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FINAL REPORT

after the final field mission combined with ***TTPR***
Terminal **T**ripartite **P**roject **R**eview
at 21 October 1994 on site in Beijing

UNDP-Project CPR/91/323

Title:

"Establishment of a Pilot Autonomous Manufacturing Island"

Project site:	Beijing, P.R. China
Implementing Agency:	Beijing No. 2 Machine Tool Works (BMTW No. 2)
Executing Agency:	United Nations Industrial Development Organization (UNIDO)
Contractor:	Ruhr-University Bochum Department of Production Systems and Process Control (LPS)

Dr. H. Schlange, Project Co-ordinator from LPS, ***7. December 1994***

1. List of Abbreviations

AMI	Autonomous Manufacturing Island
BDE (PDA)	Betriebsdatenerfassung (Process Data Acquisition)
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CAPS	Computer Aided Planning and Scheduling
CE	Concurrent Engineering
CICETE	China International Centre for Economic Trade and Exchange
CIM	Computer Integrated Manufacturing
CNC	Computerized Numerical Control
CRT	Cathode Ray Tube
DNC	Distributed (Direct) Numerical Control
FMS	Flexible Manufacturing System
NC	Numerical Control
PDA (BDE)	Process Data Acquisition
MMEI	(Chinese) Ministry of Machinery and Electronics Industry
MMI	(Chinese) Ministry of Machinery Industry
MRP II	Management Resource Planning II
TTPR	Terminal Tripartite Project Review
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
WIP	Work In Process

2. Abstract

The structure of the box-case workshop of the machine tool builder BMTW No. 2 has been successfully reorganized to establish a Pilot Autonomous Manufacturing Island (AMI).

Therefore at first a comprehensive and extensive data acquisition has been carried out. On the basis of the results, a new layout has been worked out with the main emphasis on an easy and unidirectional material flow and on processing a specially selected part family, as complete as possible. This group technology oriented manufacturing is aimed at processing of the work-pieces, delivered from casting, until transport of the finished parts to the assembly-shop in order to have an easy model for scheduling, a better overview in one workshop and to avoid unnecessary transportation and down times.
Some additional modern and automated equipment like a tool pre-setter has been added to the machinery of the new AMI while a lot of the existing inventory has been retained and integrated by the introduced automated information system.

The second major step was the conception of a powerful integrated software system to support the staff of the AMI, both on the one hand for the work-preparation in the AMI-office and on the other hand for the processing and machining in the workshop. Systems available on the market have been evaluated for the AMI of BMTW No. 2 and finally selected. They have been integrated, connected via network and then step by step successfully introduced and taken into operational status by BMTW No. 2.

The third major item is the highly successful training of the AMI-staff, mainly aimed at the principles of the management of an Autonomous Manufacturing Island, efficiently using the powerful modern software tools and improving the practical use of the existing NC-knowledge. This human aspect is the key issue for introducing more and better efficiently using of advanced equipment.

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4. Introduction

4.1 Goal of the project

The goal of this project is to introduce and set-up appropriate modern high-technology and high-performance manufacturing structures in a box case workshop of a machine tool builder under the special conditions of a fast developing country and without investment in completely new machinery. This is done by restructuring and improving the organization and management skills, by supporting the staff with computer based information tools and thus creating a higher degree of autonomy and flexibility and by enhancing the technology base especially in the field of NC.

4.2 Concept of the Autonomous Manufacturing Island

The AMI is generally based on the Group Technology, that is to say a part family especially selected as to geometrical or processing similarities, will be processed completely from raw material to finished product without leaving the AMI in between. Therefore the AMI comprises all machinery needed to process the part family, that means normally machines with different technology (drilling/boring, milling, turning, grinding...) and also all accessories like marking, checking, measuring, tool and fixture preparation and also manual working places. There are no separated workshops for boring, milling, turning and grinding. The machine tools usually have different degrees of automation from conventional to CNC, that means an AMI must not necessarily be a high investment "Flexible Manufacturing System" (FMS). The degree of automation is adjustable and can be increased step by step as to future demands and following the built-up of expert knowledge to handle the full range of automated machinery. **Fig. 4.1** gives a general overview of the AMI-principles.

Instead of buying fully automated machinery the information flow and management will be automated and computer supported as a mean to support the AMI-staff for technical work preparation and organizational management.
The AMI-staff takes over and is responsible for all activities for the AMI-parts and orders from drawing, process planning, scheduling and monitoring, quality controlling until delivery on time, on specification and on demand. The work is group-oriented and not divided as to the Taylor-principle.

The inclusion of all activities within the AMI means a high degree of autonomy. That is to say, the AMI is not so dependant on central services, which are not so quickly available and which often lack the detailed internal knowledge of the current AMI-situation. Thus the AMI is a decentral structure, workshop-oriented, that means near to the process and human-centred. By its autonomy, its short ways both physically and as to information flow, it is very responsive to every change. By this mean it has in-built Flexibility and Adaptability.

The AMI is principally aimed at reaching the CIM-goal in a much more appropriate way, step by step with lower investment using the existing machinery, conventional as well as NC or CNC, and concentrating on improving and on better using the skills of the workers, on a more efficient organization and on better management methods and preparing and laying the foundation to carefully introducing automation and more sophisticated machinery. Thus the AMI is an affordable approach to introduce modern manufacturing.

The AMI is also a necessary foundation to improve or renew the product range, as its flexibility and workshop-oriented creation of new parts support an easier and shorter introduction of new parts. The possibility to change products and processes faster and easier is improved.
Another aim, which is also very important in the nowadays environment, is to improve the quality without the normally associated high cost increase, to keep down scrap and rework rates by producing parts to specification with safe processes from the very beginning.

The principal goal of an AMI is to deliver the orders on time with shorter lead times, be able to deliver more quickly on time and on market demand and thus be able to compete in a more and more competitive and global environment. Therefore again the autonomy of an AMI has to be emphasized to get some rough order due dates from central level and decide the fine scheduling and monitor the actual progress by itself (**fig. 4.2**) and in case of delay or disturbances or unforeseen urgent orders (rush jobs) to decide by itself about the best possible reaction to fulfil the requirements from central planning. Thus the AMI is a small factory within the factory.

5. Summary of findings and recommendations

5.1 AMI - Structure

The layouts of the former workshop for box-case parts and the newly established Autonomous Manufacturing Island are shown in **fig. 5.1** and **fig. 5.2** respectively. The machine tools and other inventory are also listed in these layouts.

The part family currently consists of 95 different box-case parts, i.e. mainly prismatic parts with multi-face operations of borings with very accurate axis positions.
There is always some change in that part list. New parts will be introduced while some older will be cancelled. This is one aspect to be supported by the flexible AMI-structure.

Recommendation:

- *More parts as to number and particularly more complex parts should be taken in the future to even better use the flexibility and productivity potential of the AMI.*

Concerning the AMI-building and the AMI-environment it can be said that while establishing the AMI in a new building, BMTW No. 2 has also largely and with great success improved the general conditions of manufacturing on the shop floor. A much better illumination, clearly marked ways for transport and marked areas for special purposes are a necessary precondition for the safety of the workers, for quality work and for a higher motivation of the staff. Free access to all areas also improves the internal material flow. The AMI-office with a good overview of the shop floor is the base for the autonomous AMI management close to the workshop and also avoids the danger of creating a hierarchical structure and offices far away from the process.

The AMI-structure has been successfully set-up and gives a very good foundation for future development.

5.2 Material Flow

The general material flow has been largely reorganized and is according to the following rough pattern:

* material coming in either raw from casting or already after rough processing and heat treatment outside, will be stored in the AMI until order release decided by using CAPS-scheduling,

* after releasing the order internally, the operations follow one by one to shorten through-put time and down-times in between,

The operations in the AMI can be roughly divided in:

- marking (marking area),
- rough machining (mainly on the conventional machines), if not already done before outside,
- fine machining (mainly on the NC-machining-centres) ,
- checking (checking area, measuring device),
- delivery to grinding, paint-shop or assembly as appropriate.

For storing the AMI provides a High-Bay-Storage with a stacker (fork-lift), which is located at one end of the workshop-hall. It also stores the fixtures. A Tool Storage is located beside the Tool Pre-setter. Thus the material and the work pieces are either stored or located beside the current work place and not scattered around forming obstacles for transport and material flow.

A new 3-coordinate-measuring-device currently in the process of implementation will provide an improved checking of the parts inside the AMI and will also support the AMI idea of complete processing.

5.3 Information Flow

On the basis of the data acquisition an overall concept for the computer support has been created. Then the market has been evaluated especially using the expert knowledge of the respective engineers responsible for the certain field of planning, scheduling, NC-programming and so on. This selection has been aimed at getting a suitable AMI-information-system, whose components can easily be integrated. As standard products from the market were taken, this solution can also be adjusted to other Chinese machine tool factories.
The **fig. 5.3** represents the overall factory CIM-concept and **fig. 5.4** the realized AMI-system as part of the former. The Computer supported systems have been successfully implemented and step by step taken into daily operation while the staff is building up more and more practical experience with the comprehensive functionality of the different modules of the systems.

Recommendation:

- *The practical use of all systems should be enforced more and more to become daily routine work.*
- *Additional trainees should be made familiar with the system-handling and the functional procedures for all systems. For example every designated system operator should get an assistant to learn while the normal operator is working on the job and time by time the assistant will take over the routine work.*

5.3.1 Technical information flow

The **fig. 5.5** gives an overview for the normal procedures of creating a new part or a new version of a part with CNC-programming starting from drawing (creating geometry), via NC-programming and post processor run to sending it to the respective machine control unit through PDA (BDE)/DNC. A standard interface to take over CAD-data is prepared.

5.3.2 Organizational information flow

The **fig. 5.6** represents the organizational procedures, the normal sequence of AMI-management activities from taking over the order list from central level via computer supported scheduling in the CAPS, sending the job lists to the respective machine tools via PDA (BDE), getting the progress reports from the machine tools (feedback by PDA (BDE)), automatic adjustment of the schedule as to current situation, monitoring the predetermined dates and if necessary change the schedule. The finished orders and related numbers of correct parts will be reported back to the central level.

Various software-supported methods and algorithms are available within the CAPS to get an optimized schedule (different optimization goals) and also different procedures to react on disturbances and possible special emergency orders like splitting and joining of orders.

5.3.3 AMI and the central factory level

The connection of the MRP II (BPCS from SSA System Software Associates) on the central factory planning level and the "Leitstand" or CAPS for AMI-scheduling and fine planning is prepared and will be carried out when the MRP II is running smoothly. The MRP II will come on stream step by step. This is a normal process as the experience shows even in the highest developed countries. The interface is generally prepared.

The interface to take over data from the centrally located CAD-system BRAVO from Applicon is also prepared. The Drawings can then be processed by the CAM from COSCOM in the AMI-office. It is also possible to make some refinements and adjustments to the drawings within the AMI-system, taking into account, that the AMI-staff has normally the deeper knowledge of the special manufacturing conditions and machine tool capabilities in the AMI. The AMI-system comprises a small CAD-system suitable for the special demands of manufacturing and the workshop conditions and so gives some autonomy for the AMI in this respect. It is also used for creating new fixtures and storing and administrating the drawings of them. Fixtures are very important for box-case manufacturing and to include all the handling and preparation of them is a typical AMI feature.

The centrally located CAD from Applicon is for the overall design of new products, which requires special knowledge.

