existing Terminals
- Other existing peripherals
- CMEA produced terminals

Also to enable the system operate in conjunction with the central NTCTC system in Prague there is a requirement for IBM connectivity.

Network

The anticipated terminal network to support the PCS is illustrated by the following charts:

Perceived Future Interactive Terminal Use

PCS Use	Predicted Terminal Usage	No Vdus	No Ptrs	Location	Modems
Live Running	500k Input Characters per month 400k Output Characters per month	21	8	Pilot Plant	9
Support Maintenance	Interactive System Support, Maintenance and Development for up to 26 staff	8	3	Computer Systems Centre	6
NTCTC Support	Databank Link	1	-	Computer System Centre	3
Total		30	11		18

Location of Terminals in Pilot Plant

	VDU's	Remote Printers
Plant Production Control	2	2
Shopfloor Production Control	5	2
Engineering Office	3	2
Workshop	8-11	2

Alternative Configurations

Since it is a requirement of this report that alternative systems of different levels of sophistication be studied, two objectives are considered:

- Skoda to make available a full scale computerised on-line Production Control facility for the proposed Pilot Plant by December 1986.
- Skoda make available a subset of the total PCS, by December 1986 but probably for a plant smaller than the one currently selected.

For each objective an outline strategy is examined to clear away the present deficiences and install a total system which will produce:

- Timely and accurate short term forecasts
- Immediacy of data collection and change

The strategy for each objective is set out in terms of:

- PCS Function Supported
- Hardware procurement
- Software requirements
- Services
- Implementation Milestones/Timescales
- Manpower requirements and recruitment
- Finance
- Timescales

Objective 1: Full Pilot Scheme by December 1986

Appendices A,B, and D are relevant to this section.

Hardware

In order to overcome present difficulties with the production of short term factory loadings and data collection, the final configuration shown in Appendix D will be required.

In short this comprises:

- Main Processor (800 Kips and 4 Megabyte Store)
- 800 Megabytes of Exchangeable Disc store
- 5 Magnetic Tape Units
- 2 Line Printers
- 9 Vdu's and 3 Matrix Printers for Systems development
- 21 Pilot Plant Based Vdu's and 8 Matrix Printers

This represents a minimum final configuration and will need to be fully installed by September 1985.

To allow for the three phases of the systems implementation: training and design(1984), development(1985), final implementation(1986), it is thought that a phased delivery of the full configuration could take place - these are detailed in Appendix D.

The Objectives and Terminal Functions for each phase are set out below.

The power of the processor is set at approximately three times the power of existing equipment to enable the Plant Loadings Suite to be run two or three times in any day - Appendix B gives a summary of loadings under present conditions and in such circumstances it seems that only one full run could be made in any 10 day period.

Appendix B figures are used to quantify the peripheral equipment.

The terminal environment has been chosen to meet the requirements detailed in Appendix C - this principally will enable information to be collected on-line from the Pilot Plant for completed jobs and material availability; and will allow on-line correction to the system data base for work in other suites in the total system.

Terminals are also included for general systems support and development.

System Requirements

There are a number of advantages to systems development and implementation if the operating system on the proposed configuration is able to emulate the operating system of the existing machines.

Firstly the systems, programming and operations staff would be working in a familiar environment. Not only would there be immediate savings in training and support services, but a rapid transfer of work onto the new machine could take place and development work started almost immediately.

Secondly, the database structures now in use could also be used without the need of a file conversion exercise. Further cost savings may be possible by transferring some peripherals from the old machine to the new.

Thus the preferred strategy for software is to obtain a system supporting emulation of the existing operating system but providing the required overall power of 800 Kips.

The other software is identified from the system requirements detailed in Appendix B.

Given that the above hardware and software is selected and installed the services shown below will need to be provided during the life of the project.

Objectives by Phase

Phase-1 Objectives:

To Provide Initial PCS Development System

To provide the NTCTC Education and Training Support

Phase-2 Objectives:

To provide Full Implementation of Sub-System 2 in the 3 Workshops of the Pilot Plant.

To provide Implementation of Sub-System 3 Order Scheduling in all 3 Workshops and 4 Month Factory Loadings

To provide Implementation of Sub-System 3 Ten day Factory Loadings in the Gearbox Workshop only.

