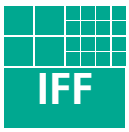


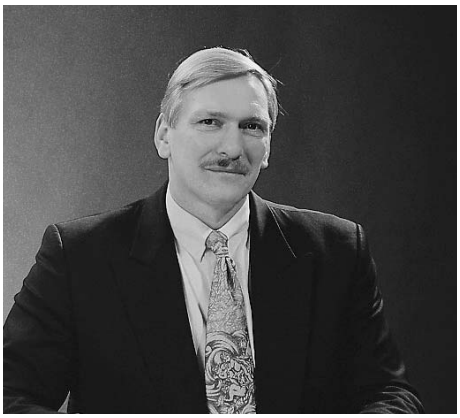

Fraunhofer Institut
Fabrikbetrieb
und -automatisierung

# Achievements and Results
# Annual Report 1998

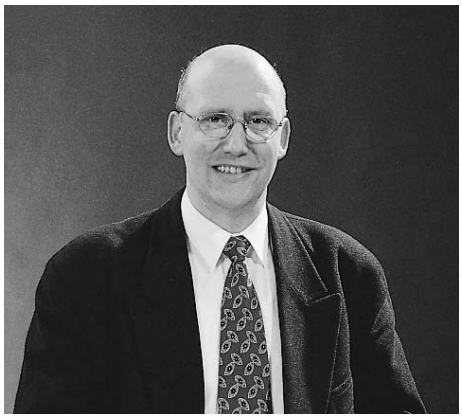
# Foreword

In 1998, we succeeded in intensifying cooperation with our partners at home and abroad and thus in consolidating the IFF's top position in the future fields of factory operation as well as automation. Order backlog shows that our partners place great confidence in us. We are particularly pleased to have won some more project partners in the Federal Country of Saxony-Anhalt. The occupation and dedication ceremony of our institute's new building in the Sandtorstrasse in Magdeburg were important events of the business year 1998. With this building that has architecturally turned out outstandingly well and comprises over 5,000 $m^2$ office and laboratory area as well as an engineering training facility of 1,300 $m^2$, we have the very best research potentialities at our disposal. During the opening period of the new building, we succeeded in realizing further important investments in the fields of control equipment, Rapid Manufacturing as well as in-house logistics.

Prof Hermann Kühnle



Prof Michael Schenk



# Performance and Results - Annual Report 1997

## Contents

# Outline of the Institute

## Tasks and goals

The Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg is committed to applied research and development. It meets this duty as an autonomous institute of the Fraunhofer Society, in cooperation with industry, science, and state by producing innovative solutions in the relevant set of topics. The high dependence on the efficiency of our industries of our prosperity puts an obligation on us to continue to successfully strive for top positions in the fields that are relevant for producing industries. Thus the focus is on innovation, securing life quality through development of technologies, the interlinking of research and application as well as the establishment of enterprises specializing in technology training and research.

We ensure achieving goals through intensive cooperation with the Otto-von-Guericke-University Magdeburg by keeping ready a suitable infrastructure and creating a pioneering atmosphere in the institute. In our working fields, we are always bent on a know-how lead and strive for leadership in key fields. To this end, we work in interdisciplinary teams and closely cooperate, nationally and internationally, with experts in related fields.

The implementation of research results in future fields, aiming at innovation and generation of employment, will be the IFF's sphere of activity of highest priority for the years to come. The perspective, which was previously focused on the value creation of existing production systems, will be extended to include also the initiation and construction of new production units.
Besides mastering key technologies, the integration of information technology and the combination with services within the design of manufacturing plants are gaining increasing importance.

## Guiding rule

– The Fraunhofer Institute for Factory Operation and Automation IFF is active in application-oriented research and development for production technology.

– The Fraunhofer Institute for Factory Operation and Automation IFF is an autonomous institute of the Fraunhofer Society and carries out its work on its own scientific responsibility.

– The Fraunhofer Institute for Factory Operation and Automation IFF brings forth, in cooperation with industry, science and the state, innovative, market- and demand-oriented results in a dynamic, perpetually changing environment.

We pursue an interdisciplinary method of working, professional project management using state-of-the-art laboratory equipment and, based on permanent advance research, and guarantee research results that our clients and partners have at their disposal and may use for their benefits.

– We use a cooperative style of leadership and support creativity and direct responsibility. Further development and qualification are well to the fore.

– We create an atmosphere characterized by pioneer spirit and competion. Personal integrity and fairness observed in mutual relations are of great importance.

## Mission

The Fraunhofer Institute for Factory Operation and Automation IFF promotes employment in our region and safeguards prosperity through globally acknowledged supreme achievements that contribute to highly competitive production systems, products, and services. We commit ourselves to this task with all of our know-how and productive power.

## Vision

In all of its activities, the Fraunhofer Institute for Factory Operation and Automation IFF aspires to reach the world leading position in designing production systems and pursues this vision while being integrated into a global network of partners and research institutions.

## Board of Curators

### Chairman

Mr. Klaus R. von Hörde
MEMC Electronic Materials, Inc.

### Vice Chairman

Prof. Hans-Peter Wiendahl
University of Hanover
Institute for Production Systems

MinRat Hellmuth Bertuleit

Mr. Manfred Doese
Siemens AG

Dr. Hartmut Grunau
Ministry for Science, Education,
Research and Technology

MinDirig Dr. Christoph Helm
Ministry for Education
of Saxony-Anhalt

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FER Ingenieurgesellschaft für
Automatisierung GmbH Magdeburg

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Bosch-Siemens-Hausgeräte-GmbH

Prof. Friedhelm Lierath
Otto-von-Guericke-University
Magdeburg
Institute of Production Technology and
Quality Management

Dr. Hanspeter Stabenau
Stiftung Deutsche Außenhandels- und
Verkehrs-Akademie Bremen

Mr. Gerd Stotmeister
Sto AG

Dr. Odo J. Struger
Allen-Bradley Company, Inc.

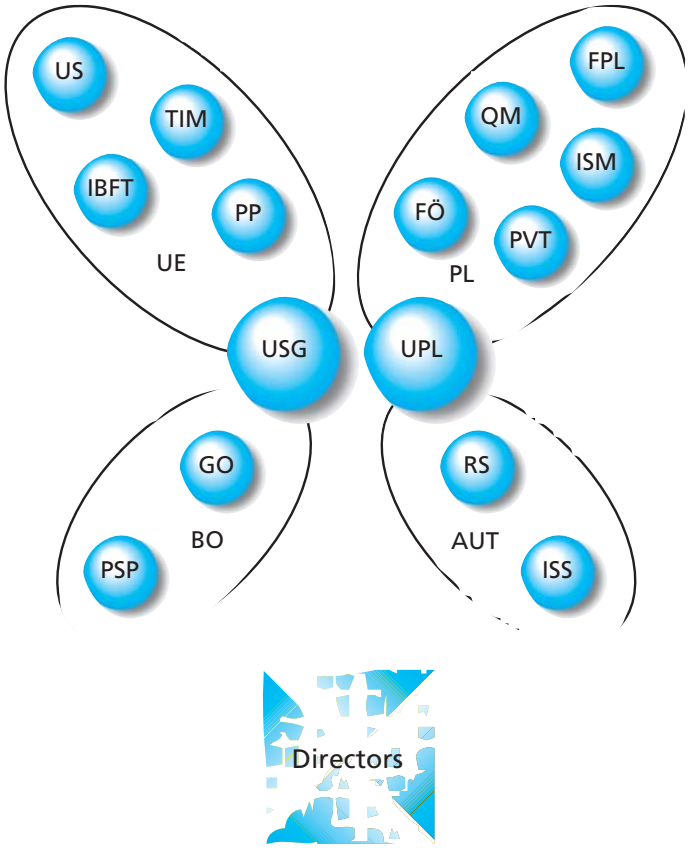
## Equipment

Virtual Reality and Media Center
Industrial Robot and Service Robot
Center
CAQ Center
Rapid Manufacturing Center
Image processing

## Future domains

The future development of the Fraunhofer Institute of Factory Operation and Automation IFF is essentially determined by the advancement of pacemaker technologies, such as generative molding, actor and sensor engineering, and process engineering on the one hand, and management techniques, strategies, and organizational solutions on the other hand. The further development of technologies is designed to enable them to be applied on a wider scale for industrial production. The Fraunhofer IFF chooses special techniques appropriate for this purpose and advances them selectively. In this, reference is made to the industrial application in already existent manufacturing sequences; but also potentials of technology-driven disincorporations/reestablishments are pursued vigorously. Special indicators and metrics systematics are made available for support. The wider use of high technologies requires their linking and to master all linking potentialities. The Fraunhofer IFF considers the systemic idea a promising approach for the holistic control of production systems in all their impresses (for discrete and continuous performance) using novel methods and tools. Ecological products and ecological manufacture presuppose in particular the complete utilization of information-engineering possibilities for describing and characterizing products and manufacturing sequences. Besides the reusability of substances, the Fraunhofer IFF investigates especially into the potential utilization of artifacts without residues and harmful substances.

## Organizational schematic and contacts

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## Abstract

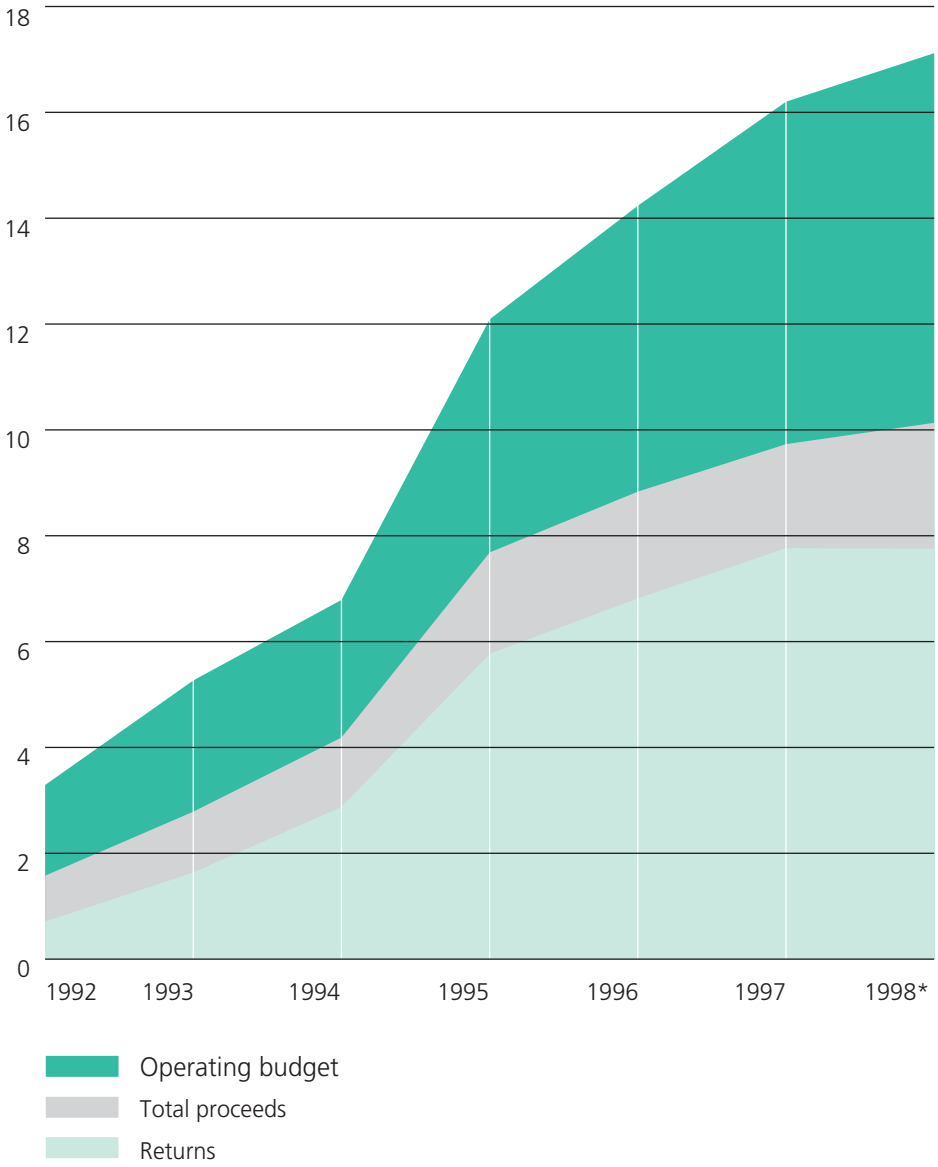
# The Institute in Figures

## Operating budget and returns development

Budgetary expenditure are in 1998* DM 17.2 million. The total proceeds rose in 1998 by 4 % to DM 10.2 million as compared with the previous year. Returns are now DM 7.8 million.