5.4 Project related software modules and equipment for enhanced information flow

This paragraph shall give a general overview and a short list of the major items, hardware as well as software, procured with budgets of this project:

Supplier Plansee Messma Kelch

- Tool pre-setter with accessory and in-built standard-PC control
- Tool-Management-Software EA9 implemented on in-built PC

Supplier PSI

- Comprehensive CAPS or "Leitstand"-system PIUSS-O based on powerful PC in Windows-environment, Chinese language user interface
- GAT-module for order and process-plan administration and statistical evaluations of the AMI also in Chinese,
- BDE-connection to shop floor-level, interface to COSCOM-Terminal,
- Chinese printer forms for shop floor use,
- interface to host prepared (MRP II BPCS from SSA, System Software Associates, Chicago).

Supplier COSCOM

Comprehensive CAD/CAM-system including:

- CNC-Programming-system DIALOG with various modules, e.g. Graphic Editor, Milling/Boring Technology Module, JOKER NC-converter

(Chinese version prepared and currently tested and debugged and improved).

- 11 PDA/BDE-Terminals (Chinese user interface necessary for a workshop located device).

- Six different NC-control units from various origin connected via PDA/BDE-Terminal
  (2 FANUC 6M, FANUC 7M, Heidenhain TC135, Fagor, Permac Selca 1200).

  The occurrence of really different control units from different countries, date of purchase and level of automation and technology (transfer rate and so on) is often to be met on the shop floor level. It is a principle AMI-feature to integrate existing inventory and automation in contrast to FMS - Flexible Manufacturing Systems with a very expensive and normally prohibitive total new investment from one main supplier.

- 6 powerful Personal Computers including File-Server, BDE/PDA-Server and accessory like 4 high resolution 20"-colour-screens (CRT), barcode reader, tape streamer for back-up.

- NOVELL Network within the AMI office and connecting the AMI shop floor.

For the detailed list see **ANNEX 4**. The installation is completed. All suppliers stay in contact with BMTW No. 2 for support, maintenance and possible distribution to other Chinese factories and are also willing to take part in a high-level dissemination.

5.5 Staff Training and Qualification

The human-related aspect is the vital issue of the project with the aim of enhancing the management and organization skills and better using the technological skills and especially the practical use of the technical and NC-knowledge. Only by these means you can get the full benefits of the new AMI-management structure and the automated machinery and equipment on the shop floor.

Therefore study tours and extensive training missions specially tailored to the needs of BMTW No. 2 and the AMI-project have been planned and successfully carried out (see **ANNEX 3**) during the project time. At the end of the project for all key areas of the AMI there is highly qualified staff.

One problem possibly arising in the future may be to keep the qualified project staff in the factory after finishing the project against higher salary offers from the private sector and thus avoiding the erosion of the knowledge base. A carefully built-up knowledge base is essential for every machine tool builder. It is his human capital.

Recommendation:

- *set-up of incentives or wage benefits scheme related to the AMI output to further increase personal motivation and the responsibility of the AMI-staff as a group,*
- *transfer and spread knowledge from trained project staff to other "trainees" of the factory for example by assigning talented young people to each member of the qualified project staff and thus increase the "human capital" of the factory,*
- *offer better career opportunities combined with permanent further education for the high qualified staff,*
  thus the staff will have steady long term prospects for personal development and qualifying instead of short term oriented high salary offers from the market.

5.6 Output and major Achievements

5.6.1 Achievements reached by now

The general development has to be seen against the background of tremendous changes in the outer environment on the Chinese market, the world market and particularly concerning the world-wide slump in the machine tool branch during the project time especially in the last 2 years.
It was initially targeted in the **Project Document** to increase the capacity to 900 parts per month instead of 600 at the project beginning. The capacity has been

increased strongly but currently is not fully used. This is actually not relevant, as this high production output is currently not needed due to market demand increasing with a lower than expected rate. In fact this reflects the **ongoing market reforms** to adjust production targets to actual demand and not to follow pre-planned targets. The box-case workshop has been identified in the **Project Document** as the bottle neck of the factory and this **bottle neck is virtually removed**. The target is now more shifted to cost and efficiency. This is elaborated in the following.

This paragraph provides data from the project beginning (1991/92) and at the project end (1994). The overall efficiency is higher by now. It will go up even more in the future, as the following rough measures indicate (see also **ANNEX 5.1 - 6**).

a) Productivity:

The new AMI now comprises 10 machine tools in operational status against the old AMI (at the beginning of the project) which the new AMI has replaced and which had 16 machine tools. Yet it has a higher productivity. The old AMI-workshop was the bottle neck of the factory. The new AMI is now no more bottle neck and has indeed virtually a leading function within the whole factory. Furthermore two additional machine tools currently in test operation will further increase productivity and output.

The total number of workers in the AMI has been decreased to 21 persons: The workshop staff number is down to 10 (operators) plus 8 in the AMI-office for autonomous management and planning and for miscellaneous purpose another 3 workers. Yet the task and the share of the whole factory work are the same or even higher than before.

The monthly machine hours have been increased from 210 per machine tool (and also per operator) to 262 per machine tool (and per operator). The monthly output per machine tool has been increased whereas the over all total man hours for the AMI are going down in accordance with the lower staff and machine tool numbers from 3360 to 2620 hours (**ANNEX 5.1**).

At the same time additional planning functions have been implemented in the AMI, so that this capacity demand normally provided by the central level

(research institute and central planning) has been strongly reduced and taken over by the AMI-staff.

b) Schedule performance:

The schedule performance or term accuracy has been largely improved. The planned due dates of the AMI can be better kept. With ongoing reforms the necessity of shorter planning cycles and thus the requirement for more accurate scheduling will increase.

By now there is a higher planning and scheduling safety, because the result of the planning and the scheduling will be displayed graphically in the Gantt-chart of the CAPS.
For example there is a better overview when there are immediate requirements from assembly workshop for some specific parts, it can be seen how fast they can be produced and what is the consequence for the other orders with respect to their due dates. It can also be decided which capacity (machine tool) shall be used and if it is necessary to order an additional shift for a certain machine and operator.
The CAPS will also support with automatic functions a quick rescheduling to get back an optimized sequence of jobs after a disturbance of any kind.

c) Through-put time:

The average through-put times have been decreased from 45 to 50 days before to 30 to 35 days now and combined with this the "Work In Process" (WIP) and the necessity for storage in between the processing is down **(ANNEX 5.2).**

d) Inventory:

The inventories and "Work In Process" (WIP) are decreased. This is obvious already when simply looking at the shop floor in comparison with the situation at the beginning of the project, where batches of work pieces were lying not only near every work station but virtually scattered around on

all transport areas. This decrease is apparently related to the shortening of the through put time.

e) Capacity utilization:

The capacity utilization rate is 15 % higher than at the beginning, especially the utilization of the important NC or CNC machine tools has been increased.

f) Output:

The total output will be increased soon by simple numbers and even more important by value, i.e. higher values per part, after all new procedures are well-known practice, the two new machine tools in testing status are operational and machine-tool demand picks up again.
The AMI is especially designed to increase the percentage of higher value (high precision) parts and thus increase the output value.

g) Quality:

The quality has improved. The average rate from AMI internal auditing has dropped from 2.5 items(faults) per machine and month to 1.5 items **(ANNEX 5.3)**. From outside auditing the rate has gone down from 4 items per machine and month to 1.5 items **(ANNEX 5.4)**.

The rate of reworked parts has slightly been decreased from 3.8 % before to 3.3%. This will further improve, once the new NC-programming is fully introduced **(ANNEX 5.5)**.

The average rate of finally rejected parts is now down to 0.28 % from 2.5 % from before the project **(ANNEX 5.6)**.
The reducing of scrap results in a rough calculation to a cost saving of RMB 50.000 Yuan per year.

5.6.2 Future potential

At the beginning of the project, the box case workshop was identified as the bottle neck for the factory. By increasing of its **PRODUCTIVITY**, the output capacity of the whole factory has been increased by now and will do so even more. This higher productivity will emerge more and more when all procedures and the use of the new organizational tools for management will virtually be daily routine work and the technical support for part generation becomes familiar to the AMI staff and more new parts will be integrated into the part family of the Autonomous Manufacturing Island. The additional machine tools now being tested will also contribute to this.

As this higher output is connected with lower staff numbers, this also means higher **EFFICIENCY**, especially when taking into consideration, that the staff salary will rise in the future following the general development and thus will have more impact.

Especially for a market-oriented machine tool builder it is equally important to focus on an enhanced degree of **FLEXIBILITY** and **ADAPTABILITY**, which is a main feature of the new AMI, to cope with the more and faster changing market demands and to be able to better introduce new parts needed for new or improved products. Therefore the capability of the powerful office software systems will get more and more importance.

This office software will also bring another **COST REDUCTION** for the factory, as the AMI gets more and more independent from the work preparation in the central level and can do the preparation nearer to the process and more efficiently.

Another issue is the higher **MOTIVATION** for the staff to work in a modern technical environment and combined with the AMI - principles to take over more responsibility by themselves. This is not only relevant for a high quality output but may become a greater concern to all state enterprises, as more and more other business sectors attract the qualified staff.

A future aspect of the AMI-office software system is its possibility to support a **CONCURRENT ENGINEERING** process aimed at being able to design and

introduce into manufacturing a range of advanced products efficiently and in a shorter time. This will become a major issue for the Chinese machine tool industry when the PRC will eventually re-enter the GATT-treaty or as it will be called from 1995 onwards World Trade Organization WTO.

5.6.3 Dissemination

A national dissemination was hold during the last project-mission at 20 October one day before the official TTPR. Fifteen qualified guests related to the machine tool branch have been introduced to the project contents and results by lectures (s. **ANNEX 6**) and demonstrations in the AMI shop floor and computer office. The Dissemination was mainly carried out by the subcontractor LPS, staff of BMTW No. 2, and national expert Prof. Zhang Shu (Tongji University Shanghai). The AMI of BMTW No. 2 will also be open for future demonstration to visitors from other Chinese machine tool factories.

Beyond that, it is planned to hold a full scale international dissemination under the auspices of MMEI/CICETE and UNDP/UNIDO. The date is currently set on June 1995 so that there is enough time to prepare and organize such a conference like inviting the audience. Another advantage is also to have some time so that the use of the new equipment has become more and more common and all new procedures are settled in the new AMI. A proposal has already been submitted by the UNIDO-Subcontractor LPS. A revised and more detailed schedule for this dissemination was worked out during the mission for TTPR.

5.7 Conclusion

The structures and principles of an Autonomous Manufacturing Island as an affordable approach to introduce and implement modern manufacturing technologies, have been successfully and well implemented. As an AMI is a very flexible and adaptive structure it can easily be adapted as to future demand in a fast developing environment. During the project the AMI-staff has got a good understanding of its function as a partly autonomous working group. The handling of the systems still needs some time to become day by day practise for all AMI-staff. To ensure a future development the knowledge base must also be further spread within the factory. The economical improvement can already be proved by now but will become more clear when the system handling and all related

procedures are well-known, the whole performance range of the systems is used and by these means new parts and processes are introduced.