Phase-3 Objectives:

To complete PCS on all Workshops including Sub-System 3 Factory Loadings

To provide Decision Support Facilities to Skoda Management

Pilot Plant Terminal Functions by Phase

	Proposed Function	Phase 1	Phase 2	Phase 3
1.	**Management Input to Computer** (40,000 Characters/month)			
	*Short term (10 day) Loadings Enquiry (Start Date/End Date) - Gearbox Workshop Only		*	
	*Short term (10 day) Loadings Enquiry (Start Date/End Date) - All Pilot Workshops			*
	*Due Date for Orders		*	
	*Engineering Change			*
2.	**Plant Information to Computer**			
	*On-line Delivered Materials			*
	*Process Completion for Job Cards		*	
3.	**Computer Information to Plant**			
	*Some Standard Listings to Shopfloor		*	
	*Short Term Loading - Gearbox Plant		*	
	*Short Term Loading - All Pilot Plants			*
	*Sub-Contracts Information			*
	*Order Status Report			*
	*Total Current Works Loadings			*
	*Orders Forecast (Start/End)		*	
	*Available Capacity at Specific Workshop Location			*

Services

The following table itemises the services that would be required from either a system providing emulation or a system requiring full conversion.

Service	Emulation	Conversion
Training	Student Weeks	Student Weeks
- Operations	4	8
- Cobol	-	30
- File Access	-	30
- Communications	30	30
- Interactive Cobol	15	15
- Production Control	16	16
- JCL	-	30
- Engineering	80	80
Total Training	**145**	**239**
Management Visits	4 man-weeks	4 man-weeks
Support		
- Operations	2 man-weeks	6 man-weeks
- Systems/Programming	2 man-weeks	6 man-weeks
- Engineering	26 man-weeks	26 man-weeks
Total Support	**30 man-weeks**	**30 man-weeks**

It should be noted that for a system without an emulation capability full conversion of the current Production Control System would be required - this is estimated to be in the order of 10 man-years or more.

Implementation Programme

The following summarises the system development milestones:

Activity	1984	1985	1986
Phase 1			
Hardware Procurement by	March		
Hardware Installed by	December		
Engineering Training by	December		
Systems Training by	December		
Support completed by		June	
Interactive Production Control Design Complete	December		
Implementation of Design		Jan xxxxxxxx	Dec xxxxxxx Jul-Dec
Phase 2			
Hardware Procurement by	December		
Hardware Installed by		Sept	
Engineering Training by		Sept	
Systems Training by		Sept	
Management Visits by		Dec	
General Support by			Dec
Factory Testing			xxxxxxx
Phase 3			
Hardware Procurement by		Sept	
Hardware Installed by			Jun
Engineering Training by			Jun
Systems Training by			Jun
Management Visits by			Dec
General Support by			Dec

Manpower

In addition to current staff, it is believed the following new staff will be required to implement the system and provide the necessary on-going support and maintenance to both the Pilot Plant and the NTCTC.

Skills	1984	1985	1986	Total
Pilot Plant	-	6	6	12
Operators	3	3	-	6
System Designers	5	-	-	5
Programmers	5	5	-	10
Engineers	2	1	-	3
Totals	15	15	6	36

Objective 2: Factory Loadings on Small Plant by Dec 1986

Appendices A, B, and E are relevant to this section.

Hardware

The assumption here is that a smaller pilot scheme than the one currently envisaged is undertaken, and interactive systems development takes place primarily on the order scheduling and plant loadings. A further assumption is made that the two suites that undertake this work can be detached reasonably easily from the rest of the system and run independently on a separate machine - logically this seems reasonable.

This separate machine is postulated in Appendix E and comprises:

- Main Processor with 350 Kips Power
- 360 Megabytes of Exchangeable Disc Store
- 4 Magnetic Tape Units
- 1 Line Printer
- 4 Vdu's and 1 Matrix Printer for Systems Development
- 8 Pilot Plant Based Vdu's and 2 Matrix Printers

With this option it would be necessary to select a Pilot Plant whose resources could be scheduled by the machine in a run-time of not more that say 3 hours dedicated machine time and whose database could be contained within the configuration specified in Appendix D.

Software Requirements

Most probably this option will involve conversion work on the programs and files associated with the Order Scheduling and Plant Loading Suites - it is unlikely that emulation facilities will be available. However a machine whose architecture resembles that of the existing Skoda equipment may reduce the conversion effort to some degree.

Services

The following table itemises the minimum services that would be required to support this option:

Service

Training	Student Weeks
- Operations	1
- Cobol	2
- File Access	2
- Communications	2
- Interactive Cobol	3
- Production Control	3
- JCL	2
- Engineering	22
Total Training	**37**

Support 2 man-weeks

Implementation Programme

The following summarises the system development milestones:

Activity	1984	1985	1986
Hardware Procurement by	March		
Hardware Installed by	December		
Engineering Training by	December		
Systems Training by	December		
Support completed by		June	
Interactive Production Control Design Complete	December		
Implementation of Design		Jan xxxxxxx	xxxxxxxx Dec
Factory Testing			Jul-Dec xxxxxxx

Manpower

In addition to current staff, it is believed the following new staff will be required to implement the system and provide the necessary on-going support and maintenance to both the Pilot Plant and the NTCTC.