## Capital expenditure budget

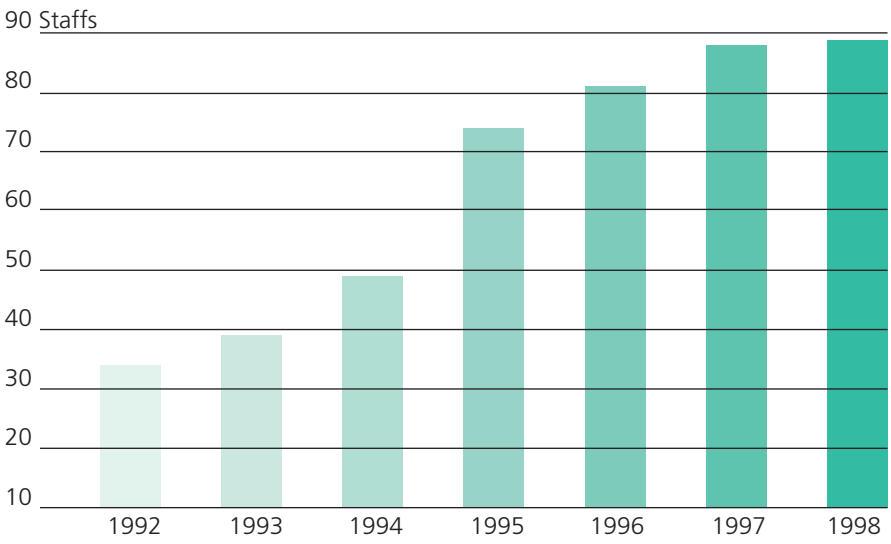
In 1998, a total amount of DM 4.9 million was invested.



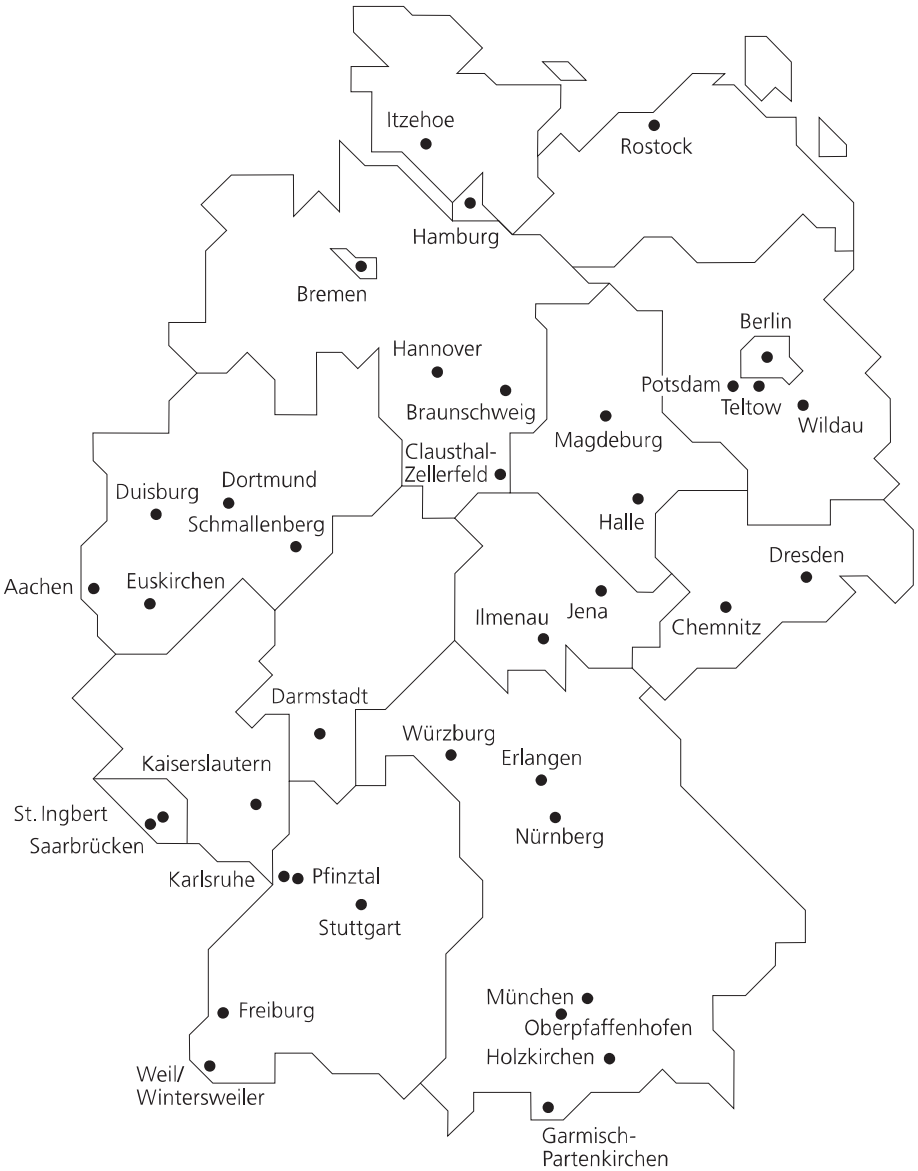

* Preliminary figures 1998

## Staff development

In december 1998, the Fraunhofer IFF had a body of regular 88 employees.



# The Fraunhofer Society at a Glance




The Fraunhofer Gesellschaft is the leading organization of applied research in Germany. It operates 47 research institutes in Germany with about 9,000 employees, about the half of them scientists and engineers. The Fraunhofer Gesellschaft expands to a worldwide Organization, especially in USA and Asia. Home of the Fraunhofer-Gesellschaft is Munich.

One of the goals of the Fraunhofer company policy is a rapid transfer of innovations.

The total expenditure for 1996 reached the level of about 1.3 billion DM; more than two-thirds of this amount is earned through contracts from industry and the public sector (>50% of the industrial earnings come from small- and medium-sized enterprises). International activities are increasingly important. Apart from the collaboration with numerous companies and research establishments within Europe the Fraunhofer Gesellschaft operates resource centers and research units in the United States. The Fraunhofer-Management-Gesellschaft mbH (FhM) was founded as a subsidiary company in 1990.

The name Fraunhofer Gesellschaft was chosen in reference to the researcher, inventor, and entrepreneur Joseph von Fraunhofer (1787 -1826), who won high acclaim for his scientific and commercial achievements.

## The research fields of the Fraunhofer Gesellschaft

Eight fields form the core of Fraunhofer research:

- Materials and Components
- Production Technology
- Information and Communication
- Microelectronics and Microsystems
- Sensor Systems, Testing Technologies
- Process Engineering
- Energy, Environment, Health
- Technical and Economic Studies

Apart from research services, certified test beds and other facilities can also be provided.

## Advantages of contract research with the Fraunhofer Gesellschaft

- More than 2,600 experts are available for the development of complete systems.
- All developments are based on profitability considerations.
- The Fraunhofer Gesellschaft collaborates with various renowned companies whose research contracts have resulted in successful products.
- Modern laboratory equipment and scientific aids such as project management and internationally linked communications systems enhance the quality of the research work.
- Detailed project reports, instructions for use, staff training and complete introduction strategies for new technologies round off the contract research services.
- Reliability, continuity and service of a large organization are available to all companies.

## Collaboration with the Fraunhofer Gesellschaft

Contract research with the Fraunhofer Gesellschaft has advantages for all companies. Orders come from all branches of industry and companies of all sizes. The institutes' facilities are particularly recommended for small businesses who can take advantage of Fraunhofer research when their own capacities are not sufficient to make the technical innovations necessary to stay competitive. We would be glad to provide further information on subsidy programs for small businesses.

# Project Reports

# The DYNAPRO-FORUM, an open network of leading enterprises

The Adaptable Enterprise

Project Report Company Development


## Abstract

Future chances within turbulent markets are open only for those companies which are able to adapt market changes dynamically and to shape the competition arena actively. The change ability of enterprises will be an increasingly important factor within the competition. This is the result of the successfully finished integrated project DYNAPRO and at the same time impulse to continue the work. Consistently the foundation of the DYNAPRO-FORUM took place at the 3rd DYNAPRO-Conference. DYNAPRO transformed into an open network of leading companies.


## The 3rd DYNAPRO-Conference - Foundation of the DYNAPRO-FORUM

The 3rd DYNAPRO-Conference was hold in Stuttgart and Straubenhardt on the 12 and 13 of October. The motto of the two day event was »out of the praxis - into the praxis«. On the first day well-known speaker could be won to present their practical results and were on the other hand available for following panel discussions with present experts. The information platform which was open in the run-up to the meeting the breaks offered beside new research activities the opportunity for contacts and further discussions.

On the second day was the visit of the company Schroff on the order of the day. Schroff, one of 11 enterprises which took part in the project, could present the impressive results of the company development towards a innovative and flexible organization as »best in practice« result to the critical guests. All in all the 3rd DYNAPRO-Conference can be described as successful occasion for the participants to obtain new impulses and encouragements for specific issues, future challenges and actions.
As an highlight of the event, the DYNAPRO-FORUM was founded officially. With that Fraunhofer IFF took up a frequently expressed wish to carry on the successful work of the project DYNAPRO on a larger scale. As the honorary president of the FORUM Prof Warnecke (president of the Fraunhofer-Gesellschaft) could be won. Already in the course of the conference 15 participants joined the FORUM as founder member and many more stated their definite interest on the subjects and on an active cooperation.

## Benefits

The DYNAPRO-FORUM offers its members above all know-how and new chances. The building and imparting of know-how, which is here a combination of practical experiences and theoretical elements, is made by:

- Communication between »best-practice solutions« and recent research results
- Training for managers who wants to go ahead towards increased change ability
- Research projects towards new solutions of priority issues of the member
- Invention of recognized experts to discuss present subjects.

New chance are offered to the FORUM members in form of

- Offering cooperations which, for example, makes access to new markets possible
- Continuous exchange of new innovations
- Opening successful solutions to all members as valuable suggestions for the own work.

The knowledge transfer is guaranteed by using several media (publications, e-mail, Internet, ...). Conferences will take place twice a year to give successful member a chance to present »best practice in action« solutions. Additionally expert circles will discuss current issues at colloquiums.

## The DYNAPRO-FORUM

With the foundation of the DYNAPRO-FORUM the DYNAPRO project transformed into an open network of leading enterprises. Within this network of excellence innovative companies and leading research institutes join their forces to shape the development and implementation of forward-looking organization concepts. Therefore the DYNAPRO-FORUM will be a source and centre of know-how where continuously impulses and suggestions come from. The DYNAPRO-FORUM is open for enterprises from all industrial sectors, for research institutes, for consultants and federations. The FORUM depends on the active contribution of its members. Interested manager and scientists, who wants to shape the strategic success factor adaptable enterprise, are invited to join the DYNAPRO-FORUM.

For further information you are welcome to contact the authors of the article who are mentioned above or visit us at www.dynapro-forum.de.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Mr Mario Spiewack

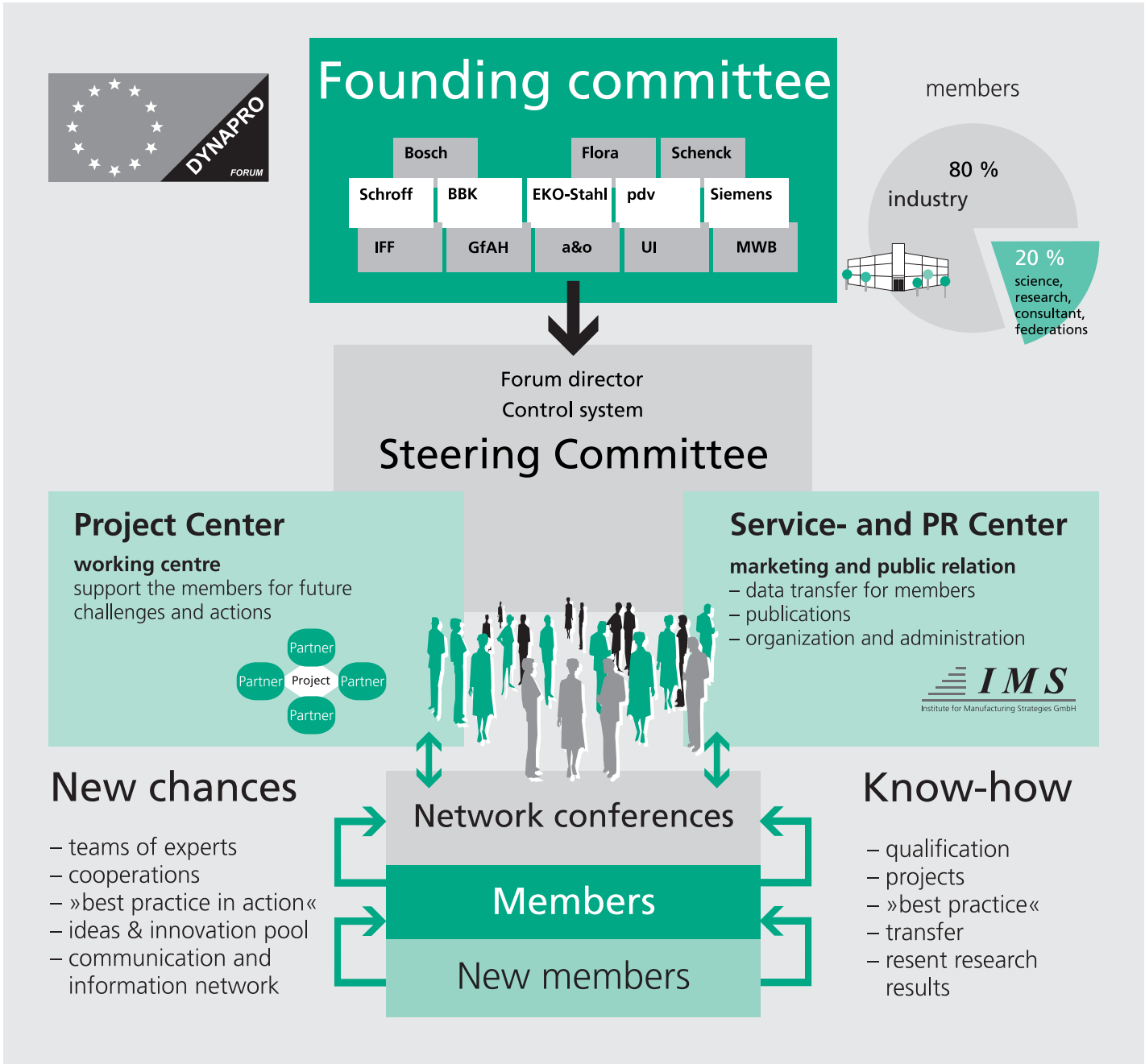


Fig.: DYNAPRO-FORUM

# Purchase, production and sales in life-cycle-oriented dynamic production structures - design tools

The Adaptable Enterprise

Project Report Factory Planning and Logistics


## Abstract

To a smart business surviving in a dynamic market means to constantly adapt itself to new situations, even by adapting its structure. Therefore, it will be necessary in the future to generate and evaluate the development scenarios required for the strategic positioning of complex production and distribution structures in ever shorter cycles. Developing holistic methods and tools from virtual prototyping of production systems to support measures in the utilization stage is a prerequisite for permanent and continuous planning.