The AMI has been intended as a pilot structure for the Chinese machine tool industry. Indeed the newly created AMI of BMTW No. 2 can be used for demonstration and as a showcase for other Chinese machine tool factories. Of course its structure and its information and management system are specifically configured but can easily be adapted and transferred to other units. For this adaptation of course a detailed analysis and data acquisition are essential. And even more important for spreading of the AMI-principles and the introduction of the management and technical support software an adequate and extensive training and education of the staff designated to operate the AMI is required. Therefore the AMI of BMTW No. 2 can also serve as a training unit.

5.8 Outlook

A future aim, which is already prepared by this project and has a good foundation by the established island structures and the AMI-computer-office, is the introduction of the principles of "Concurrent Engineering" to improve, renew or partly change the product range following the more and more rapid market development by enhancing and interlacing the design of parts and processes, the work preparation and the scheduling. That means a much more comprehensive view of the whole process chain from the product idea via part design, work preparation, scheduling, manufacturing, assembly until delivery in order to

- reduce the time for product or part renewal,
- reduce the cost and efforts for the product or part redesign,
- better use the manufacturing and assembly knowledge already in the earlier stage of design and work preparation,
- avoid mistakes and quality problems in the early stages of product and part design, because later on the related cost to repair is much higher.

6. List of Drawings

7. Annexes

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Project time schedule (Milestones)

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Detailed time schedule for the last year of the project

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Overview major working steps (Field missions, study tours and training missions)

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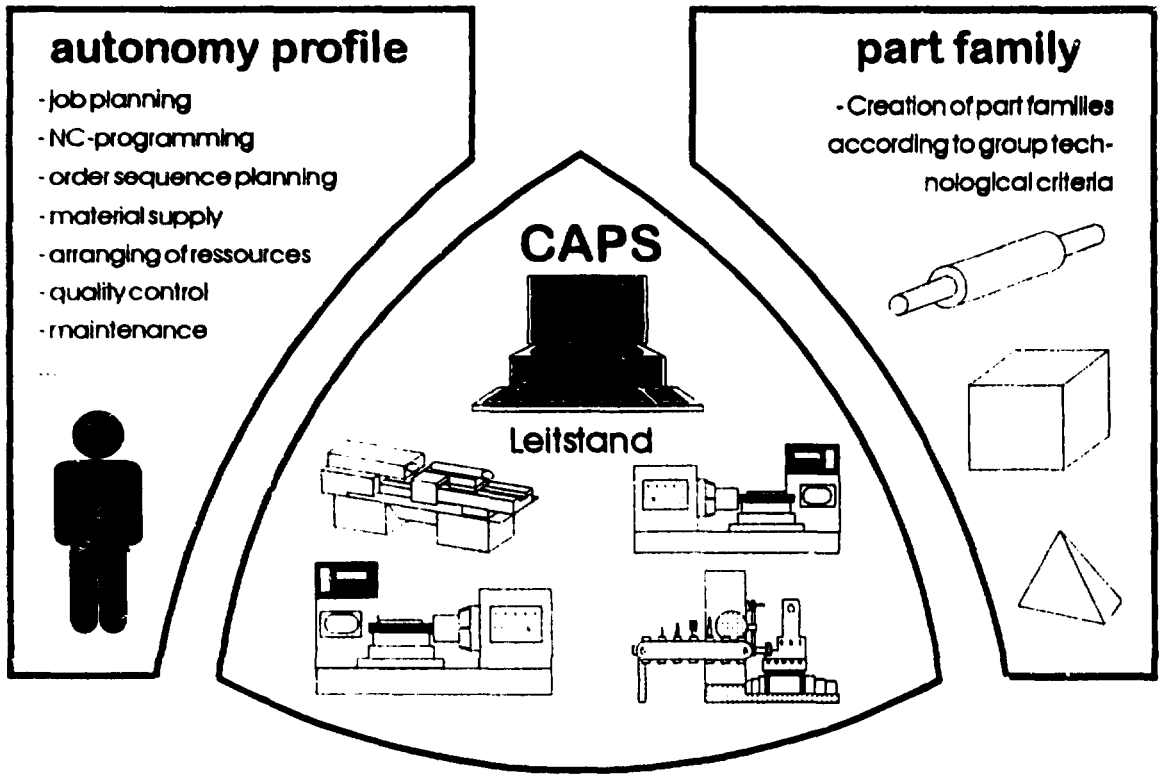
Proposal for an international Dissemination

Autonomous Manufacturing Island



part family oriented combination of facilities

Turning | Drilling | Milling | Grinding

Kreimeier e90765-

Unido chart A1.0

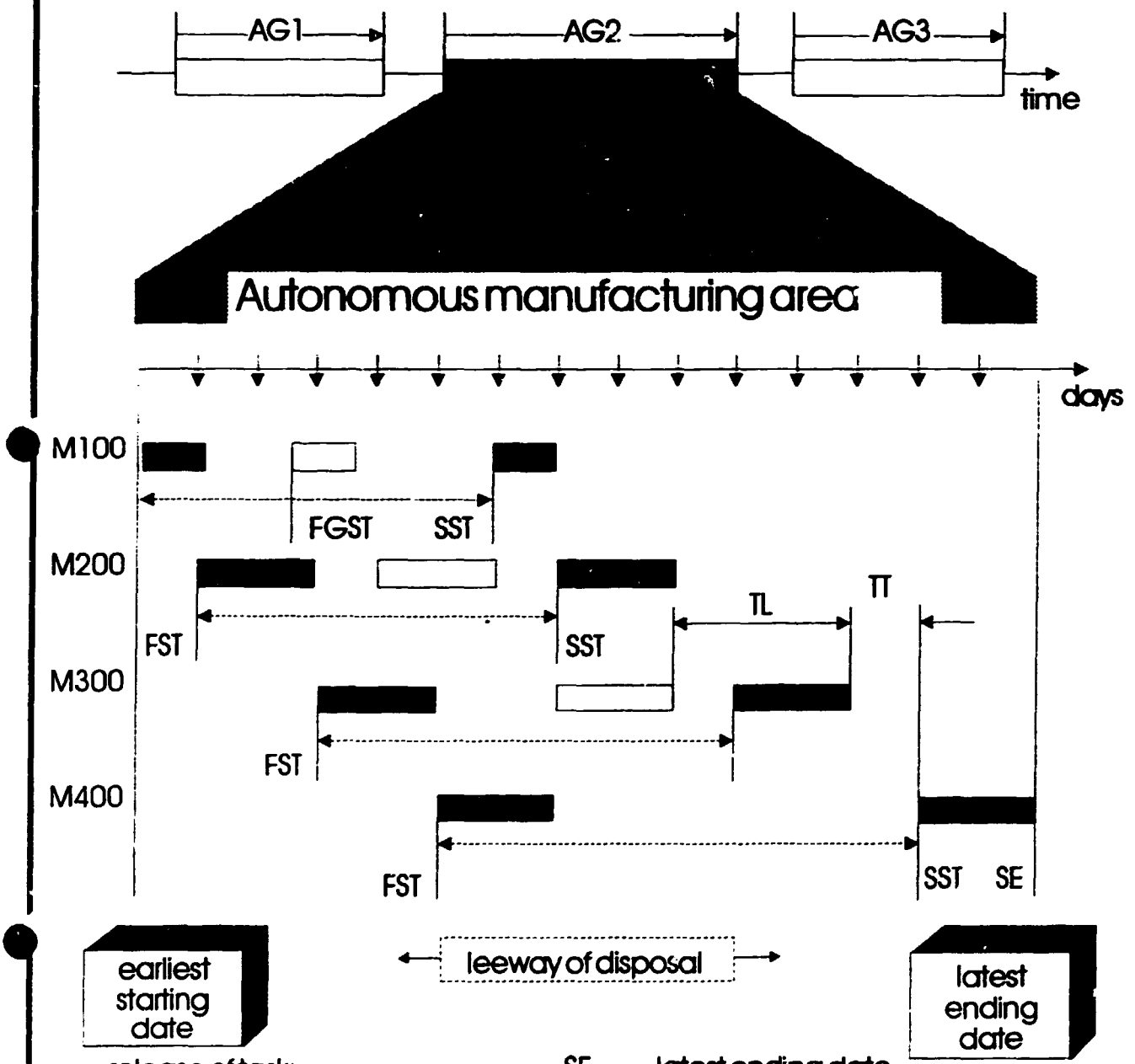
fig. 4.1

Characteristics of Autonomous Manufacturing Structures

Ruhr-Universität-Bochum

W. Maßberg

Central planning level: rough scheduling



earliest starting date

leeway of disposal

latest ending date

release of task:

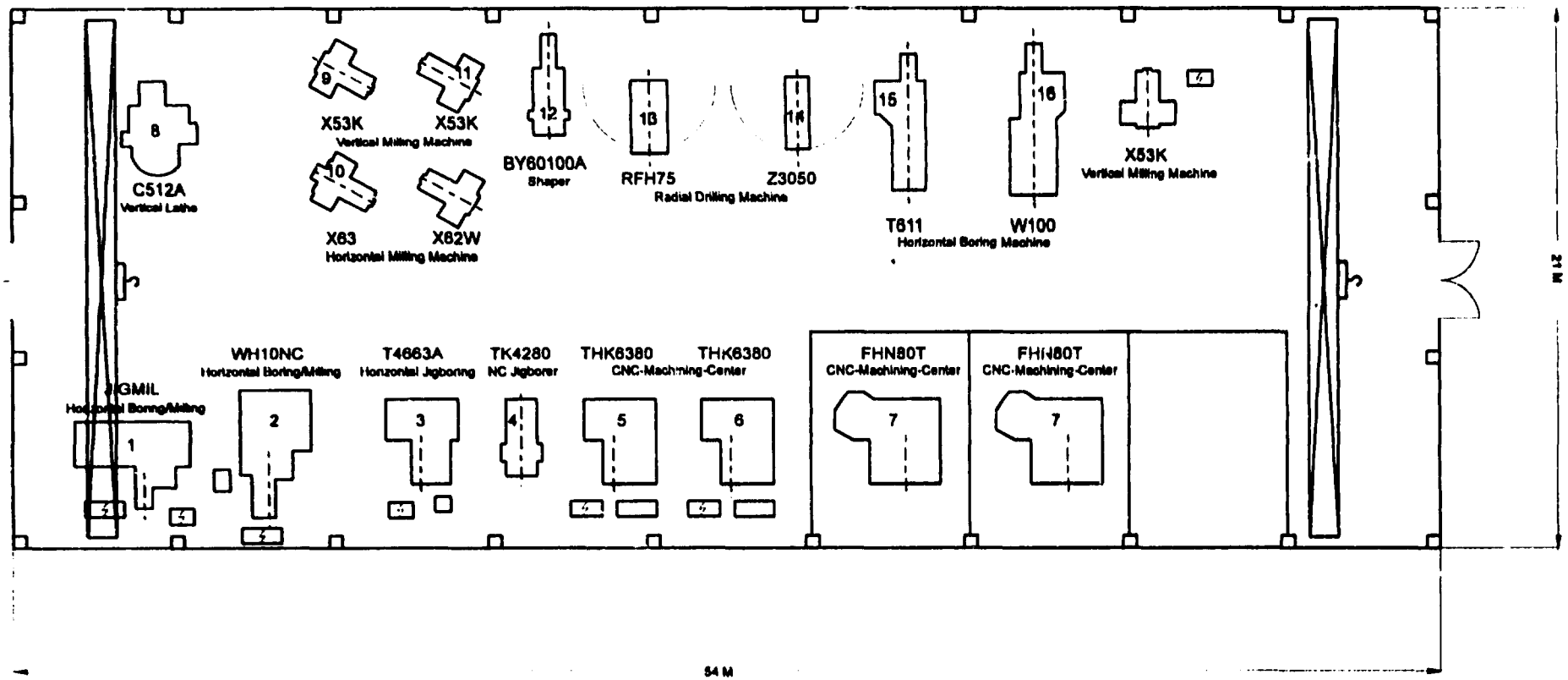
$$FGST = SE - \sum_{a=1}^{n} (TA + TT + TL)$$

leeway of disposal:

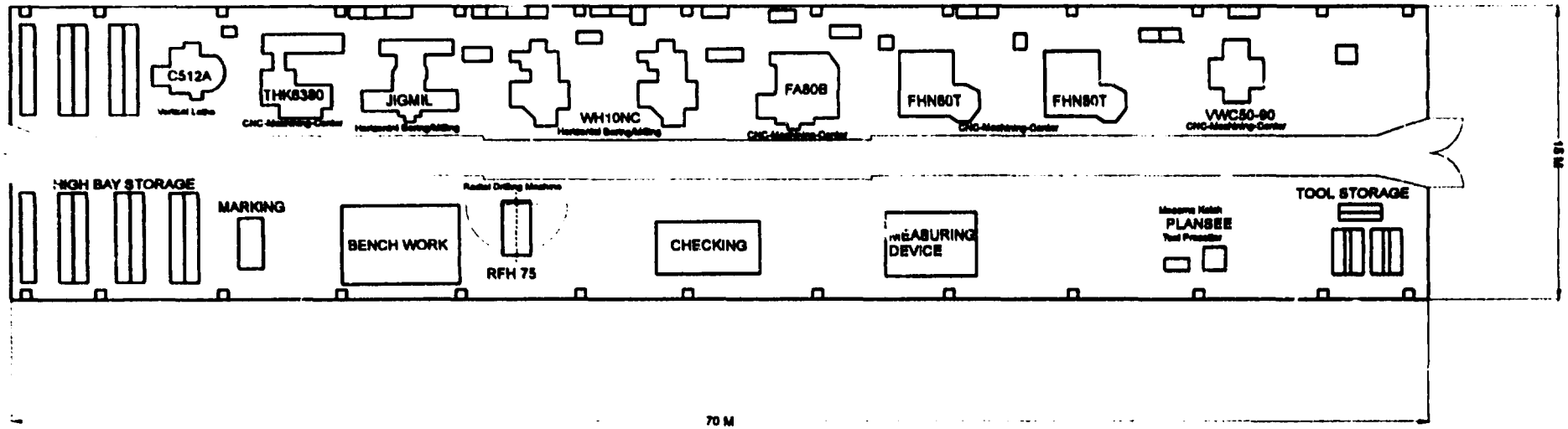
$$D_b = FST_{b,a} - SST_{b,a}$$

SE = latest ending date
SST = latest starting date
FST = earliest starting date
TT = transporting time
TL = delay
a = index on location of work
b = index on operation

W.Maßberg	scheduling principle of AMI	fig. 4.2
		E90763-Kreimeier
	Ruhr - Universtät - Bochum	A1.1



W. Maßberg	**BMTW No. 2** — **Layout: old AMI (before project)**	Schlange October 1994
	Ruhr-Universität-Bochum	Fig. 5.1



BMTW No. 2 Layout AMI

Schlange

October 1994

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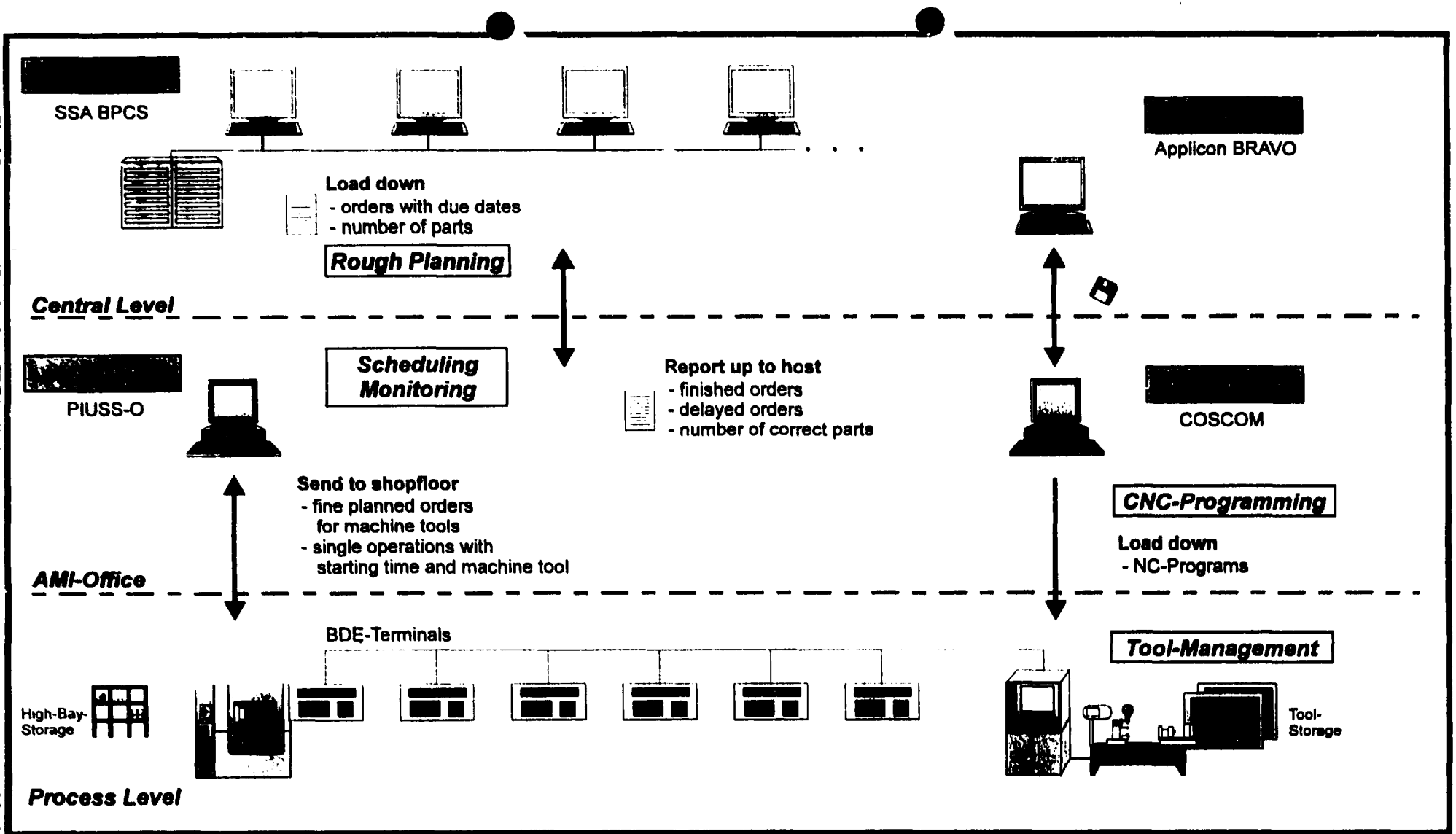
Fig. 5.2



W.Maßberg

Factory CIM-Concept

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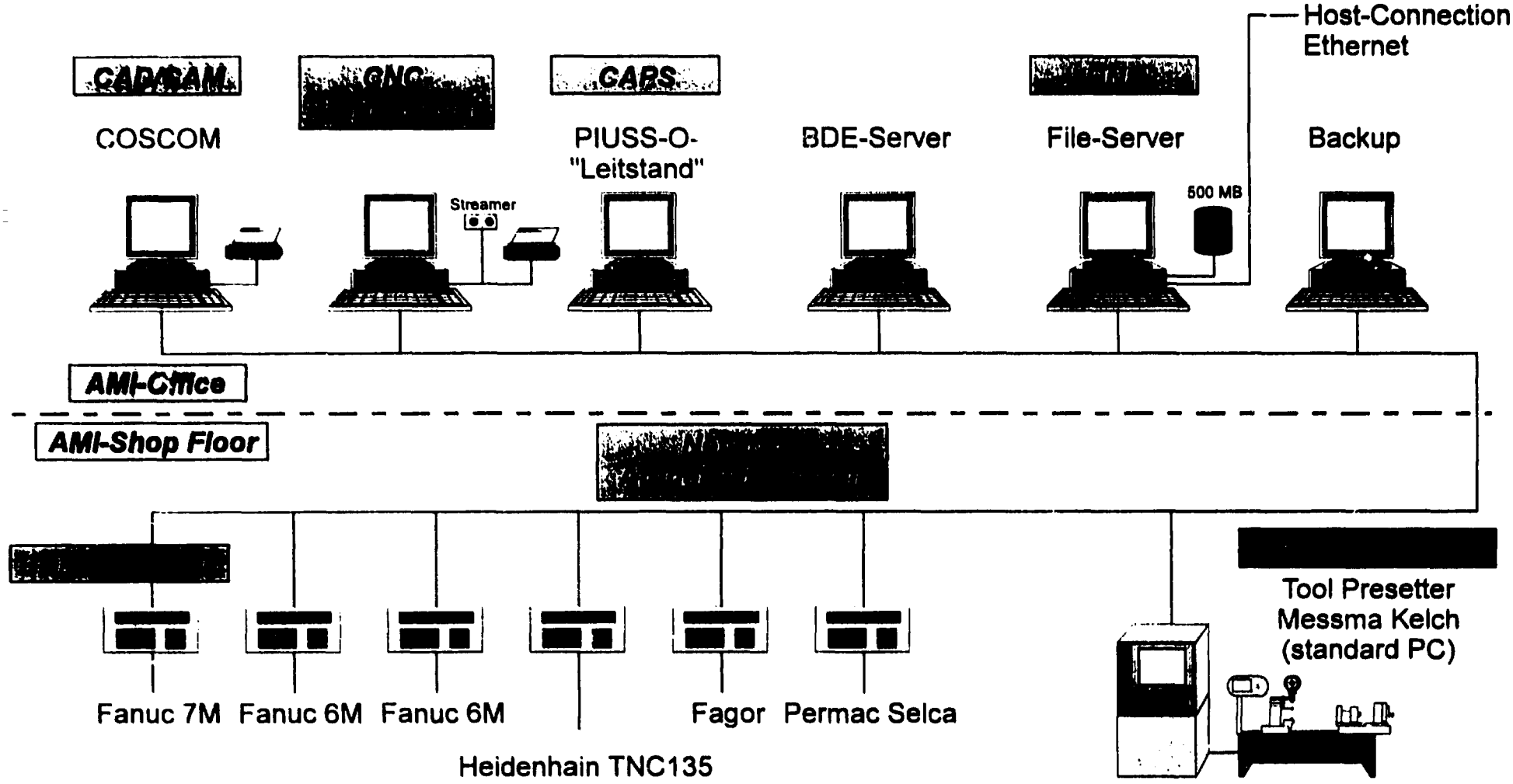
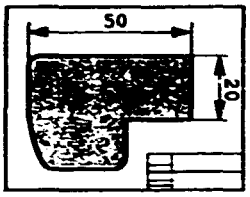
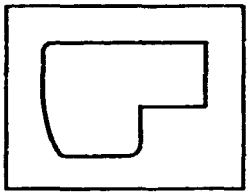
Ruhr-Universität-Bochum