Skills	1984	1985	1986	Total
Pilot Plant	-	6	6	12
Operators	1	-	-	1
System Designers	2	-	-	2
Programmers	2	2	-	4
Engineers	2	-	-	2
Totals	**7**	**8**	**6**	**21**

Conclusions

A number of conclusions can be identified from the study of the Skoda Production Control System. These are as follows:

1. The existing computer equipment is inadequate to provide a convincing control system for the Pilot Plant visited.

2. There is no terminal network to record up-to-the-minute data from the shop floor.

3. There are no terminal facilities available to support an interface to NTCTC, nor is the future day-to-day working interface with NTCTC clearly defined.

4. The central processor does not have the power to cope with the demands of forecasting or scheduling shop floor loadings, under current loadings.

5. There is a shortage of staff to develop the current batch control system to provide the interactive facilities to control the Pilot Plant and to fulfil the support role expected by NTCTC. The staff shortage comprises: 12 Pilot plant Operators; 6 Central Machine Operators; 5 System Designers; 10 Programmers; 3 Engineers.

6. The existing computer equipment is fully loaded and does not have the spare capacity to allow full development of the current batch system to introduce interactive running.

7. The present staff have built up considerable experience in developing the present batch control system and have tested the system in the control of a locomotive plant.

8. There is a working batch control system from which an interactive system can be developed.

9. The Pilot Plant visited is well run and organised and would provide an excellent opportunity for Skoda to introduce computerised control and planning.

10. The present batch system is only partially implemented.

11. The future implementation of Orders to Parts, Material Control and the possible interface to CAD/CAM systems have not at this stage been

investigated in depth.

12. The use of an emulation capability on any future computer system is a highly desirable feature to save on implementation costs.

13. In the event that a full system as detailed in Appendix D cannot be made available, a much smaller pilot plant must be selected to match the computer resources as detailed in Appendix E.

Recommendations

1. As soon as possible agree objectives and scope of Pilot Scheme, prepare and commit to appropriate work plan.

2. As soon as possible confirm finally selected Pilot Plant.

3. Closely involve the management of the selected Pilot Plant from the outset and obtain their commitment to the scheme. Arrange a suitable familiarisation programme for them including visits to similar sized organisations who have implemented computerised PCS systems.

4. Agree and place an order for suitable equipment based on the configurations set out in the appendices to this report.

5. Follow the timescales, recruit and take the services detailed in the report.

6. Agree with the management of the Pilot Plant on staffing and training arrangements for terminal operators and carry them out.

7. Agree with the Pilot Plant Management the siting of the factory terminals and the procedures to be adopted for recording shop floor data.

8. Train the shop floor terminal operators in the agreed procedures and explain them to the shop floor workers involved.

9. Endeavour to make contacts and share ideas with companies with similar operations to Skoda - the management visits can be used to further this.

10. Where possible, and if necessary, involve external expertise for advice and guidance on the factory aspects such as: involvement of factory personnel, training, factory testing and acceptance, day-to-day running procedures and interfaces, use of interactive terminal techniques etc..

11. Involve external expertise for development of ideas for a totally integrated production control system including, for example, Order to Parts Breakdown, Material Control, or possible CAD/CAM systems interfacing.

12. Formalise the future working relationship with NTCTC.

Appendix A

Current Skoda Hardware Configurations

Current Skoda ICL Configuration

Quantity	Type	Description
1	1903T	Main Processor 128 Kwords
1	2812	EDS60 Disc Controller
4	2815	60 Megabyte Disc
2	MTS304M	Magnetic Tape Controller
9	PT3M	9 Track Polish MTU's 96K CPS
4	1973	Magnetic Tape Units
1	2101/1	Card Reader 1000 CPM
1	CK325	Card Reader (Polish) 900 CPM
2	DW325	Line Printer (Polish) 1100 LPM
1	2430	Line Printer 1500 LPM
1	1916	Paper Tape Reader 1000 CPS
1	1925	Paper Tape Punch 110 CPS
1	7930	Scanner
2	MDS1200	Modems
1	7502/15	Remote Terminal Controller
6	VT2000	2000 Character VDU's
1	HCP180	Remote Hard Copy Printer

Current Skoda Odra Configuration

Quantity	Type	Description
1	1305	Main Processor 160 Kwords
1	2812	EDS60 Controller (ICL)
5	2815	60 Megabyte Disc (ICL)
3	PT3	Magnetic Tape Units 96K CPS
5	PT3M	Magnetic Tape Units 96K CPS
1	2101/2	Card Reader (ICL) 2000 CPM
1	CK325	Card Reader 900 CPM
3	DW304	Line Printer 1100 LPM
1	CDT325	PTRP 1000/110 CPS
4	57100	VDU (Videoton)
1	-	Local ICL VDU
2	MTS304M	Magnetic Tape Controller
1	JSG7801	Local VDU Controller