## Initial Situation

Globalization of economies will gather further momentum. Businesses are forced to operate at increasing speed in turbulent markets and must quickly and flexibly adapt their resources to changing conditions. In addition, another essential factor for a further reduction of the time-to-market is the synchronization of product and process development by means of digital prototyping.

Similar to the time savings obtained in the field of product design with the help of rapid prototyping and visual systems to ensure fast and flexible adaptation to market requirements, it will be necessary to plan and optimize a »factory« as a product with similar tools within a short period of time. In order to meet these requirements, factory planning is more important than ever before to develop and maintain competitive factories. It is also necessary to develop holistic methods and tools, from virtual prototyping of production systems to support measures in the utilization stage. Concepts which satisfy these requirements find their expression in designations such as the »high-tech factory«, the »low-cost factory«, the »rapid factory«, the »cooperative factory« or the »breathing factory«. Each concept is tailored to the specific needs of each individual factory. But apart from the concept, it must also be possible to design and visualize the product with the tools to be created. They must allow to accommodate different strategies (market, product and site strategies) as well as various logistic integrations in networks (supplier networks, networks of final manufacturers, mixed networks, etc.). The same applies to ecological requirements.

## Procedure

Tools for modern factory planning have been developed at an increasing rate. However, there is still no holistic approach which is determined by logistic flows and which can be adapted to changing strategies. The Fraunhofer IFF (Institute for Factory Planning) understands factory planning as a comprehensive task in the planning, realization and utilization stages of businesses and factories faced under dynamic business environments. Within this cycle factory planning is perceived as a holistic product with its specific planning fields. This approach requires to support the companies from the market and regional level to the factory and even shop level.
This objective can be achieved by integrating existing methods and tools on an uniform platform and generating open interfaces in order to guarantee easy access to typical market transaction systems (capacity and time-oriented factory data) and international data bases (market information, benchmarks). Decisions on international locations for production facilities made with the help of geographic information systems and derived from market trends which are no longer based on sales data from the past but on market potentials which can be identified.

## Perspectives

The integration enhanced at the Fraunhofer IFF facilitates evaluation, 3D-visualization and simulation of complex factory models based on a uniform data base. Generated to meet specific needs, simulation models for the evaluation and visualization of factory scenarios offer the following functions:

- identification and evaluation of market trends and market potentials (site planning)
- evaluation of regions by analyzing infrastructural and geodetic data in connection with logistic variables (delivery time, etc.),
- continuous verification of restructuring needs.

It is our objective to provide our customers with a dynamic system suitable for permanent market-oriented dimensioning, structuring and evaluation of production sites taking into account the relevant environmental, logistic, quality and service aspects. There is a great need for such a system as reflected by discussions with companies held regularly at workshops and international fairs.


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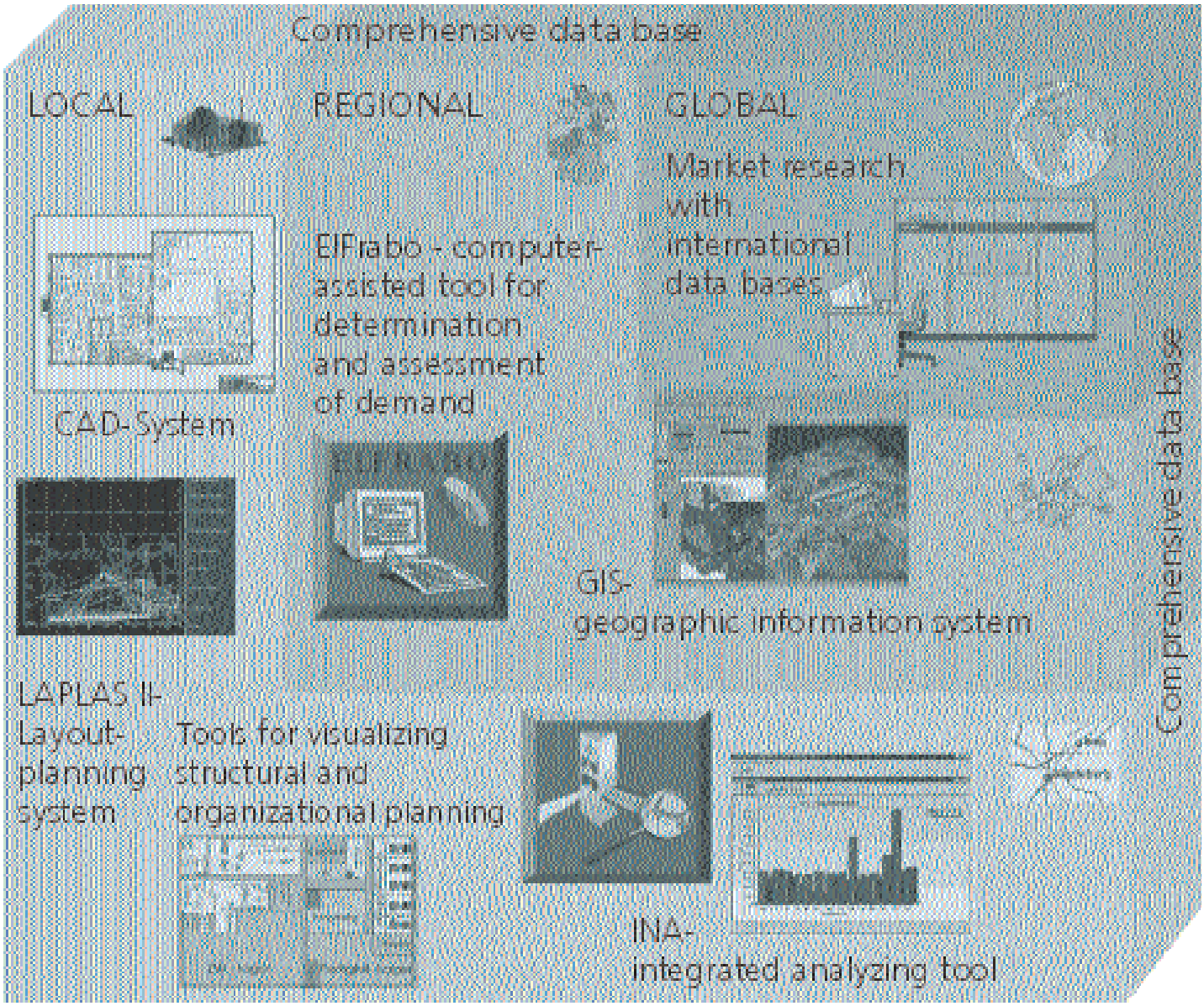


Fig.: Tools for life-cycle-oriented factory planning

# Competitive distribution concepts for Europe

Project Report Industrial Plants and Factory Engineering


## Abstract

The task of a project for an enterprise of the electronic industry was to combine competitive distribution concepts with potential warehouse sites by variation of different delivery times and transport types and to plan it as an ideal concept for an efficient distribution.

To fulfil this task, scenario engineering was used for determination of the future developments of the markets and the relevant cost categories. With these information an at the Fraunhofer IFF developed site-controlling-system was configured which facilitated a fast valuation and comparison of the developed concepts.


## Starting Situation

In the field of distribution the global active enterprise is in keen competition, especially in Europe. The starting points for improvements were too long delivery times within Europe, an inefficient decentralized warehousing and deficits by the informal order processing.

## Procedure

### 1 The present distribution structure and development of the markets

In the first step, the existing distribution structure was analyzed with regard to its costs structure and the handled product flows in Europe. After this the European markets of the enterprise were investigated in detail and extrapolated in three market scenarios (realistically, optimistically, pessimistically) until the year 2006.

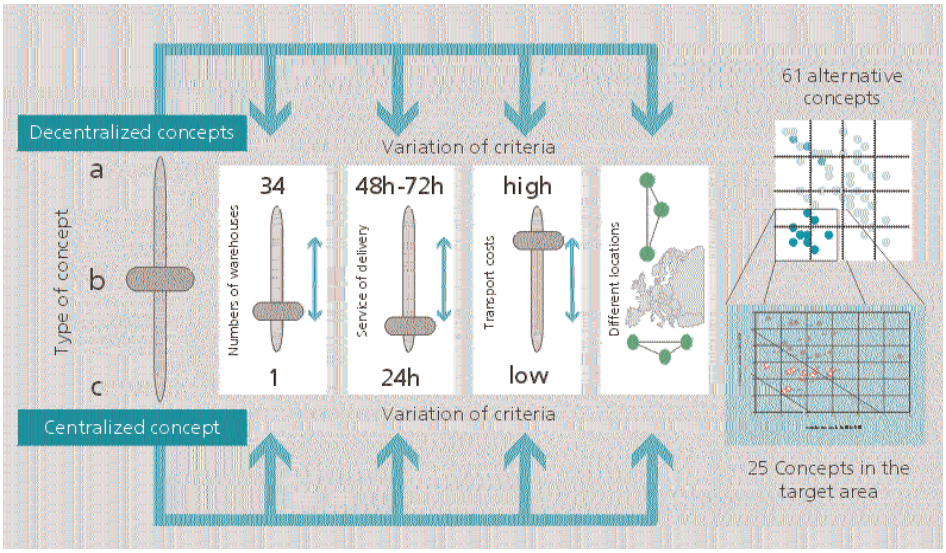


Fig. 1: Lever for the concept development

### 2 Site and transportation price information

In the next step extensive research according to current transportation prices and location information e.g. salaries, wages, work productivity, year working times and inflation rate for 34 European countries were carried out. The demands on the future distribution structure resulted from Workshops together with the marketing and distribution department of the enterprise.

### 3 Developing distribution concepts

In this step one began with the illustration of the current distribution structure in order to receive a reference point for arrangements with alternative concepts on the one hand and to be able to verify the concept at the actual costs from controlling on the other hand. After this alternative concepts were developed depending on geographic situation of the markets and volumes of turnover. In this case the individual distribution concepts were defined by means of the criteria: Supplies services, transport cost and kind of transport (direct dispatch of the central warehouse, part freight/ parcel), number of warehouses in Europe, warehouse sites in Europe and supply form of the warehouse sites. Further outsourcing alternatives were worked out and with cost- and utility value assessed.

### 4 Valuation and limitation of the distribution concepts and visualization

In the connection the individual alternative concepts were valued and compared with utility values and costs. For this purpose the optimal number of subsidiaries was determined by analyzing the warehouse and transport cost development.
For every developed distribution concept the total costs (warehouse and transport costs) and the utility degree were calculated by the use of the site controlling system, developed at the Fraunhofer IFF. From 61 concepts two first-best concepts for two different supplies degrees (24 h and 48h-72h delivery time in Europe) could be selected within short time.
After this the developments of selected concepts in the case of different market scenarios were checked in a sensitivity analysis in order to be able to derive an optimal transferzation strategy.

## Results

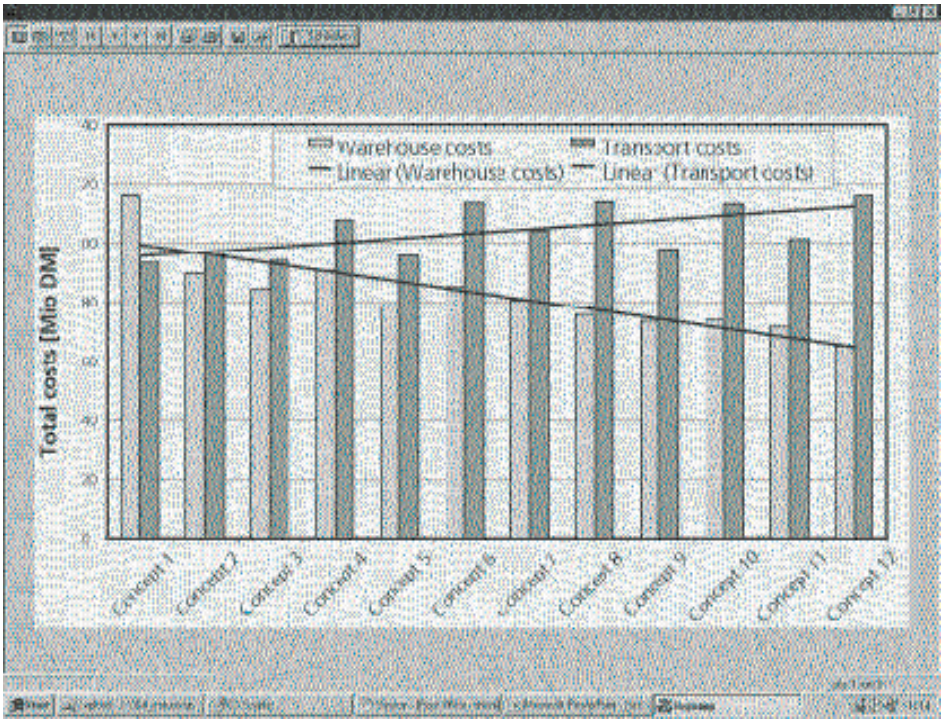


Fig. 2: Results of the project

At the end of the project, one distribution concept could be selected, which achieved the desired supplies services in Europe with minimized total costs. A centralized distribution structure with three warehouses in Europe could be identified on the basis of the assumed volume development. The supplies service for this distribution structure consists of a combination of 24 h and 2-3 days ex works to the respective markets. An economising potential of 16,1% of the total distribution costs is expected by this new structure. A pure 24 hour supplies service in all of Europe causes additional expense in the transport costs to the customer.