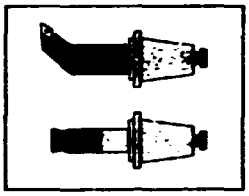
Fig. 5.3

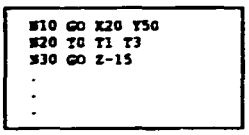


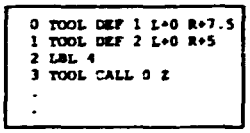
W.Maßberg	**AMI-Information-System** **Hardware configuration**	Schlange October 1994
	Ruhr-Universität-Bochum	Fig. 5.4











Interface IGES, DXF

CAD-CAM Geometry

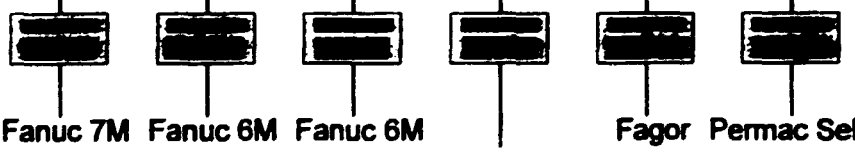
Geometry, Technology EDITOR

NC-Programming DIN 66025

JOKER Development-Kit

Post-Processor for:

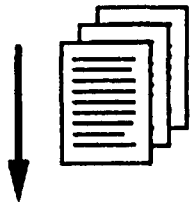
DNC-BDE with standard ARC-Net network



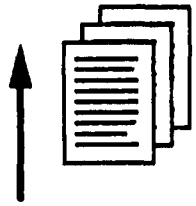
Fanuc 7M Fanuc 6M Fanuc 6M Fagor Permac Selca

Heidenhain TNC135

W.Maßberg	**Technical Information Flow**	Schlange October 1994
	Ruhr-Universität-Bochum	Fig. 5.5



Orders with due dates and number of parts



Finished orders

Process plans

[redacted]

Computer- supported

Scheduling

Assignment of single operations/processes to machine tools with a starting time

Automatic rescheduling

as to current situation

Monitoring

- keeping due dates
- number of correctly produced parts
- quality

Change schedule

If necessary
- change sequence
- split an order, rejoin
- overlap
- reduce transition time
- additional shift

[redacted]

Load down

List of operations to machine tools

Report up

- order progress from shopfloor
- finished operations
- delays
- scrap

Information Flow Organization, Scheduling

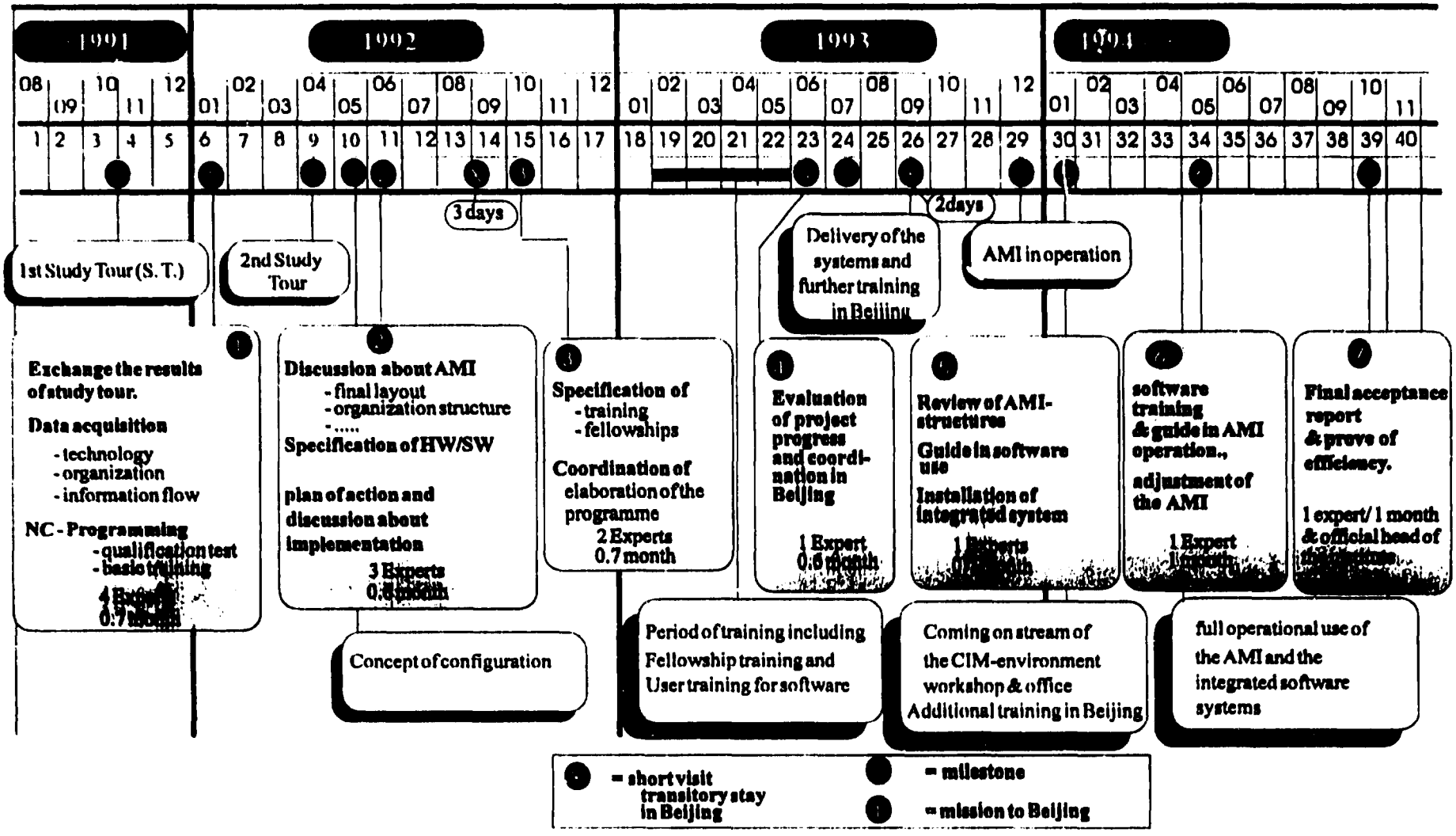
Schlange

October 1994

W.Maßberg

Ruhr-Universität-Bochum

Fig. 5.6



W. Mellberg

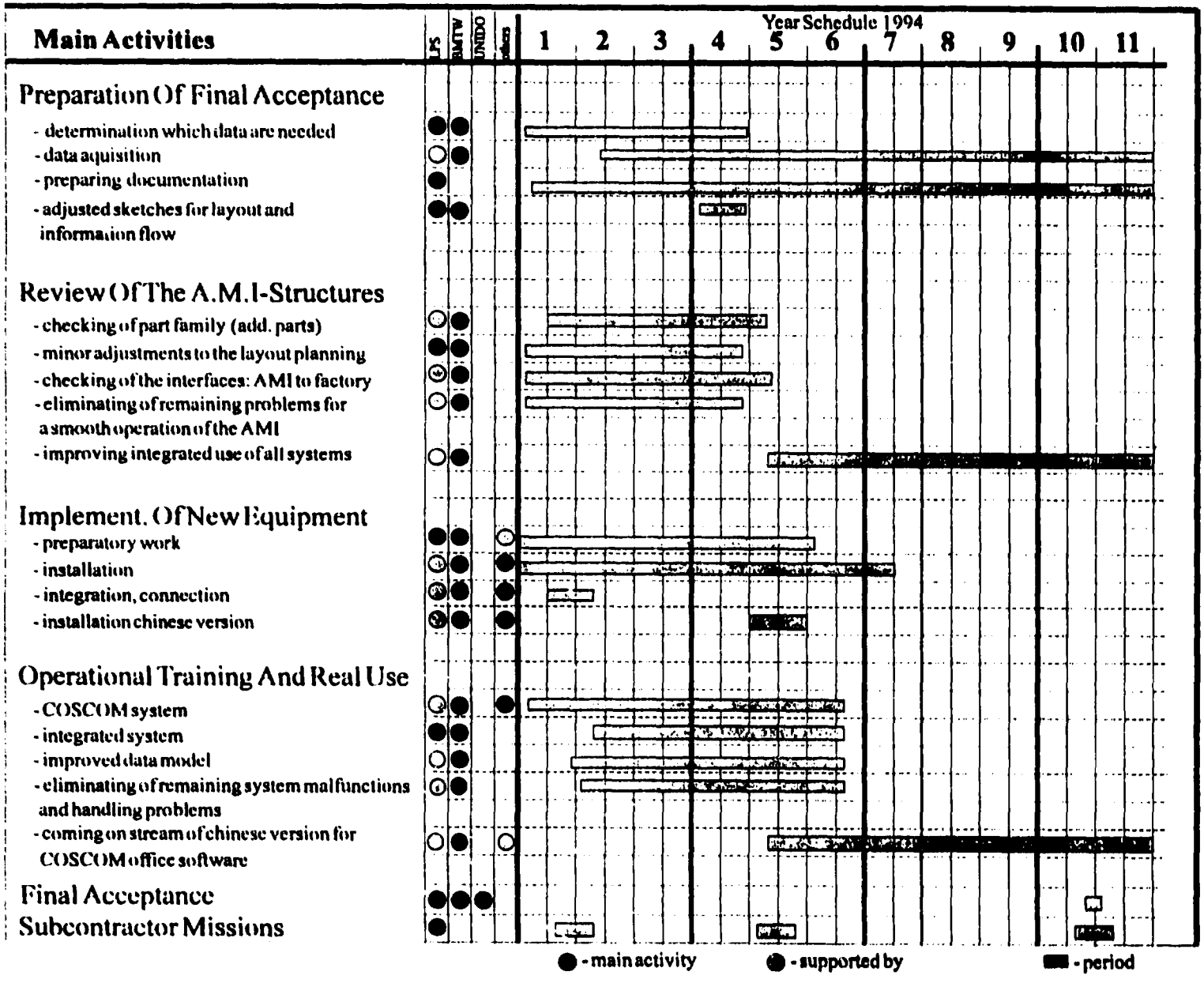
Project Milestone implementation schedule (October 1994)

for AMI at Beijing No. 2 Machine Tool Works

Release 4.5
October 1994
Schlange / Künzel

Ruhr - Universität - Bochum

UNIDO
Chart A1.4



UNIDO - Project
Chart 94.02

Schlange / Künzel

October 1994
Release 94.5

UNIDO-Project, BMTW No.2

Actualized Schedule Of Project Activities

Ruhr - Universität - Bochum

W. Maßberg

Annex 3

Overview of major working steps and project stays

For a detailed description of the project stays (date, duration, participants, results) see the relevant Memorandum and the quarterly Reports of the subcontractor.