Current Skoda Scandata Optical Character Reader

Quantity	Description
1	Scandata Optical Character Reader
1	PDP8 with 32 Kwords
1	Operators Console
1	7 Track Magnetic Tape Unit
2	9 Track Magnetic Tape Unit

Current Skoda Redifon System

Quantity	Description
2	Redifon Seecheck
2	Ampex 30 Megabyte Disc Unit
2	7 Track Magnetic Tape Units
1	9 Track Magnetic Tape Unit
1	Centronix Printer
24	Video Terminals
1	Line Printer 600 LPM

Appendix B

Predicted Pilot Plant Loadings On Current ICL/Odra Equipment

Predicted Pilot Plant Loadings On Current ICL/Odra Equipment

Suite	Dedicated Run Time (Hours)	Normal Elapsed Run Time (Days)	Main Store (KBytes)	Main Disc Files (MBytes)	Line Printer Usage: PCS Reports	Lines ('000)	Other Reports	Lines ('000)	Cobol Progs	Other System Progs	Max MTU's on Line	No MTU Files
Order Entry			120	156	47		46		106	93		
Order Processes	24	30	126	224		450		100			5	35
					37		38		105	145		
Job Cards			126	52								
Order Scheduling	1		280	135								
		10			24	150	24	10	75	41	5	25
Plant Loadings	6		280	1								
Totals	31	40	1032	568	108	60[illegible]	108	110	286	279	10	60

Comments

1. Dedicated Run Time is the estimate of run times if only the Production Control System were running on the machine.

2. Normal Elapsed Time is the approximate time taken under normal operating conditions with other work loaded on the machine.

3. Main Store is the average program size.

4. Main Disc File refers only to the main file associated with the suite. In normal running it is estimated that between two to three times more on-line disc storage is required for intermediate and other workfiles - space must also be allowed for the operating system, the future NTCTC use and contingency for breakdowns.

5. Max MTU On-Line states the number of magnetic tape units required for the program which requires the largest number of magnetic tape units.

Appendix C

Interactive Terminal Deployment

- Perceived Future Interactive Terminal Use
- Pilot Plant Terminal Functions
- Location of Terminals in Pilot Plant

Perceived Future Interactive Terminal Use

PCS Use	Predicted Terminal Usage	No Vdus	No Ptrs	Location	Modems
Live Running	500k Input Characters per month 400k Output Characters per month	21	8	Pilot Plant	9
Support Maintenance	Interactive System Support, Maintenance and Develop - ment for up to 26 staff	8	3	Computer Systems Centre	6
NTCTC Support	Databank Link	1	-	NTCTC	3
Total		30	11		18

Pilot Plant Terminal Functions

Proposed Function

1. **Management Input to Computer**
   (40,000 Characters/month)

   *Short term (10 day) Loadings Enquiry (Start Date/End Date)

   *Due Date for Orders

   *Engineering Change

2. **Plant Information to Computer**

   *On-line Delivered Materials

   *Process Completion for Job Cards

3. **Computer Information to Plant**

   *Some Standard Listings to Shopfloor

   *Short Term Loading

   *Sub-Contracts Information

   *Order Status Report

   *Total Current Works Loadings

   *Orders Forecast (Start/End)

   *Available Capacity at Specific Workshop Location

Location of Terminals in Pilot Plant

	VDU's	Remote Printers
Plant Production Control	2	2
Shopfloor Production Control	5	2
Engineering Office	3	2
Workshop	8-11	2

Appendix D

Option 1. Hardware-Software-Services

Option 1. Hardware-Software-Services Enhancement

With this option, it is envisaged that the current equipment, software and services will be enhanced in three main phases to coincide with the general timescales of the implementation of the production control application at the proposed pilot plant.

The general timetable for the PCS development is known to be:

Activity	Starting and Completion Dates
Development of PCS Concept.	10/83-6/85
Procurement of equipment required to enhance additional capacity.	1/84-7/85
Development and installation of problem-oriented software package for Pilot PCS including: - Order Planning/Processing - Capacity Planning and Balancing - Short-Term Production Scheduling	1/84-12/86
Testing of System.	7/85-12/86
Internal Evaluation of the Pilot Application.	9/85
Preparation/Dissemination of Documentation on Pilot PCS for Using in the Framework of NTCTC	7/85-12/86

The specific hardware, software and services are detailed herewith:

Hardware Enhancement - Phase 1

Delivery 1984

Item No.	Description	Qty	Estimated Price($)
1.	Main Processor with 450 Kips Power and 1.5 Megabyte Main Store.	1	165,000
2.	Emulation Feature	1	14,000
3.	Exchangeable Disc Drive of 100 Megabyte storage capacity	4	78,000
4.	Magnetic Tape Unit (96 or 60 KCS)	1	17,000
5.	Line Printer 900 Lines per Minute	1	29,000
6.	Cluster Control Unit	1	7,000
7.	Video Display Unit	6	15,000
8.	Matrix Printer width 132 Character Positions and speed 200 Characters per second	3	5,000
9.	Peripheral Interfaces etc.	1	5,000
	Total Hardware - Phase 1		**335,000**

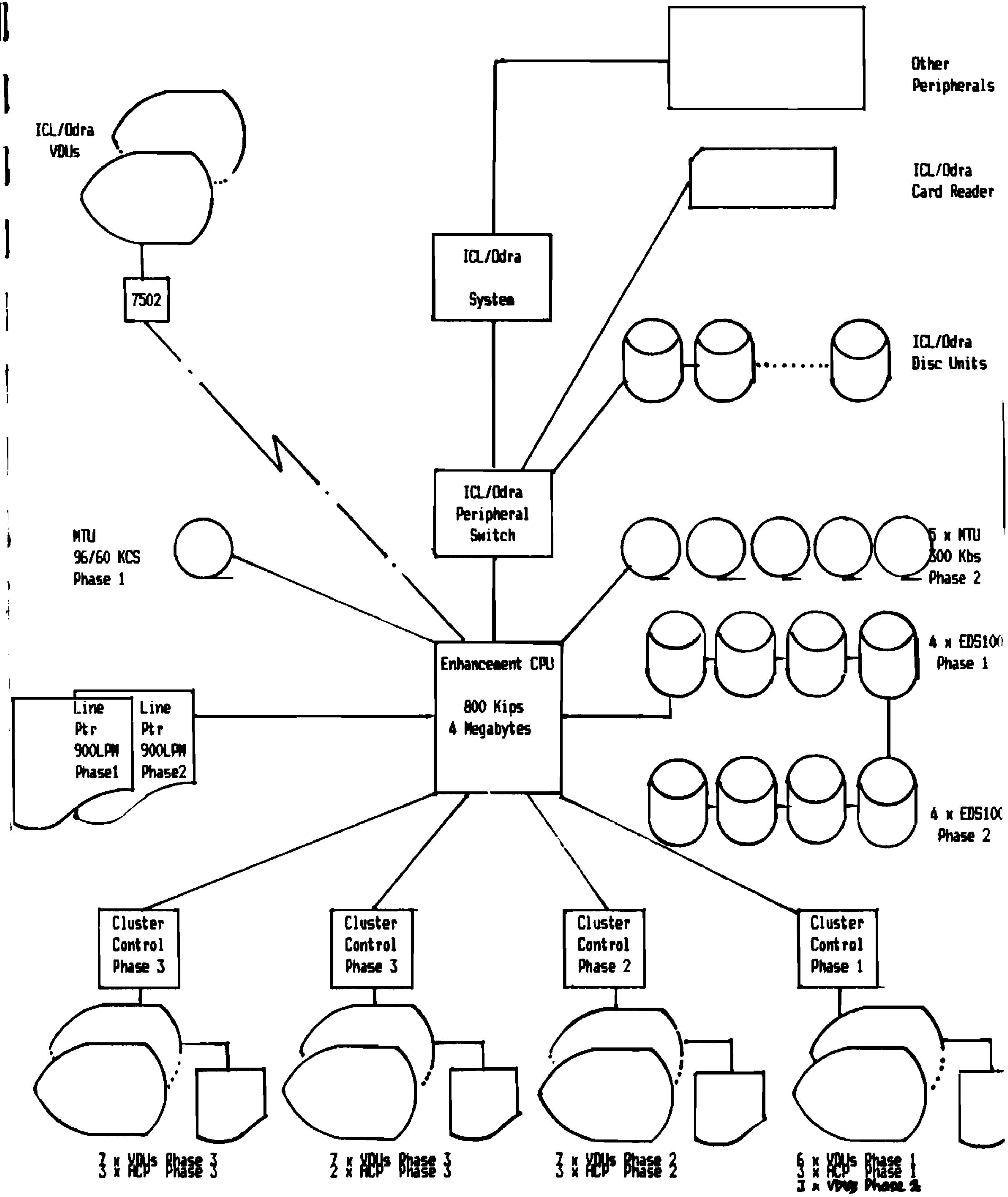
Hardware Specification - Phase 2 (Enhancement to Phase 1)