Further, sales increases can be achieved by improvement in the customers service degree in individual markets, through what the Economies of Scale and further advantages of centralization (e.g. better availability, simplified order processing and inventory management) could be intensified.

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# Benchmarking in maintenance



## Initial Situation

The world, companies operate in today, has become more complex. This fact is illustrated by increasing competition, cost pressure and globalization. As a result of competiton, there is a growing need for new solutions and approaches in optimizing operations. Benchmarking could be the answer because it addresses the problems of poorly developed out-side orientation of instruments of analysis by offering an opportunity for integrating the maintenance department which so far was difficult to include. Benchmarking helps identifying resources in organization, controlling and process design which are a prerequisite for increasing efficiency in a best practice scheme.

## What is Benchmarking?

The idea of benchmarking is based on the assumption that internal knowledge should be enriched with external experience by identifying best practices as the cause for improved parameters. Consequently, benchmarking is the systematic search for rational procedures and increased professionalism. Instead of copying the best-practice company, the emphasis is laid on promoting innovative thinking in order to find a progressive solution. Therefore benchmarking aims at identifying differences between the performance of your company and that of another company (best-practice company) in order to encourage innovative thinking about external experiences /1/.
An analytical evaluation of problem solutions increases the understanding of the need to identify oneself with successful methods. At the same time, it triggers an open discussion reflecting on traditional approaches and spurring possible changes to operations based on similar experiences made by other companies. An analytical evaluation of problem solutions increases the understanding of the need to identify oneself with successful methods. At the same time, it triggers an open discussion reflecting on traditional approaches and spurring possible changes to operations based on similar experiences made by other companies.

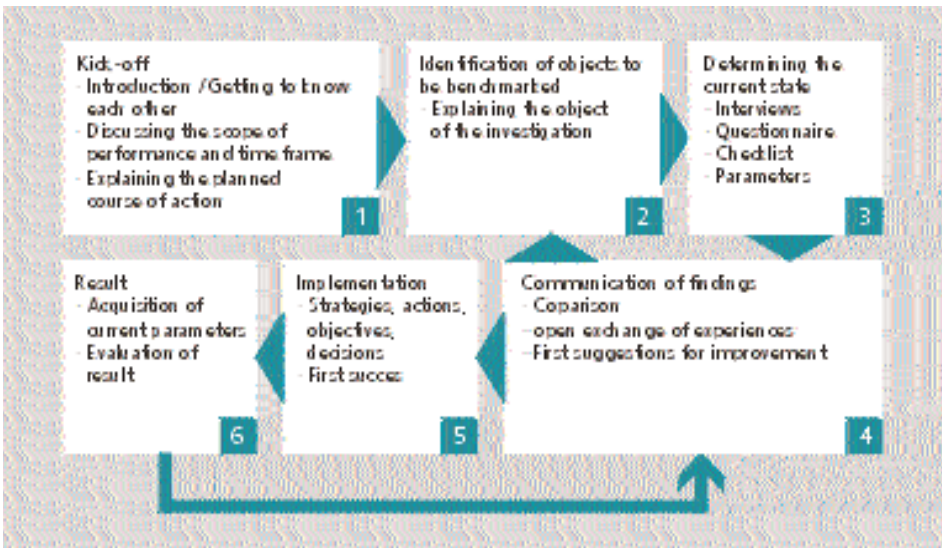
## Conducting a Benchmarking Study by the Department of Maintenance and Service Management

In order to conduct a benchmarking study it is necessary to form a benchmarking action group. The Magdeburg Fraunhofer Institute will act as a mediator and organizer. Through workshops, the action group will implement its task to plan the actions required (such as setting dates and deadlines, making appointments), gather information, analyze and finally implement the findings. The preferred approach is illustrated in figure 1.

Since the number of potential benchmarking objects within a company can be large, it is necessary, also in the light of market-based priorities, to make a selection. It is, however, important that benchmarking is not conducted on primarily unimportant processes. For this reason it is necessary to identify the company's core processes. The maintenance department is such a core area because it greatly effects operational parameters such as revenues and success, it is characterized by relatively high material and personnel costs with high added value, allows repeating benchmarking procedures and is strategically important /1/.
An analysis of maintenance organization includes the revision of processes or process activities. A structured approach as illustrated in Figure 2 helps identify »best practices«. These best practices include suggestions for reorganizing the maintenance department in order to increase efficiency.
Potential results may include:

- Identifying potentials in Electronic Data Process-support of maintenance
- Suggestions for improving documentation and evaluation of breakdown and stand-still times maintenance

Fig 1: Actions to be taken in the course of conducting the study



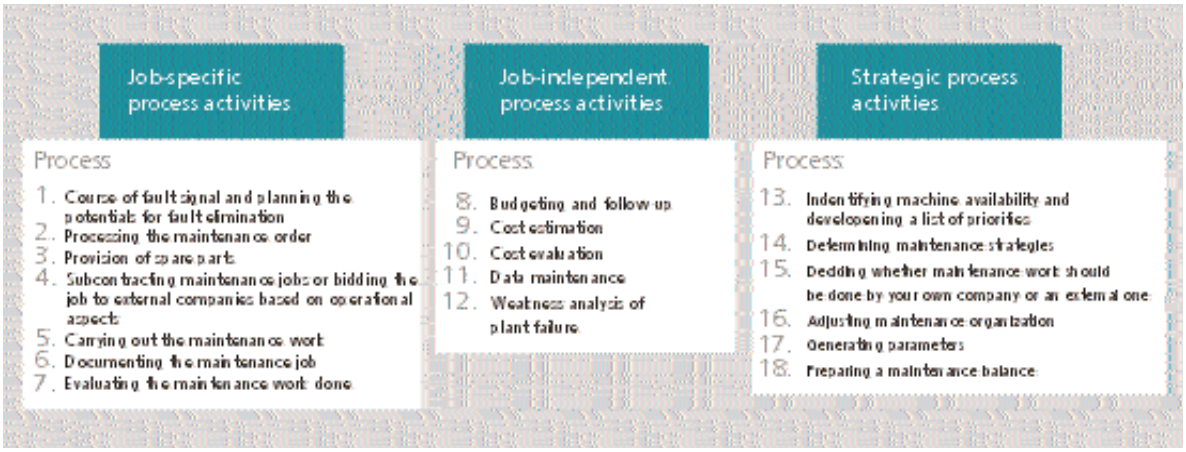



Fig 2: Process-based comparison of benchmarking processes in machine and plant maintenance /2/

– Suggestions for improving spare part controlling
– Supporting the strategic orientation of maintenance
– Supporting the profit-center idea.

In the implementation phase the results generated by the analysis must be translated into strategies, actions, decisions, and objectives, thus defining the necessary performance improvement in order to reach a competitive edge. Discussion must focus on the question of what can be successfully executed in the company under which circumstances and what cannot be done. Actions to be taken should be put in concrete terms as to what, when and who. Then the improvement process to be implemented must be described and illustrated so that advantages over the current situation become clear. Observing and monitoring effects is of prime importance, particularly in view of the implementation of a continuous improvement process. To this end, a measuring system should be installed which will support the adjustment and perfectioning of processes. Continuous monitoring and further development of performance standards (see Figure 3) will ensure a high degree of efficiency in maintenance and prevent that previous performance parameters will decline.

Based on previous experiences made in this field, the Department of Maintenance and Service Management offers its support to companies interested in conducting benchmarking studies as well as implementing actions aiming to increase efficiency.

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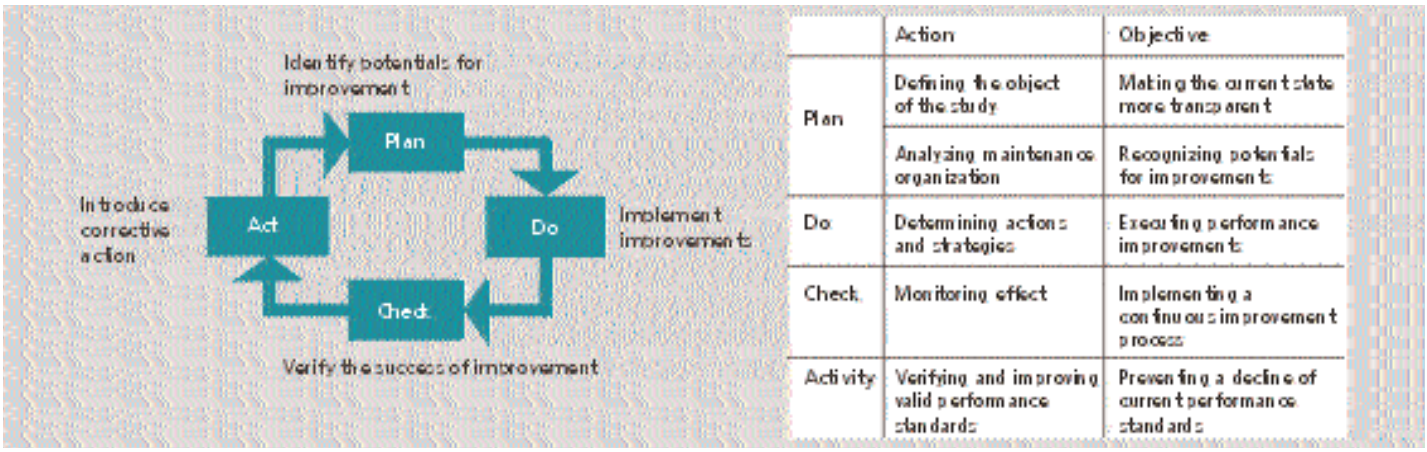


| | Action | Objective |
|---|---|---|
| Plan | Defining the object of the study | Making the current state more transparent |
| | Analysing maintenance organization | Recognizing potentials for improvements |
| Do | Determining actions and strategies | Executing performance improvements |
| Check | Monitoring effect | Implementing a continuous improvement process |
| Activity | Verifying and improving valid performance standards | Preventing a decline of current performance standards |

Fig 3: Action circle: benchmarking over time /3/

# Layout and providing concepts with capability of transformation

Assembly planning in automotive industry

The Adaptable Enterprise

Project Report Industrial Plants and Factory Engineering

## Initial Situation

The demands for capability of transformation during the creation of layout and providing concepts increase permanently caused by the change of conditions in the planning stage. In course of the simultaneous planning, the product is developed, processes of manufacturing and assembly are planned and systems for logistics and the appropriation of material are configured. As the net of the relationships became more and more complex, a separation or at all sequential processing of the partial tasks is no longer possible. The planning of an assembly in the automotive industry is a typical example for this. The increasing number of the models and variants is faced with an abridging cycle of models. Simultaneously the productivity and the quantity must be increased and the requirements of space for the manufacturing must be reduced. Furthermore, one can see a tendency of the automotive industry towards outsourcing of the planning of manufacturing areas. This requires a completely planning of factories starting with the conception via planning up to putting plants into operation including realization of comprehensive concepts for logistics and appropriation of material. The responsibility of the service provider increases in this manner with regard to the reliability and the capability of the whole system.

## Project Description

Within the framework of an industry project, the task was to plan an area of assembly of an enterprise of automotive industry in detail. The concept of adjustment that coordinates start up of the new model and run out of the previous model should be considered. In addition, the complex flows of material should be defined in a comprehensive layout and providing concept. In fact of the complexity of the task there have been used innovative methods and tools including the simulation and the visualization of the assembly with the help of Virtual-Reality-technologies. The efficiency of the assembly line should already be tested simultaneously with the assistance of these methods and tools in the conception and planning stage. Starting with an examination of the existing concept of assembly for the previous model, we developed a flexible assembly concept for the new car.

## Approach

Planning bases were determined in classical procedure at the beginning of the project. For this, the needed add-on pieces for the assembly were identified and the variants (approx. 12,000 pieces) were assigned. Based on a description of the product and workshop drawings an optimal order of the steps of assembly was defined. In the following step, from a temporal valuation of the operation steps a completely working plan was developed that was visualized by bar graphs. Steps of assembly which can occur simultaneously were identified to reduce the accumulated runtime of the whole system. To that, stops of assembly were defined and the steps of assembly were distributed among these stops considering the defaulted cycle time. To react on constantly changing demands a database was configured, in that needed components and steps of assembly were managed by the determining variant.

The contractors of the add-on pieces were included prematurely during the conception of the strategies of providing for components in planning in the form of workshops. The points of intersection between appropriation and assembly had a special importance. The parts should be delivered in receptacles which allow a simple assembly. Advanced principles of assembling (1- step-principle, reduction of stages of commissioning) could be implemented in this way. Furthermore parameters for example kinds and sizes of receptacles, ranges for components, requirements of space for zones of delivering and closed-loop control systems for the regulation of the appropriation were determined and defined into the workshops.