1. Study Tour (CICETE, BMTW No. 2) November 1991

* General understanding of project contents for all parties
* Detailed introduction of AMI-concept

1. Field Mission of LPS-subcontractor in Beijing January 1992

* Extensive Data Acquisition on site
* Preparation of AMI-layout and organization structure
* Discussion of about Software Support

2. Study Tour (BMTW No. 2) April 1992

* Conception of Software Support
* Evaluation of Software components
* pre-selection of Software and related hardware
* visits to possible suppliers

2. Field Mission of LPS-subcontractor in Beijing June 1992

* Fixing layout and organization of the AMI
* Detailed specification of Software and Hardware
* Preparation of supplier contracts

3. Field Mission of LPS-subcontractor in Beijing October 1992

* Preparation and specification of the tailor-made training and fellowship-programme

* Review of Software requirements
* Review of the new AMI-building

Fellowship and User Training (BMTW No. 2) February to May 1993

* Extended Training mission for AMI-staff
  to LPS-subcontractor
  in small groups to all suppliers

4. Field Mission of LPS-subcontractor in Beijing June 1993

* Review of AMI-structures
* preparation of implementation of Soft- and Hardware

5. Field Mission of LPS-subcontractor in Beijing January 1994

* Implementation and coming on stream of major Hardware/Software-components
* Implementation of integrated network solution
* Review of the AMI-data-model

6. Field Mission of LPS-subcontractor in Beijing May 1994

* Final Installation Hardware-/Software
* Checking new Chinese Version
* Review AMI procedures
* Guide in AMI operation
* Preparation final Data Acquisition

7. Field Mission of LPS-subcontractor in Beijing October 1994

* Final adjustments to the AMI
* Preparation and successful passing of TTPR-meeting
* Preparation of small Dissemination
* Finishing final Data Acquisition for Final Report

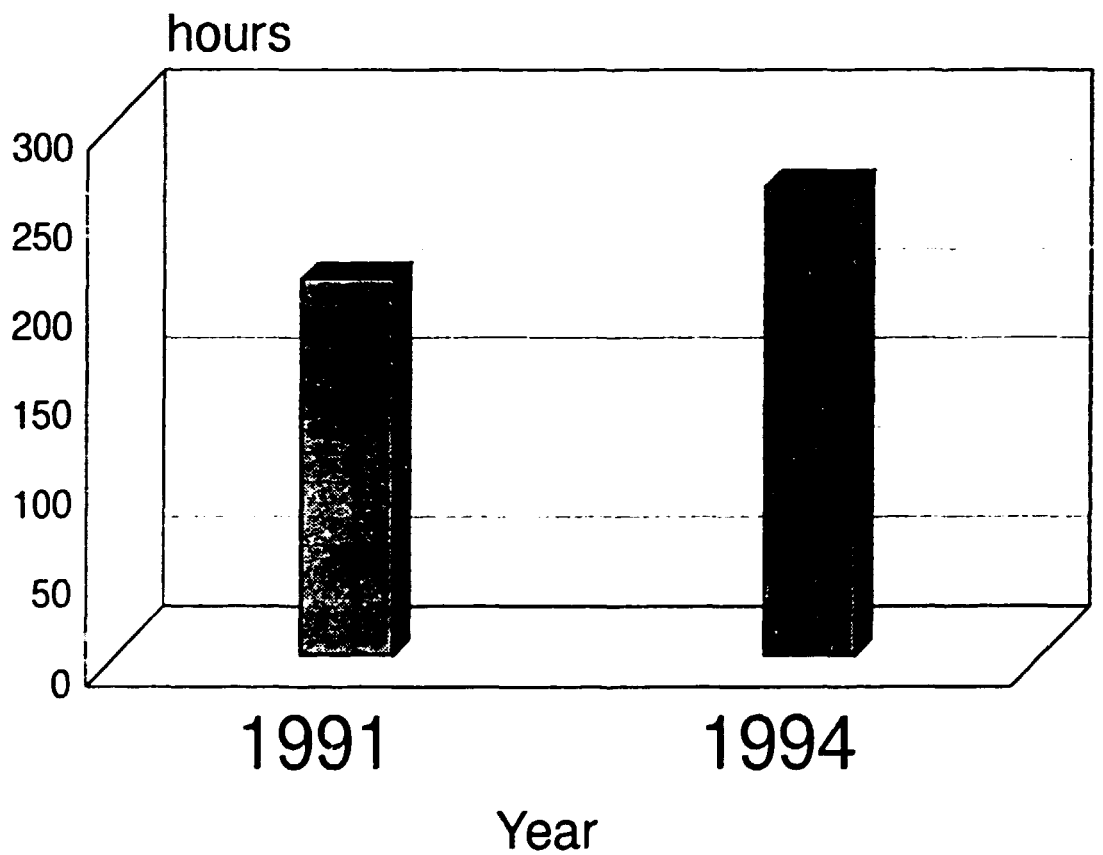
Besides there have also been some transitory stays of the subcontractor in Beijing for general project review and assessment of plan of action.

ANNEX 4

Major Items of Equipment Provided by UNDP

No.		Equipment	Pcs	U. Price	Unit
1	Hardware	Tool presetter	1 set	70,404	DM
2		486 personal computer	4 sets	15,400	DM
3		Network server	1 set	13,000	DM
4		Terminal	11 sets	6,950	DM
5	Software	CAPS system	1 set	111,206	DM
6		PDA system	1 set	18,000	DM
7		NC-programming	1 set	109,150	DM
8		DNC system	1 set	16,600	DM

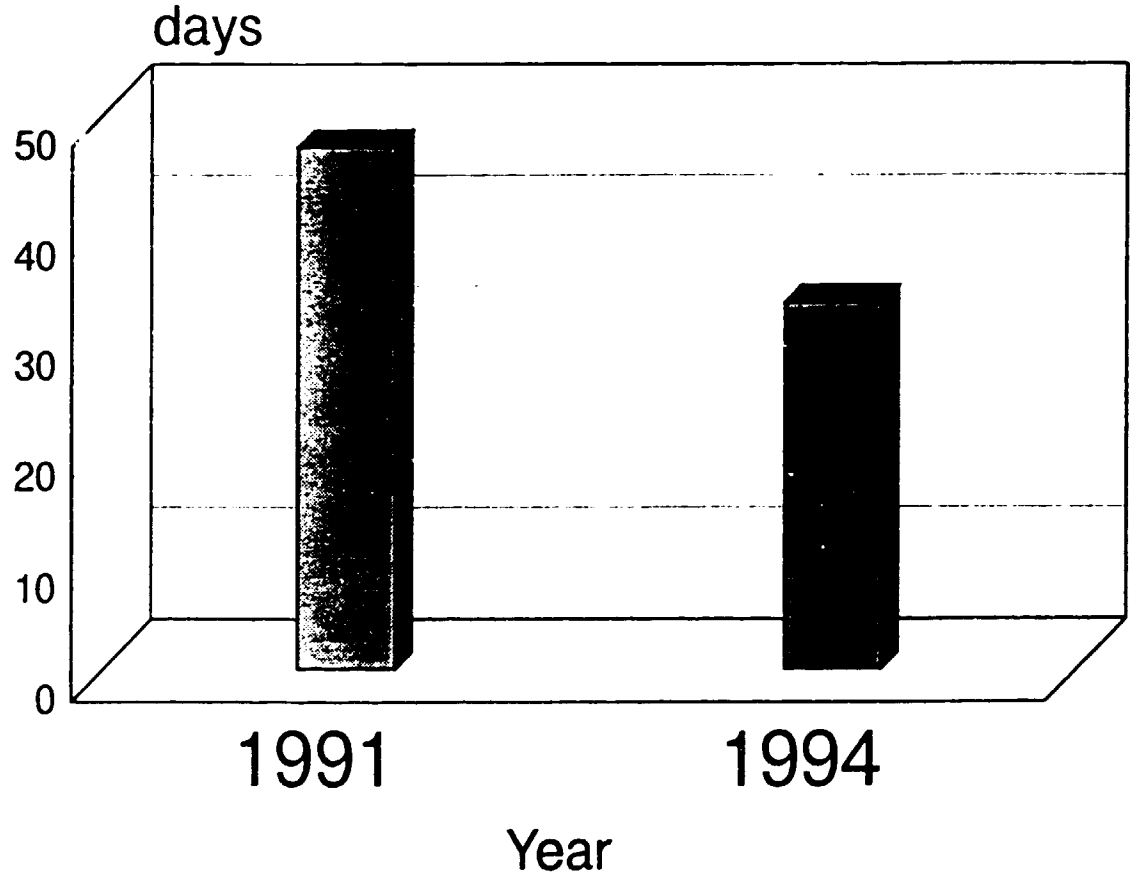
ANNEX 5.1



W. Maßberg	Average monthly machine hours	H. Schlange
	Lehrstuhl für Produktionssysteme und Prozeßlerntechnik — Ruhr-Universität Bochum	