Delivery Date: 1985

Item No.	Description	Qty	Estimated Price($)
1.	.5 Megabyte store enhancement	1	8,000
2.	Exchangeable Disc Store Control Unit	1	30,000
3.	Exchangeable Disc Drives of 100 Megabyte storage capacity	4	78,000
4.	Magnetic Tape Drive Control Unit	1	32,000
5.	Magnetic Tape Drive 300 Kbps	4	84,000
6.	Magnetic Tape Feature NRZI	1	4,500
7.	Peripheral Interfaces etc.	1	20,000
8.	Line Printer 900 Lines per Minute	1	29,000
9.	Mainframe to Communications Interface	1	8,000
10.	Modems and Cables	1	21,000
11.	Remote Video Display Unit	3	9,000
12.	Intelligent Distributed Cluster Control Unit with own Video Display Unit and 20 Megabyte Backing Store	1	23,000
13.	Intelligent Workstation for Distributed Cluster Control Unit	6	24,000
14.	Matrix Printer 132 Character Positions and speed of 120 Characters per second	3	4,500
	Total Hardware - Phase 2		**375,000**

Hardware Specification - Phase 3 (Enhancement to Phase 2)

Item No.	Description	Qty	Estimated Price($)
1.	Main Processor Upgrade to Provide 800 Kips Power	1	210,000
2.	2 Megabyte store enhancement	1	30,000
3.	Intelligent Distributed Cluster Control Unit with own Video Display Unit and 20 Megabyte Backing Store	2	50,000
4.	Intelligent Workstation for Distributed Cluster Control Unit	12	48,000
5.	Matrix Printer 80 Character Positions and speed of 120 Characters per second	5	5,000
	Total Hardware - Phase 3		**343,000**



Skoda Production Control System Study Objective 1 Configuration

System Services - Phase 1

The following sub-contractual consultancy, and software services are required to support the Phase 1 Hardware Enhancement:

Current Machine Operating System	$75,000
Emulation Software	
High-Level Language Compilers	
Communications Software	

Total Consultancy, Services	**$75,000**

The following sub-contractual training services are required to support the Phase 1 Hardware/Software Enhancement:

Engineering Training: 30 student-weeks	$41,000
Systems Training: 10 student-weeks	$14,000
This will provide training where needed in such topics as: Cobol, File Access, Communications, PCS, JCL etc.	

Total Training	**$55,000**

It is assumed that the costs of students accommodation and subsistence are included within these costs.

System Services - Phase 2

The following sub-contractual consultancy and software services are required to support the Phase 2 Hardware Enhancement:

Full Native Machine Operating System with Current System Emulation	$75,000
Total Consultancy, Services	**$75,000**

The following sub-contractual training services are required to support the Phase 2 Hardware/Software Enhancement:

Engineering Training Systems Training Management Training	$100,000
Total Training	**$100,000**

This cost will be inclusive of accommodation and subsistence expenses. The training will be used where needed in the same topics detailed under this heading in Phase 1.

Systems Services - Phase 3

The following sub-contractual training services are required to support the Phase 3 Hardware/Software Enhancement:

Engineering Training	
Systems Training	$135,000
Management Training	
Total Training Services	**$135,000**

This cost will be inclusive of accommodation and subsistence expenses. The training will be used where needed in the same topics detailed under this heading in Phase 1.

Appendix E

Option 2. Hardware-Software-Services

Option 2. Hardware-Software-Services

With this option, it is envisaged that the equipment, software and services will be used to provide a more limited pilot project than that proposed under Option 1.

The objective of this option is to supply a system which could be used exclusively for running the sub-system 3, described in this report, on a much reduced pilot plant - for say, gear production scheduling and loadings only.

This system should be delivered as early as possible in 1984 to enable conversion of the sub-system to take place - it is imagined that emulation facilities of Skoda's existing equipment would not be so easily available with this option but equipment whose architecture resembled the existing equipment may be available. This would help to reduce conversion, development and training costs.

Preference should be given to equipment which would allow a natural enhancement from this option to the final configuration of option 1, if possible.