The size of the buffers was determined in order to make the areas of assembly from each other independent and to compensate interruptions. The aim was to prevent a standstill of the production at all events. To reach this the standstills of the assembly of the previous model were analyzed in regard to reason and time. The costs for cars that were not produced, resulted from a temporal valuation of the standstills. The optimal buffer sizes could be determined by the comparison of these costs with capital expenditures for the preparation of the buffers. By the draft of a synchronized concept of control was guaranteed that the sequence of the assembly is kept with absolute safety. Doing this, it must be guaranteed that the information, which variant must be produced respectively which material must be provided, is available at the correct time at the correct place.

During the design of layout variants on the basis of determined data, an innovative CAD technology which allows to stack several files on top of each other was used. In this way members of the project staff spreaded spatially were able to lay the plans of the other participants of the project under the own planning. For example, the layout designer needed a file of the building

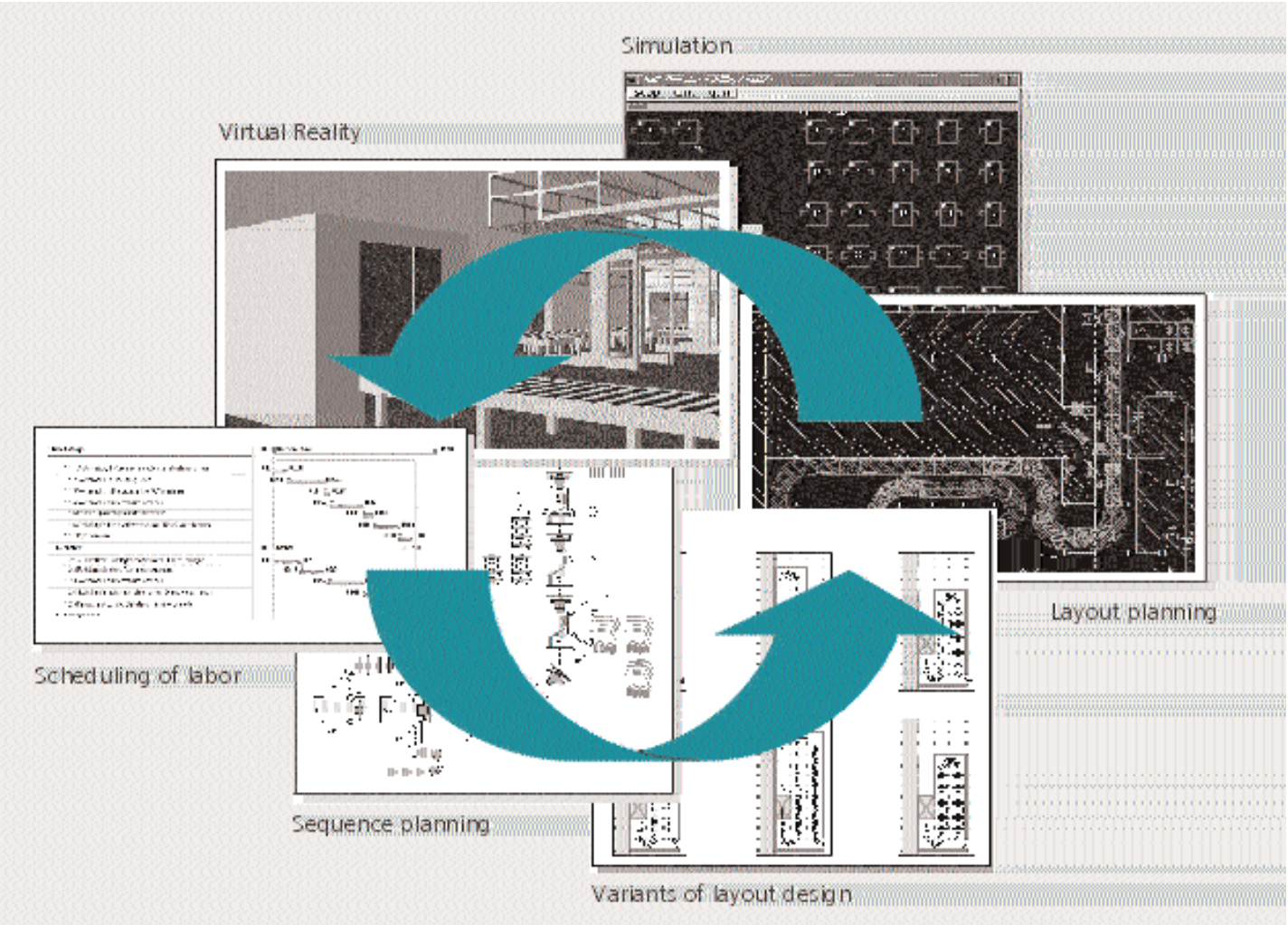


Fig.: The way for the optimal assembly concept

designer which he placed under its own layout file. As a result, protracted coordination of the participants could be avoided. Furthermore, a high consistence of data was guaranteed because all data exist only once, were in charge of a responsible member of the project staff and the files were not copied by the remaining participants.

## Foresight

The quality of planning can be tested currently by means of simulation runs. In such a way, principles of control can be examined with regard to its efficiency. By the integration of trouble sections which result from data acquisition, buffer sizes computed before can be verified in the simulation model and where appropriate, be corrected. The simultaneous illustration of the system by use of Virtual-Reality technology offers an especially vivid visualization of the process and allows further potentials for an optimization of the system. Furthermore, an education of the employees in the assembly is planned by use of Virtual Reality.

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# EUROPAhaus - Planning of a new factory in Virtual Reality

The Adaptable Enterprise

Project Report Industrial Plants and Factory Engineering

## Short Description

Due to the participative factory planning employees themselves can influence the planning of their own work places. To support this there has been used Virtual Reality with success. Due to VR it is easy to realize and to validate the future situation of the shop floor. However, even deciders and planners can use VR models to get experiences before realization. Due to this they can recognize problems earlier and the decisions are more proofed.
To make planning tasks with support of Virtual Reality there is used the software Mod!Fact in the Modelshop Industrial Building of the department IBFT.

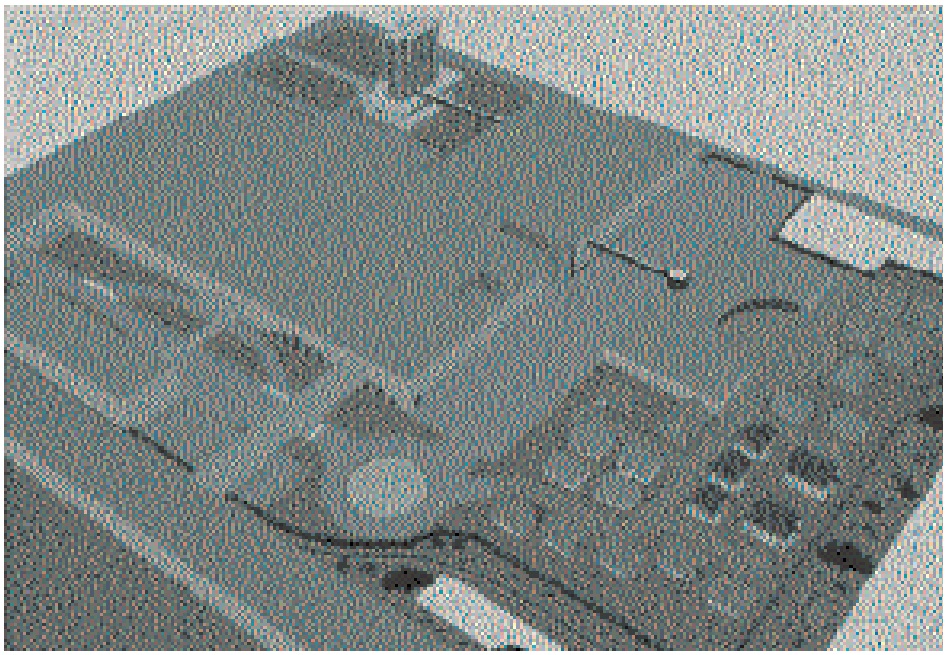

Fig. 1: Overview of the whole area of the EUROPAhaus

## Starting Point

In building trade it is currently usual that different tasks (like bricklaying, plumbing, installation and other) are provided by different firms. The whole amount of time consists of a great part of waiting time due to the lack of synchronization of the different tasks. Due to the sub-optimal order of the tasks there are repairs necessary before the construction of the house has been completed.
The EUROPAhaus GmbH has the goal to construct the parts of the house completely in a factory. The production should contain not only bricklaying and fitting of windows and doors but also plumbing and installation and even painting and wallpapering. There will be achieved a degree of automation in the production similar to car production lines and never before achieved in the field of house production.
The concept of EUROPAhaus contains a variety of new and innovative technical solutions for the product »house« as well as for the production process. It is a great challenge to the planners to combine all the independent solutions and to create a well working and well organized factory from them.

## Goals

The Modelshop Industrial Building provides consultation and visualization services to the planning team of the new EUROPAhaus factory. This makes possible an interdisciplinary discussion of the current state of the planning based on the available VR models.
The first concepts had been existed as 2D CAD layouts until start of project. This had to be visualized as 3D model. Due to use of software Mod!Fact there had to be provided a free navigation through this model. This should provide the collection of spatial and temporal experiences before the construction of the real factory has started.

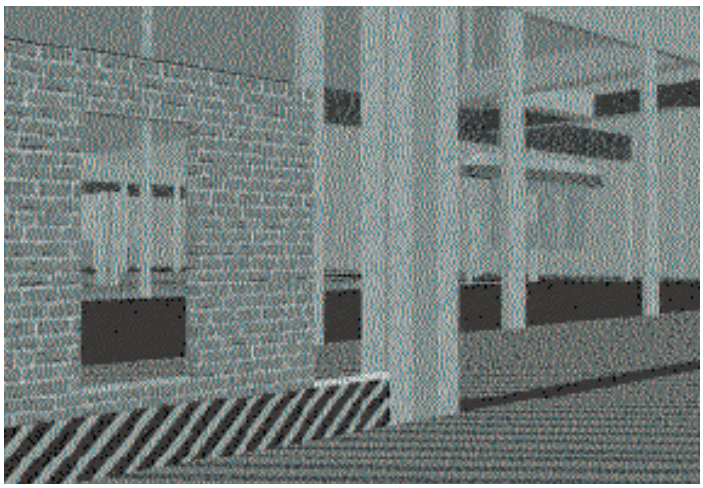

Fig. 2: Work places for post processing of walls

## Realization

The Modelshop Industrial Building has supported the planning process of the production lines for houses.
The realization of the 3D models consists of the visualization of:

- the whole area with paved and green fields (inclusive roads and parking places)
- the factory halls, exhibition hall and guest house
- the production lines, conveyors, cranes and stores
- some sample houses.

There had been held workshops (one per week). In the workshops it was possible to experience the current state of planning. The special advance was provided by the stereo projection system used for 3d visualization. The current state of planning had been discussed and changes had been decided. Depending of the effort there had been included into the model as soon as possible or until the next meeting.
Finally there was made a video tape showing the future factory and documenting the new kind of production process.

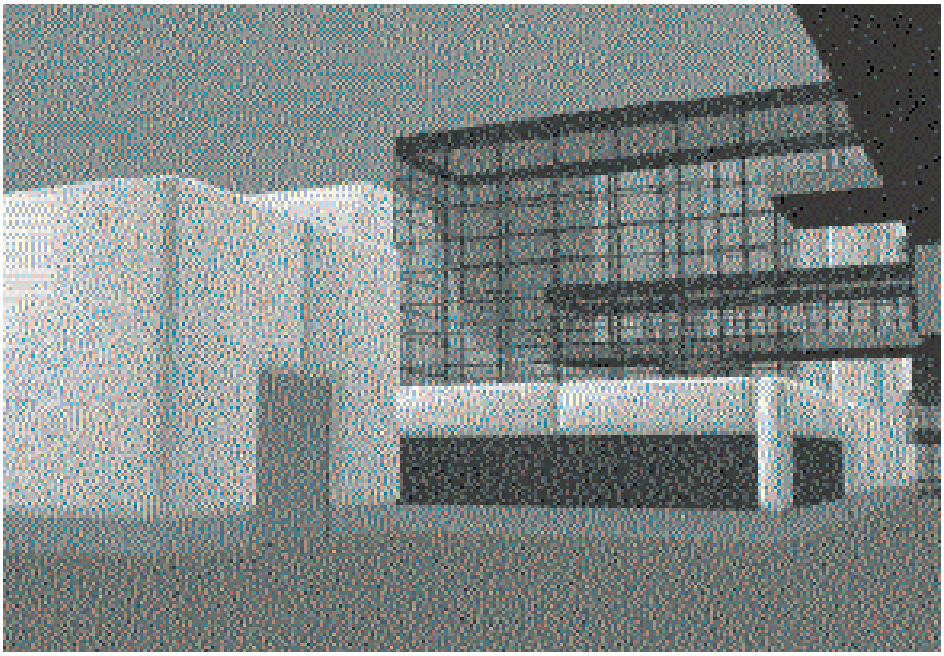

Fig. 3: Production lines of raw buildings

## Results

Due to the visualization of the factory in a VR model it was possible to verify and improve the concepts of the factory and production lines. This contains the layout of the production lines as well as design aspects.
At the Bautec '98 in Berlin the concept EUROPAhaus had been published the first time using a presentation and a press conference. This had been supported by the video tape and some additional snapshots of the VR model.

## Outlook

VR is an excellent tool to create and design individual houses involving the customers. Therefore it is planned to develop a software which provides the design and installation considering the abilities of the production lines completely. In this way the VR software is the user front-end of a bigger software bundle which includes CAD and PPC software, also. Therefore after the finish of the design process all necessary logistical and technological information can derived in the computer directly.