ANNEX 5.2

BMTW No.2 AMI

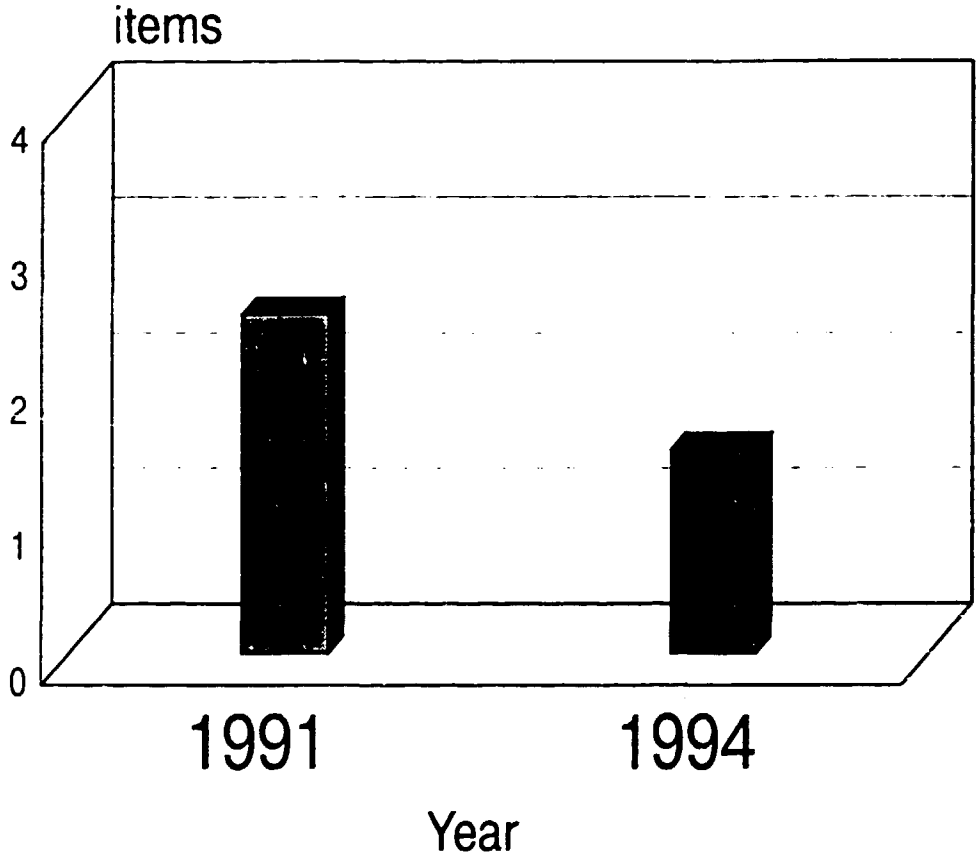


Average throughput time

H. Schlange

Lehrstuhl für Produktionssysteme und Prozeßtechnik — Ruhr-Universität Bochum

ANNEX 5.3



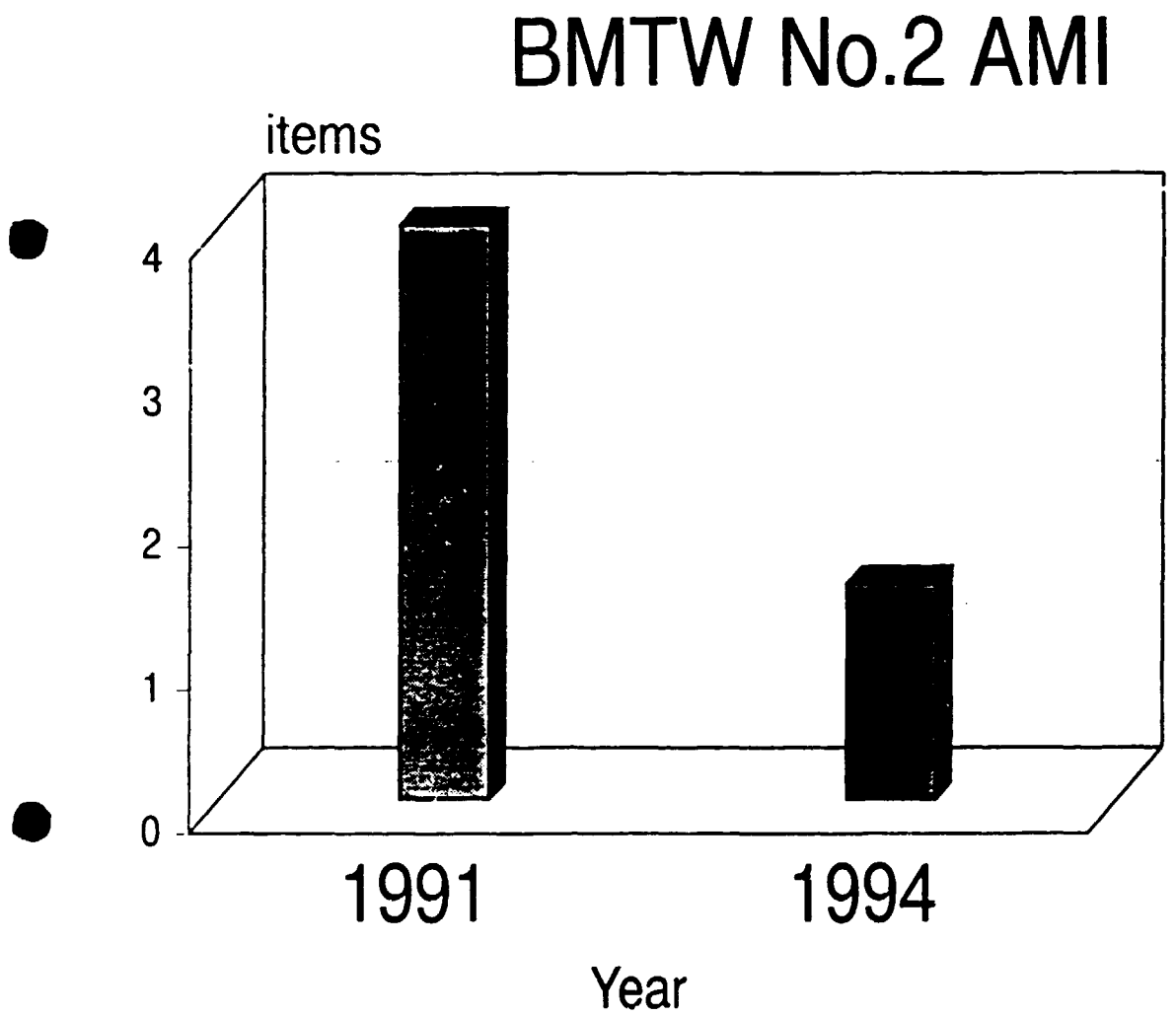
Average rate from AMI internal auditing per machine and month

H. Schlange

Maßberg

Lehrstuhl für Produktionssysteme und Prozeßlenktechnik Ruhr-Universität Bochum

ANNEX 5.4



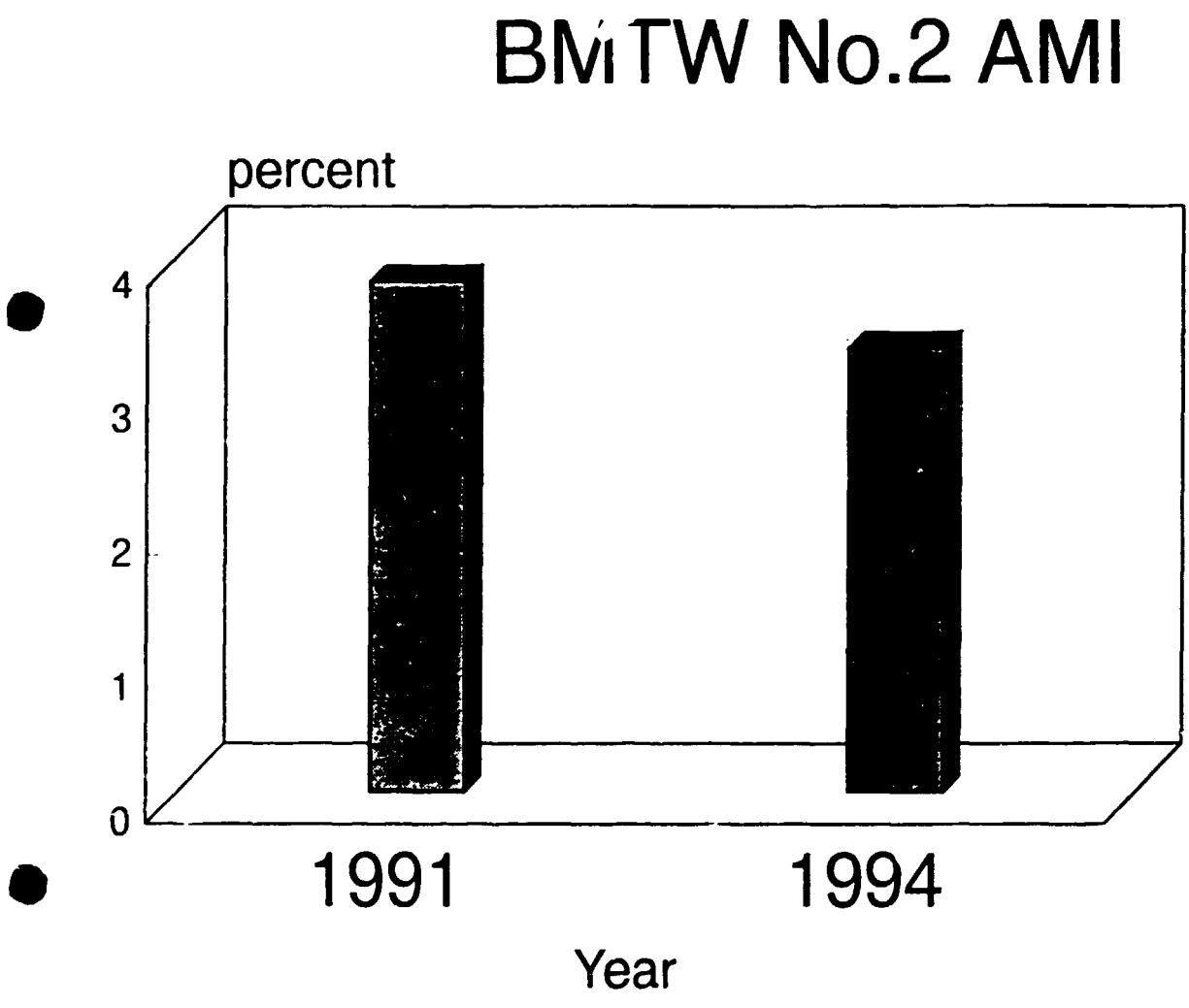
Average rate from AMI outside auditing per machine and month

H. Schlange

Maßberg

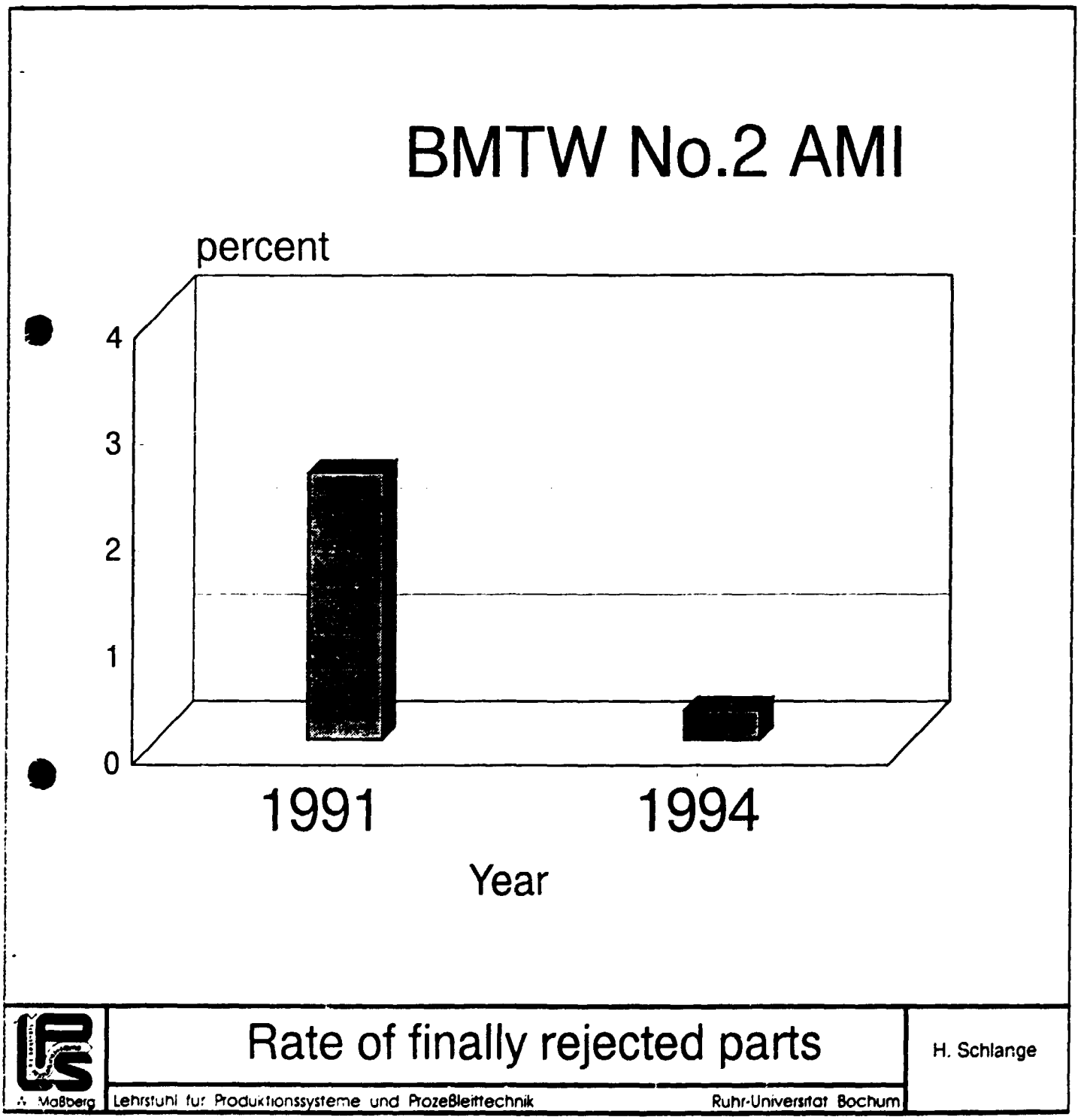
Lehrstuhl für Produktionssysteme und Prozeßleittechnik Ruhr-Universität Bochum