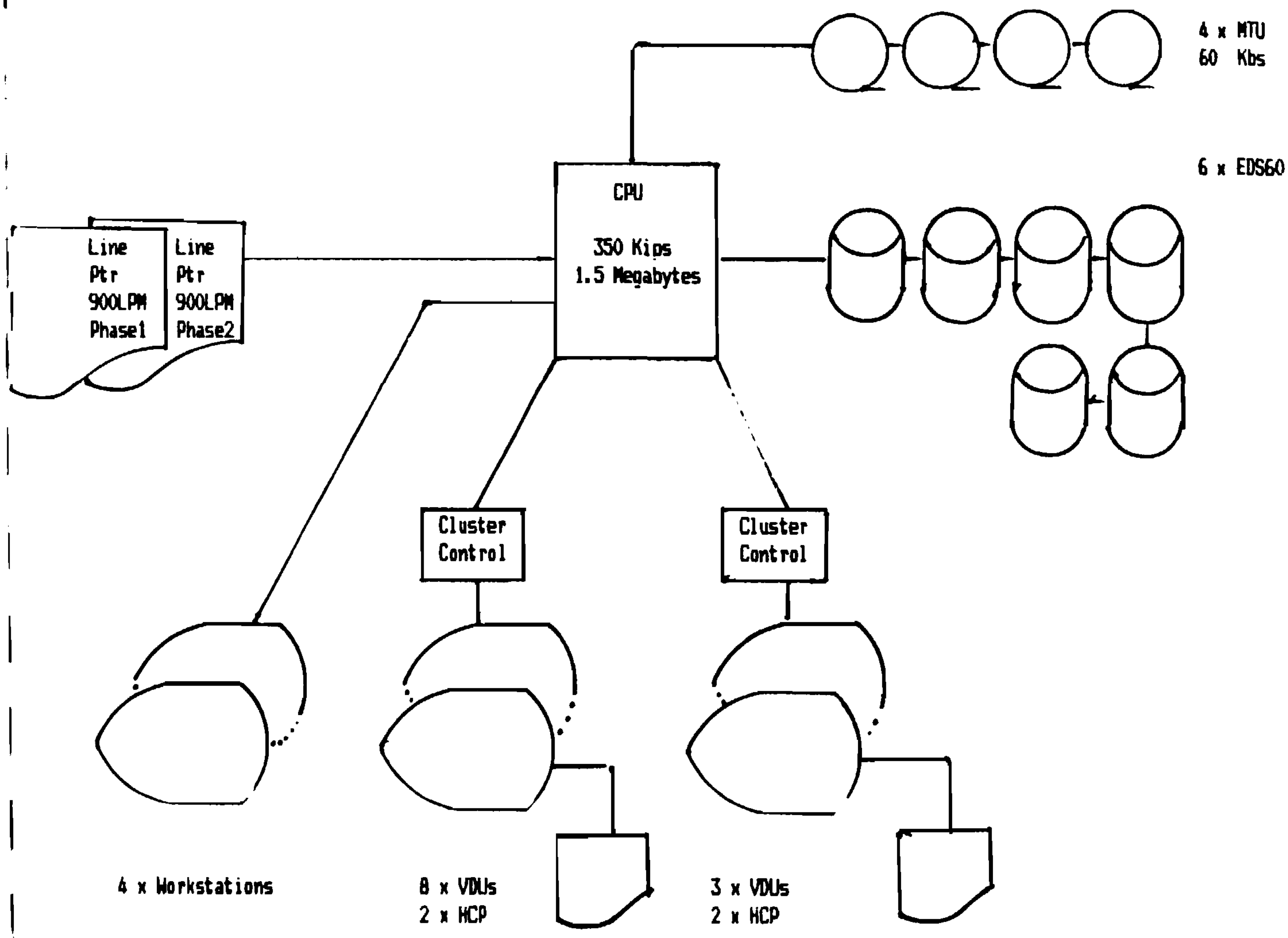
The specific hardware, software and services are detailed herewith:

Systems Project Management Limited

Hardware Specification

Delivery 1984

Item No.	Description	Qty	Estimated Price($)
1.	Main Processor with 350 Kips Power	1	95,000
2.	1.5 Megabyte store	1	32,000
3.	Exchangeable Disc Store Interface Unit	1	4,000
4.	Exchangeable Disc Drives of 60 Megabyte storage capacity	6	54,000
5.	Magnetic Tape Drive Master Unit NRZI, Phase Encoder 80 Kbs	1	15,000
6.	Magnetic Tape Drive (Slave)	3	21,000
7.	Magnetic Tape Interface Feature	1	[illegible],500
8.	Line Printer 900 lpm and 132 pp	2	36,000
9.	Mainframe to Communications I/F	1	[illegible]
10.	Modems, Cables, Printer Bands etc.	1	12,000
11.	Workstations	4	9,500
12.	Cluster Control Unit	1	9,000
13.	Video Display Unit	9	25,000
14.	Hard Copy Printer with Interface 120 Cps and 132 Print Positions	2	3,000
15.	Intelligent Distributed Cluster Control Unit with own Video Display Unit and 10 Megabyte Backing Store	1	11,000
16.	Intelligent Workstation for Distributed Cluster Control Unit	2	6,000
17.	Matrix Printer 120 Character Positions and speed of 120 Cps	2	2,000
	Total Hardware		**363,600**


4 x MTU
60 Kbs
6 x EDS60
CPU
350 Kips
1.5 Megabytes
Line
Ptr
900LPM
Phase1
Line
Ptr
900LPM
Phase2
Cluster
Control
Cluster
Control
4 x Workstations
8 x VDUs
2 x HCP
3 x VDUs
2 x HCP

System Services

The following sub-contractual consultancy and software services are required to support the hardware:

1.	Full Operating System with Standard Utilities, Sort, and Compilers	63,000
2.	Communication Software and Intelligent Terminal Support Software	15,000
	Total	**$78,000**

The following sub-contractual training services are required to support the Hardware/Software:

1.	Engineering Training: 22 student-weeks	30,000
2.	Systems Training: 15 student-weeks	21,000
3.	General Support: 2 man-weeks	6,000
	Total	**$57,000**

Appendix F

List of Participants

List of Participants

In Prague advice, briefing and assistance were provided by the following INORGA staff:

Name	Title
Ing. Jan Krouzek, CSc.	National Project Manager
Ladislav Cifka, M.Sc	Senior Adviser

The persons listed below provided information during the course of the project field work at Skoda, Plzen, Czechoslovakia.

Name	Title
Ing. Jiri Zaloucek	Adviser to the General Director
I[illegible]. Vladimir Leitl	Manager Organisation and Development Section
Ing. Milan M[illegible]	Director of CTR Division
Ing. Jaroslav Baracek	Manager of Computer Centre
Ing. Josef Bud[illegible]y	Chief of Research Department
Ing. Bohumil C[illegible]lar	Chief Systems Analyst
Ing. Vladimir [illegible]	Chief Systems Programmer
Josef V[illegible]	Systems Analyst
Ing. Jaroslav Safranek	Systems Analyst
Jaroslav S[illegible]	Systems Analyst
Ing. [illegible]slav [illegible]	Engineer

Prior to producing this Final Report, discussions and advice on the revisions to the Draft Report were held in Prague and Plzen with representatives of all the Czechoslovakian Organisations involved and with the UNIDO representative:

Name	**Title**
Professor G.D.Surguchov	Senior Industrial Development Officer

The Systems Project Management Consultant Team consisted of:

Name	**Title**
Bill Wolstencroft	Senior Consultant
John Carlisle	Systems Consultant
Glenn Bumford	Systems Consultant

Appendix G

Schedule of Field Activities

Schedule of Field Activities

Following the arrival of the SPM staff on the 7th November 1983 the project activities proceeded as detailed below. In order to meet the timescales set for the project both week-end and overtime hours were worked and both field and home based activities were run in parallel.

Wk	Activity	Location	Consultant
1.	UNIDO Briefing.	Prague	Wolstencroft/Carlisle
	Initial Skoda Hardware study.	Prague	Wolstencroft/Carlisle
	Study of Previous	Prague	Wolstencroft/Carlisle
	UNIDO Project Papers.	Prague	Wolstencroft/Carlisle
	Initial Meetings with	Prague	Wolstencroft/Carlisle
	Skoda Representative.	Prague	Wolstencroft/Carlisle
2.	Technical Discussions with Skoda Specialists.	Plzen	Wolstencroft/Carlisle
	Detailed study of Papers Relating to Skoda PCS.	Plzen	Wolstencroft/Carlisle
	Initial Recording of Material into Word-Processor.	Home	Carlisle + Typist
	Briefing Bumford	Home	Wolstencroft/Bumford
3.	Technical Discussions with Production Control Specialist.	Home	Wolstencroft/Bumford
	Preparation of Possible Hardware Configurations.	Prague	Wolstencroft/Bumford
	Continued Entry of Material to Word Processor.	Home	Carlisle + Typist
	Preparation SPM Report on Skoda PCS and further queries on the PCS.	Prague	Wolstencroft/Bumford
	Meeting with UNIDO Representative.	Prague	Wolstencroft/Bumford
	Initial Hardware/Software/Services Cost Evaluation.	Prague	Wolstencroft
4.	Visits to Proposed Pilot Plant.	Plzen	Wolstencroft/Bumford
	Technical Discussions with Skoda Specialists.	Plzen	Wolstencroft/Bumford
	Writing Draft Report.	Home	Wolstencroft
	Entry Draft Report into Word Processor.	Home	Wolstencroft + Typist

5. Revision of Draft Report.	Prague	Wolstencroft
Technical Discussions with Skoda and Ministry Representatives .	Prague	Wolstencroft
Entry of Revisions to Word Processor.	Prague	Wolstencroft
Printing Draft Report.	Prague	Wolstencroft
Delivery of Report to UNIDO.	Vienna	Wolstencroft
6. Final Review Jan '84	Prague	Wolstencroft
- First Full Meeting with UNIDO, Inorga, Skoda, and Ministry Representatives.	Prague	Wolstencroft
- Amendments to Report.	Prague	Wolstencroft
- Entry of Amendments into Word Processor.	Prague	Wolstencroft
_ Final Full Meeting with all Represent_ atives.	Plzen	Wolstencroft
- Printing and Issue of Final Report.	Home	Wolstencroft + Typist