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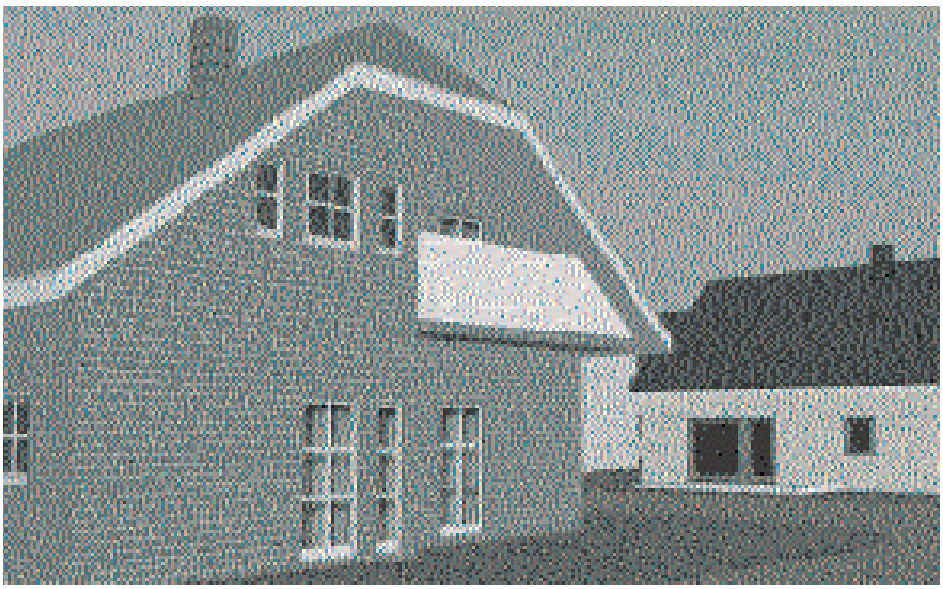


Fig. 4: Sample houses

# Method base for factory operation - knowledge base for transformation capable enterprises

The Adaptable Enterprise

Project Report Factory Organization

## Initial Situation

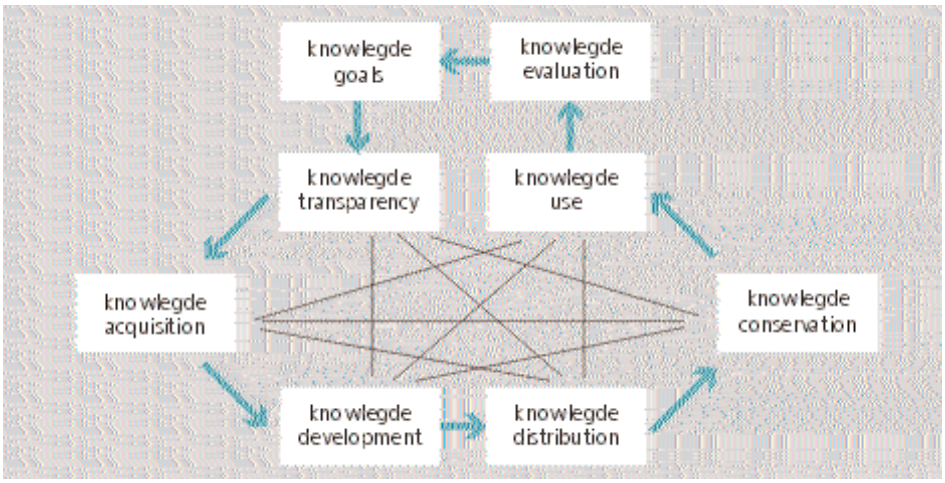
»The capability of an enterprise to manage knowledge and to move the knowledge into profit-promising products and services in shorter and shorter cycles becomes a crucial success factor in our time. To preserve and expand the competitive capacity and to be profitable, information and knowledge must be understood and used as a strategic resource for the process and for the product and as a product itself« /1/.

According to PROBST /2/ knowledge management contains eight phases which all can not be neglected (see figure 1). Research of the main department Factory Organization has shown, that today several information and communication tools supporting the phases of knowledge management are offered or developed. /3/ The identification of knowledge objectives, knowledge acquisition, knowledge conservation and the knowledge development, knowledge evaluation are not or only inadequately supported.

Tools which are able to analyze a problematical situation, locate the gaps in knowledge and define knowledge objectives are missed today. The same applies to the knowledge evaluation. Sources of knowledge which are globally available and partly not to retrace cause difficulties for users who are less and less able to differentiate between correct and wrong, complete and incomplete, current or obsolete. Fast knowledge acquisition often is very difficult in spite of or just because of the great variety of paths and possibilities of information because of often changing work tasks.

In today's multimedia world the opinion about knowledge conservation is prevalent that storage of knowledge is no problem with the aid of modern computer engineering. But enormous difficulties result just here, because in traditional there are only data and/or information stored but no knowledge. A Fraunhofer Institute for Industrial Engineering IAO study /1/ verifies that today knowledge in enterprises is mostly preserved as an experience of the individual employee. If preservation of knowledge occurs then only in not standardized or standardized documentation, via expert interviews or with the aid of sponsorship models (see figure 2).

Fig. 1: Phases of knowledge management /2/




However, the knowledge stored in such a way is difficult to call up. Not standardized documents can hardly be handled by sorting functions.

Especially in fields of knowledge - like factory operation - in which terms often are used with diverse enterprise-specific synonyms, it is difficult to find knowledge again. That's why the construction of a method base for factory operation which supports to save knowledge, knowledge acquisition, knowledge evaluation and the definition of knowledge goals is one of the research main focuses of the main department. Figure 3 shows goal groups and fields of application which are seen today for the method base.

## Method Base for Factory Operation

In factory operation, a number of methods exists for the solution of various problems. The selection of a suitable method is rarely trivial. First it is necessary to get a general idea. After that all possible methods are to be tested for their applicability. Out of the pre-selected methods that one is to select which can be integrated in the best possible way into a synchronized, aim-oriented overall concept.

In numerous publications of specialist literature collections of knowledge about methods related to an aspect and/or to a specific science discipline are available. These are very different with regard to their volume and their detail. The main department Factory Organization analyzed a great number of these method collections and detected that

– structures of these method collections depend on variously aspects and because of that the methods are variously categorized

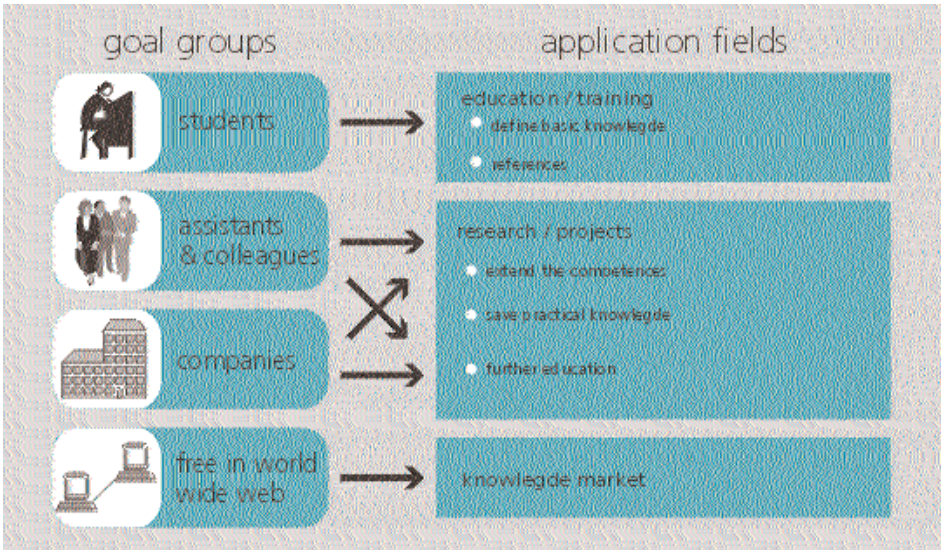



Fig. 2: Structure of the methods base for factory with methods examples

and prepared by meaning,
- methods are weighted with regard to their capability and using conditions differently and
- methods are not prepared in a way that allows a computer-assisted, problem-specific solution.

Some facts in conclusion can be derived. For support of enterprises exist some collections under special aspects. But they are not a practical relevant support instrument. The claims on a such instrument are the following:

- a list and evaluation raked file of the methods for analysis, evaluation, planning, control and information appropriation with application conditions, advantages and disadvantage and characteristic features of the models (like entry dates, master data, work load and so on)
- a preparation of the experiences for the method selection and transfer of knowledge to interrogation algorithms to create solutions in problem-specific dialogues
- a computer-assisted processing of knowledge in order to allow fast access paths for the effective knowledge handling.

The long-time goal is the creation of a competence place of work. It should provide the method knowledge and the expert knowledge.

In principle, structuring the method base was implemented in the first step. Based on the 6-level model we collected methods, models and techniques. After they were prepared depends the demands on the competence place of work (figure 3).

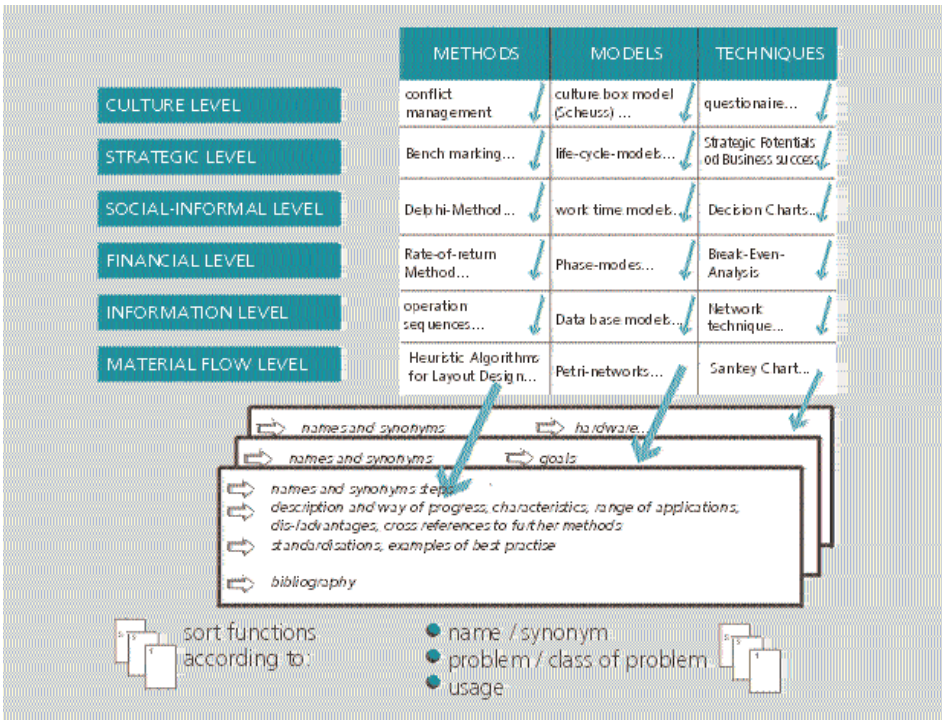



Fig. 3: Goal groups and fields of application of the method base for factory operation

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# Teleservice worldwide - machines and equipment »on the data highway«

Innovation Tools

Project Report Smart Sensor Systems, Maintenance and Service Management

## Abstract

Like in many other industries, the current development in mechanical and plant engineering is characterized by a globalization of production and marketing.
The manufacturers of machines, plants and equipment are faced with steadily growing demands for better services. Besides a high product quality, customer-oriented high-quality service is an important factor in international competition.
In the scope of an industrial project completed for a German manufacturer of mobile crushing plants a tele-service system for remote diagnosis and maintenance as well as for commissioning support has been developed for world-wide application.

## Initial Situation

Changing general settings such as globalization of markets, increasing complexity of capital goods and the demand of machine operators for improved services lead to challenges which primarily small and medium-sized companies have to cope with. It is not only the quality of the exported capital goods which is of decisive importance and decides about international success, it is also the guarantee for the client that he can expect customer-oriented high-quality services.
In addition to a potential cost reduction, the application of teleservice may result in improved service efficiency, better client relations and tapping of new markets.
Teleservice is a means to efficiently support communication between manufacturers, vendors and users of capital goods in the various phases of the product life cycle, from commissioning to the manufacture of spare parts via product use including maintenance and repair.

## Description

Ordered by industry, the objective of the project was to develop a system for remote diagnosis and maintenance of mobile crushing systems including facilities for commissioning and sales (figure).

The mobile crushing plants are used for crushing mineral and organic substances such as timber waste, construction site rubble, garbage tailings, etc. The entire system is controlled by a programmable controller. As a rule these plants are used on sites which are not connected to the mains or mains-borne communication media.