ANNEX 5.5



Maßberg	Rate of reworked parts	H. Schlange
	Lehrstuhl für Produktionssysteme und Prozeßtechnik — Ruhr-Universität Bochum	

ANNEX 5.6



Rate of finally rejected parts

H. Schlange

Maßberg

Lehrstuhl für Produktionssysteme und Prozeßleittechnik

Ruhr-Universität Bochum

来宾登记

	姓名	单位	职务	联系	电话
1	李[illegible]	机械工业部设计研究院冷加工室		助工	515.4485-385
2	王刚	机械部基础机械总局联合项目办公室		工程师	8595206
3	[illegible]	—…— 工业设计中心		副总工	8595294
4	陈宝振	北京三机床		总工	426.4975
5	陈宗岭	北一厂		主任	9731113
6	王世宏	〃		工艺处长	
7	李国强	机床处		高工	301.2119
8	马滇	〃		工程师	5712227
9	史伟	第四设计处		〃	8354885
10	张立	机械部机械基础技术总局科长		处长	8595212
11	陈崇祜	机械工业局		高工	3021349
12	J. Schlange	Ruhr-Universität Bochum		Dr. Ing.	
13	唐生荣	第机械局		高工	5712227-3008

Annex 6 I Participants

Annex 6 II Participants

来宾登记

	姓名	单位	职务	职称	电话
14	張曙	同济大学现代制造技术研究所	教授	副所长	5455080
15	[illegible]	机械部设计研究院 [illegible]	高工	5134488-540	36095[illegible]

Annex B III Agenda
Dissemination

《独立制造岛示范项目》学习研讨班
日程安排
（1994年10月20日）

时　间	内　容
上　午 8:00~12:00	1.厂长致欢迎词，并介绍北京第二机床厂独立制造岛情况； 2.请国鲁东大学独立制造岛专家讲课； 3.国内大学教授讲课。
12:00~13:30	午餐
下　午 13:30~16:30	1.独立制造岛负责人介绍岛内软件配置及现场演示； 2.交流座谈； 3.机械部领导讲话。

ANNEX 7

Proposal for Dissemination

UNDP-project: DG/CPR/91/323

"Establishment of an Autonomous Manufacturing Island"

1. Goal:

The dissemination for the AMI-project is mainly aimed at demonstrating the principles and procedures of a real working Autonomous Manufacturing Island (AMI), its management structures, its computer based support and its integration in the whole factory (central level). This integrated and mainly workshop oriented computer solution can be divided into two main aspects:

- On the one hand there is the management of the AMI, the organizational information flow and the visualization of the current situation to support the decision making in the workshop, advanced methods of scheduling.

- On the other hand there is the technical information flow for the work preparation from drawing, creating part geometry, NC-programming, until post-processor run to machine code (DIN 66025) and DNC data transfer to the process level.

This shall be demonstrated to other interested representatives of the Chinese Machine Tool Industry in order to transfer the results to other factories. A second intention is also to deepen the understanding of the AMI and the proper use of the powerful computer systems to enhance the degree of autonomy and to improve the conditions for the redesign of the product range by an easier introduction of new parts.

The special AMI-approach will be emphasized:

- at first to use the existing machinery equipment and to improve management and organization structure,

- to introduce advanced technology step by step in line with the build-up of staff skills, the development of the market and as to the overall precondition of the factory.

Therefore the modular design of the implemented solution is essential.

2. Organization:

The dissemination will be prepared and organized by the UNIDO-subcontractor LPS from Ruhr-University Bochum in Germany especially for the contents and the continuity according to the project goals. The implementing and host agency BMTW No. 2 and the Chinese Authorities shall be responsible for inviting the guests from the Chinese Machine Tool Industry. The Seminar will be conducted together by LPS and BMTW No. 2 under the auspices of CICETE and MMEI.

3. Date:

The dissemination shall be held in the first half of June 1995, for example in the week from 4 June to 11 June 1994.
There must be enough time to prepare and to invite the representatives (e. g. senior engineers) from other Chinese Machine Tool Builders as well as possibly some international representatives e. g. from Vietnam and India.

4. Duration and Location:

The total time will be one week in Beijing. The first two or three days will be used for checking of all operations and demonstrations and for instruction of BMTW No. 2 staff in case off remaining questions. The Seminar will last one week and shall be held on site, that means within the premises of BMTW No. 2, mainly in the AMI workshop and office for demonstration.

5. Experts for demonstration and lecture

Prof. Massberg intends to participate the seminar and also to hold a speech and lecture on current trends in modern manufacturing in general and especially the AMI-principles.

A)
The AMI-Staff from BMTW No. 2 will be the routine users of the computer systems and hardware in the AMI and will demonstrate the practical background.

Ms He Fang, AMI-Director, BMTW No. 2

task: coordination and organization of translation services
lecture on
AMI-development during the project
AMI management

B)
Dr.-Ing. Heiko Schlange, LPS Project-Coordinator

task: coordination and organization of the seminars
lecture on
AMI and its material and information flow
Software support and human centered approach
CIM as a future goal
Concurrent Engineering and AMI for market adjustment

C)
Dipl.-Ing. Peter Grimme, Leader of the LPS-AMI, familiar with the AMI-project and BMTW No. 2 and also involved in the training programme

task: lecture on and demonstration for
NC-Programming
comprehensive work preparation
workshop oriented programming
new trends in CNC

D)
Mr. Guenter Henkel, COSCOM export sales director, possibly supported by a software-engineer from COSCOM

task: lecture in the field of CAD/CAM, DNC, PDA
demonstration of
the whole COSCOM product range
especially CAD/CAM, NC-Programming, DNC, PDA

E)
Mr. Treffer, PSI company (subsidiary GSI), chief programming engineer for PIUSS-O-Leitstand (CAPS)

task: lecture and demonstration for
CAPS
methods and procedures
to improve utilization
to meet the order deadlines
to shorten through-put time
to lower inventory
interface to MRP II (central level)
interface to workshop, PDA (process level)

F)
Mr. Wolfgang Busse (or other representative then in place), Plansee Tizit (Messma Kelch), Service Engineer in the Beijing Office of Plansee.

task: demonstration of efficient Tool-Presetting and Tool-Management

Mr. Busse will be invited for a short demonstration, as the Tool-Presetter is only a small part of the project. Before setting up the Plansee office in Beijing he was employed by Fritz-Werner-company and was responsible for setting up the Flexible Manufacturing System in BMTW No. 1.

G)
Prof. Zhang Shu, Tongji University, chief engineer of the CIM-Centre, as national expert for AMI and Awardee of the "Chiang Technology Achievement Award 1993".

task: lecture on
CAPP,
COSCOM CAD/CAM-system,
Software support under Chinese conditions,
experiences with AMI in China,
CIM - development.

6. Audience:

With respect to the available rooms and the demonstration sites (AMI-computer-office) as well as the efficiency of the seminar, approximately 20 to 30 qualified guests with technical and/or management background and adequate level of seniority shall be invited from different Chinese Machine Tool Factories. To reflect the international character of the UNDP-programme also some guests from Vietnam or India may be invited. The demonstrations will be held in groups sized to enable efficient computer-demos .

7. Expenses:

BMTW No. 2 will provide the facilities to carry out the seminar (lecture room, overhead projector, demonstration in AMI shop floor and office, transport of guests and so on).

The cost breakdown for the experts is according to the specific regulations for foreign and local experts and includes travel, accommodation and subsistence. Referring to paragraph 5) the following budget shall be provided:

For B) and C)
The two experts from LPS have to prepare, organize and coordinate the seminar, the time required therefore is one man month each including preparation, travel time

and one week in Beijing at BMTW No. 2.
Expenses: 2 X 10.000 US Dollar

For D) COSCOM staff will come for one week to Beijing. As main supplier COSCOM has the opportunity to introduce their products to a qualified audience and will use the AMI of BMTW No. 2 as a show case. During preparation on site in Beijing COSCOM can carry out some additional and deepening training and also solve eventual problems connected to their integrated solution.

For E) PSI shall send one person for one week. PSI has the opportunity to introduce their CAPS and related software to a qualified Audience from Chinese Machine Tool Builders and can use the BMTW No.2 implementation as a show case. The preparation period on site can also be used for implementing the interface to the SSA BPCS MRP II system. Therefore some budget for PSI is still open (PSI-contract). As preparation for BMTW No. 2 the interface requirements must be defined and transmitted to PSI, Berlin, well in advance.

F) Mr. Busse from Plansee-Tizit company in Hongkong or another representative for that company resident in Beijing in June 1995 will be invited. This person has only a limited task compared with the whole project range. Up to now BMTW No.2 is the only Plansee Messma Kelch Tool-Presetter implementation in the Beijing area. So Plansee will have the opportunity to demonstrate their product range. No special budget must be provided.

G) Prof. Zhang Shu shall be paid as a national expert. He is a leading AMI-expert in China, he is strongly committed to the UNDP-project and he has a long relationship with the factory BMTW No. 2.

8. Provisional Time Table:

1. Day - Wednesday, 7 June

morning session:

- Opening ceremony to welcome and introduce the guests

- Speeches by Mr. Huang Zhe, Dir. Li Yin Zhong, Prof. Massberg and others.
- Overview of Seminar
- Opening lecture (L1): AMI-principles and project background

afternoon session:

- lectures and demonstrations I

  - two lectures for all participants (L2, L3)

  - general demonstration of AMI and integrated computer system for all participants
    AMI shopfloor and office (AMI staff supported by suppliers)

2. Day - Thursday, 8 June

morning session:

- lectures and demonstrations II

  - four lectures for all participants (L4, L5, L6, L7)

afternoon session:

- lectures and demonstrations III

  system demonstration (suppliers supported by AMI staff)
  participants divided in small groups exchanging between the demonstration sites (stations)
  - COSCOM
  - PSI
  - Plansee
  - (Okuma APT-Programming) ?
  - (MRP II)

3. Day - Friday, 9 June

morning session:

- lectures and demonstrations IV

- possibility of deepening demonstration as to special interest and request of the participants (every participant free to choose the station)
  - COSCOM
  - PSI
  - Plansee

afternoon session:

- Closing meeting

- Final lecture: Summary and outlook (L8)

- Official address by Mr. Huang Zhe, Dir. Li Yin Zhong, Prof. Massberg and others.

Banquet

9. General remark

This proposal is worked out following an earlier proposal submitted to Mr. Huang Zhe (MMEI) and Mr. Gurkok (UNIDO Vienna) in August 1994 and after principal approval of such a seminar during the final project acceptance meeting held on 21 October 1994. It shall be submitted to MMEI and UNDP to ask for support and it will serve as a working background to prepare (e.g. for expert invitation) the seminar.

A more precise time table and special topics for lectures will be worked out

following the general approval from the supporting authorities. Also the time frame must be confirmed and fixed until January 1995.

Beijing, October 31, 1994

(Dr.-Ing. H. Schlange, LPS) (He Fang, AMI-Director, BMTW No. 2)