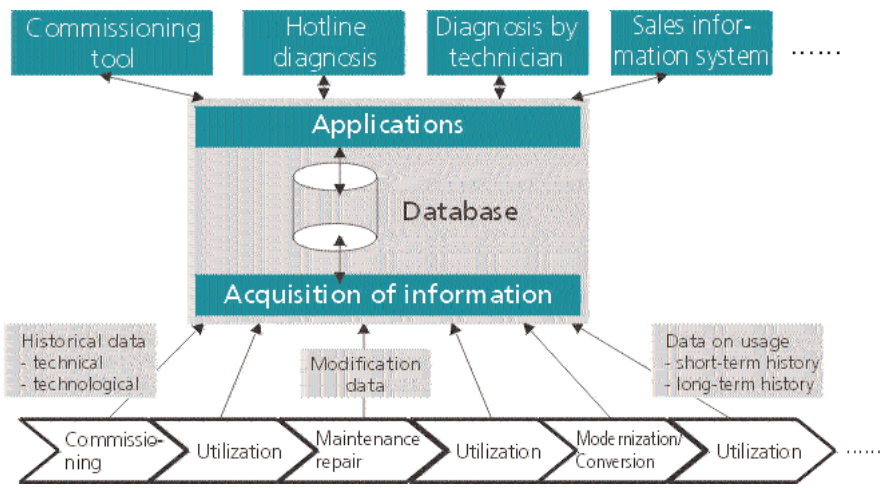


Fig.: Structure of the developed teleservice system

## Commissioning Tool

To provide efficient service and ensure optimum client relations it is necessary to have the required information about the plant and to correctly interpret any variations in current data. In this respect the initial features characterizing the plant at the time of commissioning or delivery are of prime importance because these features can be defined in the form of technical and technological data.
The commissioning tool satisfies two requirements of the company: Firstly, this tool is an efficient instrument in the hands of the commissioning personnel because it allows to provide set data for plant-specific work sequences, to show the individual steps of the commissioning process and to collect relevant plant data aiming to continuously update the life cycle of the machinery. Secondly, resulting from the automation of individual steps of commissioning by evaluating the PLC-data via control functions of information acquisition, the demand for manual work during commissioning can be reduced, work sequences accelerated and relevant data automatically collected.
Furthermore, implementation of these two measures results in a steadily high quality in the execution and recording of the commissioning process and collection of »historical« data of the plant in a database, the data of which may subsequently be used in the hotline-diagnosis for comparison.

## Control-Integrated Acquisition of Information

A programmable controller is the central control unit of the entire system. In addition to controlling the machine processes, the controller also generates diagnosis data which are available at an interface. Based on the data, both a mechanical and a technological diagnosis can be made. To facilitate efficient and quick evaluation of any situation, e. g. machine failure, the current values of sensor signals/control states and historical process data of the plant are required for a quick analysis of the cause of the fault. The current states are available in the form of binary and analog values and require a low data volume only and, consequently, a low demand for communication in the case of remote diagnosis. In contrast, historical data consist primarily of certain relevant values which have been recorded over a period of time. As a rule, these historical data comprise a large volume of data. For this reason it is urgently necessary to reduce the data volume in case of a slow communication channel. To achieve this goal, evaluation criteria have been developed in the scope of the project. These evaluation criteria provide maximum information about the history of the plant at a low demand for data.

## Mobile Communication

A modem is used for data transmission between plant operator and manufacturer. A GSM-radio modem is used in the plant. A micro-processor-based communication controller is used to provide the coupling between the machine control unit and the GSM-module.
In view of the current state-of-the-art, for modem connections in a fixed network a high degree of data integrity and data compression is already implemented in the firmware of conventional units (V.42bis, MNP5). When using GSM-based modems, however, the specific radio data backup protocol RLP can only be used where it is supported by the respective operating agency. Due to the low spread worldwide, safe data communication can only be ensured with the help of one's own end-to-end protocol. Therefore, a protocol was developed and implemented in the scope of the project which satisfies today's requirements by multi-stage data backup, automatic block repetition and variable block length.

## Software Diagnosis Tool

Quick and efficient remote diagnosis is dependent on service-supporting software tools. In the scope of the project a diagnosis and maintenance tool was developed which is characterized by the following features:

- call set-up and data acquisition from a selected remote plant
- display of states, responses and trends
- fault tree with stored fault pictures and trouble-shooting action
- comparison of master data and current values
- loading and saving of diagnosis sessions.

## Summary

The developed teleservice system is a complex system which ensures mutual benefits to manufacturers and users over the entire product life cycle of plants.
It is an important prerequisite for opening-up new markets and winning new clients on a global level.

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# Teleservice worldwide - a Java-based control console for a production plant in the chemical industry

Innovation Tools

Project Report Network Services and Data Processing


## Abstract

In the scope of an industrial project carried out for an internationally active manufacturer of chemical plants, the potentials of active access to his globally installed measuring and control systems from his home base were identified and implemented. A Java-application was selected using advanced internet mechanisms for program-program-communication.


## Initial Situation

The firm is engaged in the installation of measuring and control consoles for chemical plants located all over the world. To facilitate diagnosis and maintenance, it is temporarily necessary to provide remote access to the control systems. Currently the control software runs under Windows95. Remote access is provided via a telephone connection directly to the computer. Bypass of screen, keyboard and mouse is executed with the program pc-Anywhere. Particularly with regard to international calls, it is understood that this variant is highly problematic. Jamming and the low fault tolerance of these applications often cause difficulties in executing control functions correctly. In addition, these applications are, of course, very costly.

## Description

The aim of the project was to facilitate the operation of a measuring and control system for a complex chemical plant both locally and via remote access. The project focused on the implementation of a system console utilizing visualization and transmission mechanisms which are well-known from the Internet. The following was aimed at:

- to ensure platform-independence of the control console
- to make sure that visualization of the control console has to be programmed only once because it may be used both locally and remotely
- to make sure that access by the control console may be provided as required and in compliance with the necessary levels of security.

An SQL-database was selected as interface between the analysis /control tool and the system console. The system console has been programmed as a Java-application and accesses the database via JDBC. Consequently, it fulfills the above requirements of platform independence and it can be applied both locally and remotely.

The database stores all states of current ongoing processes. Data inquiry is performed at regular intervals by both the control software and the console. Both the control software and the system console have access to the database and may enter data. Any entries in the database made from the console result in a change in the control processes initiated by the control software. With the help of its internal locking mechanisms the SQL-database assures that sets of data are not overwritten simultaneously by the control and the console. Both applications respond not until the respective entry in the database has been completed (the control software by triggering the control processes and the console by displaying the initiated control process). The control console can be started in any Java-capable browser. To execute program communication, the control computer on site comprises the SQL-database and a www-server. Since different services have to be carried out in parallel on the control computer it is necessary to use a pure multi-tasking operating system. In this case Windows95 is no longer suitable. For the solution described here, Windows NT 4.0 was used as system platform.

Depending on the situation, access to this control computer can now be provided either directly via PPP or via the internet. To assure a reliable connection, general encoding or tunnel mechanisms from the surroundings of the internet may be imposed. In addition, this solution allows to run several control consoles in parallel, thus allowing to offer to the plant operators not only teleservice but also teleteaching.

The general validity of the solution enables the company to use any multitask-capable operating systems on control/console computers and to use the console/s remotely from the control computer which is very useful primarily with regard to large systems.


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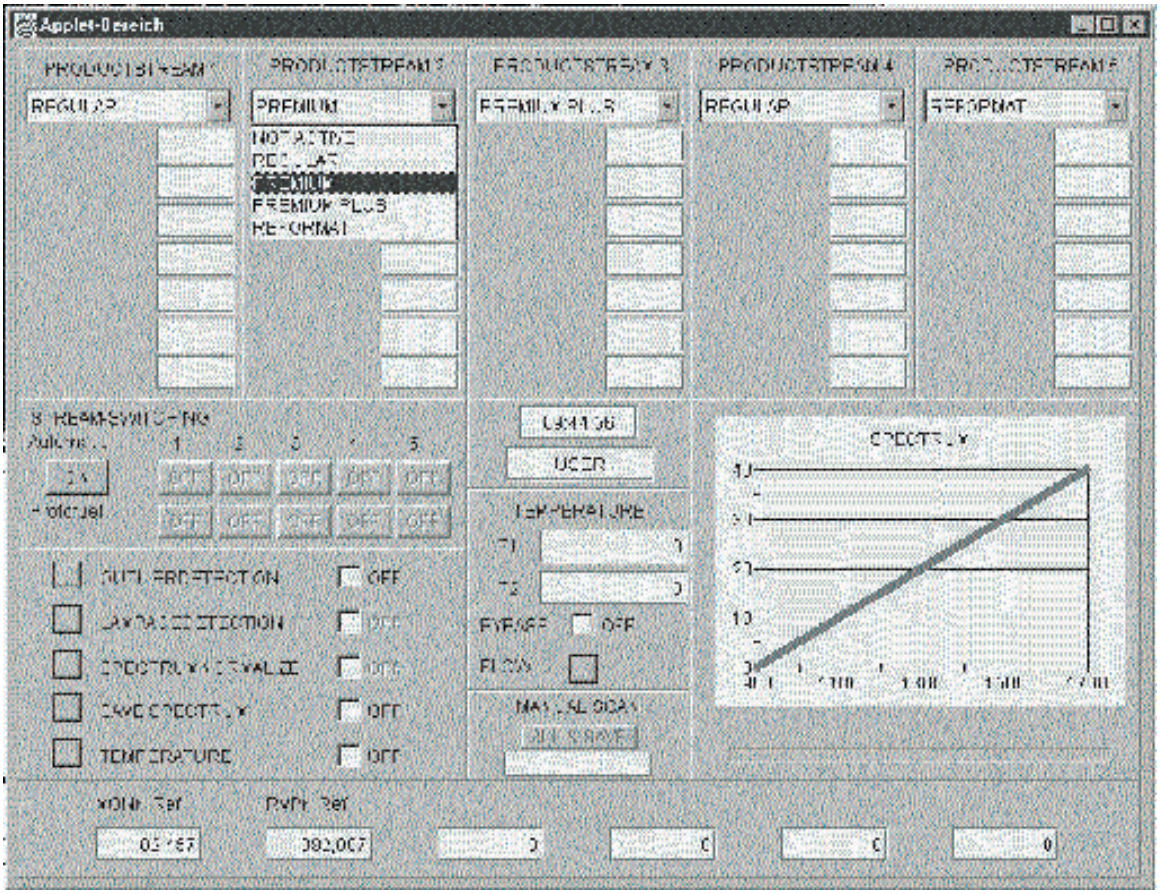


Fig.: Java-console of the control system

# Description illustrating the start-up of a biotech enterprise

Innovation Tools

**Project Report Fundamentals of Factory Operation/Organization of Inhouse Processes and Technical Innovation Management**

## Initial Situation

The Fraunhofer IFF, within a research cooperation, took over the function of searching for and develop suitable application fields for a biodegradable plastic made from regenerating raw materials. Through systematically processing the following focal topics:

- Resources and determination of the strategic project orientation
- Analysis of extraneous influential factors
- Systematized elaboration of the specification
- Determination of the market volume in the German market
- Determination of promoting and impeding factors from similar research and development projects, an inventory was made out for biodegradable plastics.

Finding a suitable way for transferring the »materials development in the laboratory« into smallscale industrial manufacture was in the focus of investigations. Principal possibilities and new approaches can be found in /2/. It turned out even in early phases of materials development that a comprehensive substitution of conventional plastics is both technically unfeasible and not wanted by the market. Marketing the material proper and products made of it thus inevitably required a niche strategy. Moreover, first contacts with potential clients revealed a compelling demand for production engineering know-how for use and application conditions of the developed material in manufacture.

## Niche Strategy and Resulting Consequences

The following demands on materials development resulted from the niche strategy followed:

- Use of conventional processing methods (e.g. die casting and extrusion) in order to avoid new investments with potential clients as far as possible
- Material delivery in plastic-like consistency and shape to enable the use of already available equipment
- Accumulation of know-how for processing the material such that the manufacturing process quality can be secured with the final client.

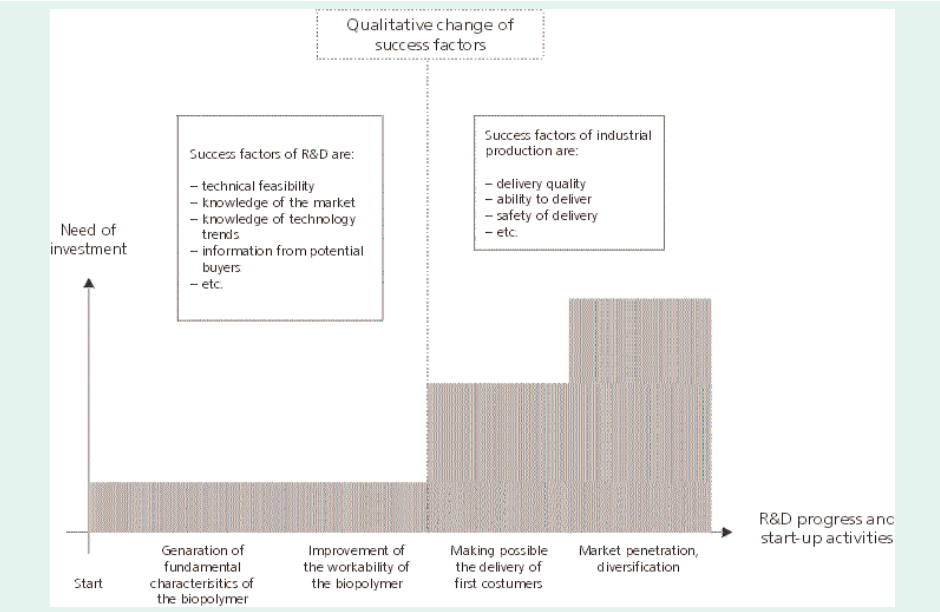


Fig. 1: Qualitative change of success criteria for securing a start-up

The basic material development (early in 1998) was paralleled by basic investigations into the processing properties of the material. Their aim was to allow, through materials development, a specific change of processing properties such that the niche strategy described above could be followed, involving only losses as low as possible. During materials development, the Fraunhofer IFF established and expanded contacts with potential users/clients for the material to be developed and kept-nursing them over the entire material development cycle. After initial successes, it soon turned out that the equipment available in the research laboratory only allowed to produce exemplary small amounts, which were sufficient for test purposes. The test of products made of this material with potential clients kept failing, however, due to low material stocks (see figure 1).

The material as available in the middle of 1998 met both material engineering and process engineering requirements, thus the persons involved in the project decided to continue devel-opment and marketing activities in a newly established enterprise - the SUPOL GmbH (Sustainable Polymers GmbH). Besides the continuation of materials development activities, most of all the transfer of knowledge gained on laboratory level into smooth factory operation is the declared enterprise goal.

## Extraneous Influence Factors

It was, therefore, one first necessary step to find out which political, technical, economic, and socio-demographical developments influence the goal of the development project. This applies, for instance, to the amended standards for detecting the degradability of materials, consumers' attitudes towards the application of such materials, possible disposal paths and not least biode-gradable plastics already available in the market, their technological potential and distribution. Details concerning the present state of extraneous influence factors can be found in /1/.

## Systematized Elaboration of the Specification

For the purpose of minimizing the technical innovation risk, a systematics was developed that allowed relevant technical characteristics of products whose materials are to be substituted, to be recorded, weighted, and processed. The central idea of this systematics is to form product families from individual products to generate generalized development goals (so-called type agents). Products used as a basis of the family cover in each case the span from the »low-tech part« to the »high-tech part«, i.e. they differ in their technical requirements. This approach minimizes the technical risk as even in case the developed biodegradable plastic will not fully meet all the requirements of the type agent, the development result will be sufficient for less demanding products of the family.

## Determining of the Market Volume

After having generated a number of type agents for various branches, the question arises which type agent development efforts with the aim of minimizing economic risk should be ultimately focused on.
One approach is derived from the determination of market volumes observed in Germany and of the number of competitors, using a market analysis program developed at the Fraunhofer IFF within the project. The basic principle of computer-aided market analysis is based on the input of production quantities as published annually by the Statistisches Bundesamt (Federal Office of Statistics) and their adjustment by (world-wide) import and export quantities. Starting from market volume, it is possible to deduce the market potential of innovative product ideas in the German market.

## Conclusions and Outlook

The transfer of prototype developments to mass production meeting cost, quality, and time requirements needs a number of issues to be cleared up, such as

- Differences in process control as compared with conventional plastics (maximum retention time etc.)
- Special features in tool design (corrosion resistance, runner system design etc.)
- Possibility of compensating quality variations of the materials produced (cp. similar projects as presented in /4/) that are due to the varying chemical composition of regenerating raw materials used as basic materials

Such issues are intended to be investigated into by the Fraunhofer IFF together with other Fraunhofer institutes in the future.

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# Rapid Prototyping technologies and product development methods for user-oriented system development at small and middle-sized enterprises

Innovation Tools

Project Report Product and Process Planning

## Short Description

The product development in small and middle-sized enterprises of the electronic branch is characterized by complexity, filigree work and a multitude of variants. Often areas of conflicts arise between design/product development and -construction and the cost intensive mold development.
Within a project, sponsored by the foundation of industry research, the Fraunhofer IFF develops in cooperation with 3 small-sized enterprises solutions which make it possible for many firms of the electronics and electrical engineering industry

- to reorganize its product develop ment process,
- to reduce iteration loops,
- and to economize start-up costs.

Focal points of the project are the connection of information- and communication systems of the involved partners and the combination of Rapid Prototyping and Rapid Tooling Models with modern development methods.

## Initial Situation

At the end of the 80ies the number of employees within the electronics and electrical engineering industry in the newly formed states of Germany fall from 400,000 down to 70,000 - most people working in small and middle-sized enterprises.
Contrary to all expectations, production and turnovers in these branches increased by 16.7 % or by 19.1 %, beginning at a very low level. Against this trend the small capital resources of the often very young enterprises involve certain dangers:

1. The refinancing of orders sometimes is impossible.
2. Necessary investments concerning process innovations do not take place.
3. Creative product ideas get lost during daily operative work.

Resulting from these facts, higher pay costs per unit arise compared to competitors from as well Germany`s old states as those from foreign countries - despite of regional pay advantages in the newly formed states. This situation is a competitive disadvantage which is strategically connected with turnover losses. By innovating in product development and cooperation concepts, it is possible to successfully avoid this.
Although the requirements by the small and middle-sized enterprises of the electronics and electrical engineering industry are realized, and expectations concerning the necessary RP-technologies as a tool for solving these problems are existing, these enterprises are afraid of doing the step to the 3D-future. This challenge is connected with basic changes concerning organization and technique.

## Project Report

Aim of this research is to analyze and recreate the usage of RP- technologies and the joining between product development/construction and mold development. These activities focus on typical product development processes of the electrical engineering and electronics industry, restricted to the conditions of small and middle-class enterprises. The necessary coordination steps between design/product development/construction of RP enterprises and mold development - considering each included group of staff - are to be determined. Checklists to identify technical and organizational sources of errors and the best possible technical and technological support are worked out and practically evaluated concerning technique and economy.
Two product developments on the fields communication- and gauge technique are accompanied by the Fraunhofer IFF. A workshop concept, especially adapted to the circumstances of small and middle-class enterprises, is the working basic for recording market information, to carry out competition analyses, to determine classified demand profiles, to deduce function features, and to work out alternatives.
Modern methods like stakeholder analyses, conjoint analyses and QFD-techniques are used for obtaining and evaluat-ing information as well as structured questionnaires and interview techniques (look at figure).

These techniques get a new quality by the usage of RP models, especially produced for finding and accelerating solutions.
By the RP driven production of a functional prototype with characteristics of a final material it was possible to clear up uncertainties concerning the efficiency of components of light circuits. This activity was prerequisite to effectively perform a QFD-technique.
A further example is the generation of RP models to increase the safety and acceleration of the decision processes with regard to design, ergonomics, functional principles, or obtaining offers. Above all, this procedure has proved to be very suitable on carrying out conjoint evaluations.

By an intensive cooperation with the included enterprises a checklist was created at the Fraunhofer IFF - adapted to the electronics and electrical engineering industry - which allows to evaluate time, quality and necessity of prototypes during a continuing product development process.
The steady reflection - on the one hand – of preconditions concerning

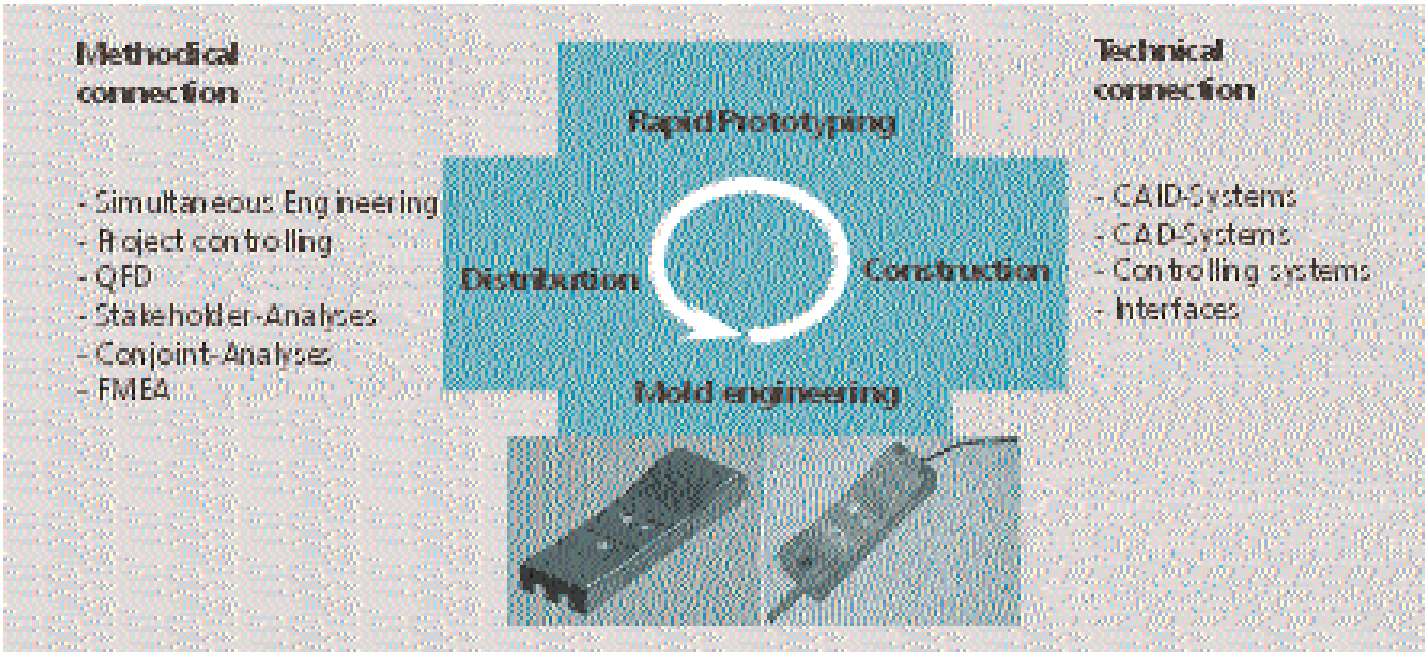


Fig.: Methods and technical/technological tools for an efficient product development at small and middle-sized enterprises

cost and resources and – on the other hand - of the possibilities for the technical solution during the realization of these activities, offer the base for an efficient usage of the results. Furthermore the base for further projects is generated by this procedure. The project's next aim is the elaboration of a technological schedule for RP-techniques and for those information processing systems which are necessary to connect the affected function fields. This context bases on a general structure of the typical components of the electric/electronic industry.
As a large part of the nowadays available RP high technologies like

– Rapid Tooling,
– Vacuum casting of plastics,
– Metal spraying,
– Laser-sintering,
– Stereolithography,

are involved into the project, but otherwise especially the cost intensive mold development is of a vital significance for far more small and middle-sized enterprises of other branches (toys industry, instrumental technique), one reckons with a high distribution ability of the from this project outcoming results.

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# Integrated service management in the machine and plant building industry - customer-specific services with growth prospects

In-house Value Creation

Project Report Maintenance and Service Management

## Brief Description

The current situation existing in the machine and plant building industry induces small and medium-sized enterprises to step up efforts aimed at identifying services which they could offer as an additional value added to their plant and systems operations proper. The services to be offered in this respect go beyond the classical services rendered in the field of installation and customer services and represent an integrated corporate policy designed to permanently get a competitive edge over other competitors by offering customer-oriented services, on the one hand, and to make an independent contribution to a company's profit, on the other hand.

## Initial Situation

While small and medium-sized enterprises (SMEs) in the machine and plant building sector offer sophisticated top-quality products in the market, they often attach little importance to the services they offer in connection with these products or fail to achieve the proceeds expected in this area of their operations. At the same time, the provision of services as a tool for strengthening one's market position is continually increasing in importance. Only an efficient service management, however, will enable a company to meet the associated requirements. For designing an efficient service management, an integrated approach was used in which service management questions were investigated within the context of the strategic triangle formed by the customer, supplier and competitors and modeled as a control loop (figure 1).

## Project Description

The association project »Service management in the machine and plant building industry (SEMA)« promoted by the BMBF was successfully completed in September 1998. Five medium-sized machine and plant builders as well as four research institutions had established an interdisciplinary co-operation for the purpose of implementing this association project. SEMA has dealt within the framework of the inter-company master project with the preparation of scientific foundations for service management, on the one hand, and in the individual company projects with firm-specific and service-specific tasks taking into account customer and employee requirements, on the other hand.

## Objective

It was the aim of the SEMA association to develop and test company-specific methods and approaches enabling the participating companies to analyze, design and operate their service in a customer-oriented, innovative and efficient manner by establishing task and organizational structures meeting the requirements of both customers and employees. Since the developed exemplary methods and approaches will be summarized and generalized in the form of a technical book forming part of the master project, the proliferation of research results will be ensured.

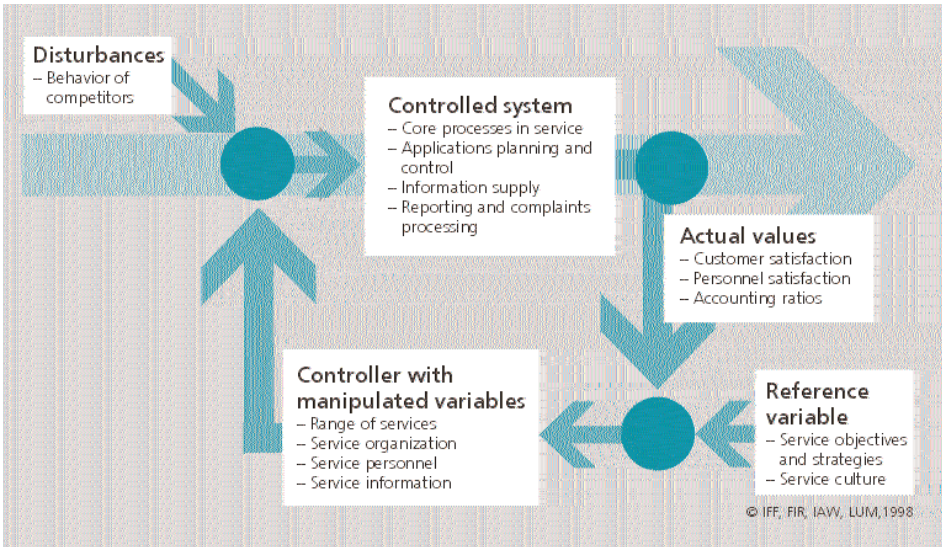


Fig. 1: Service management as a control loop

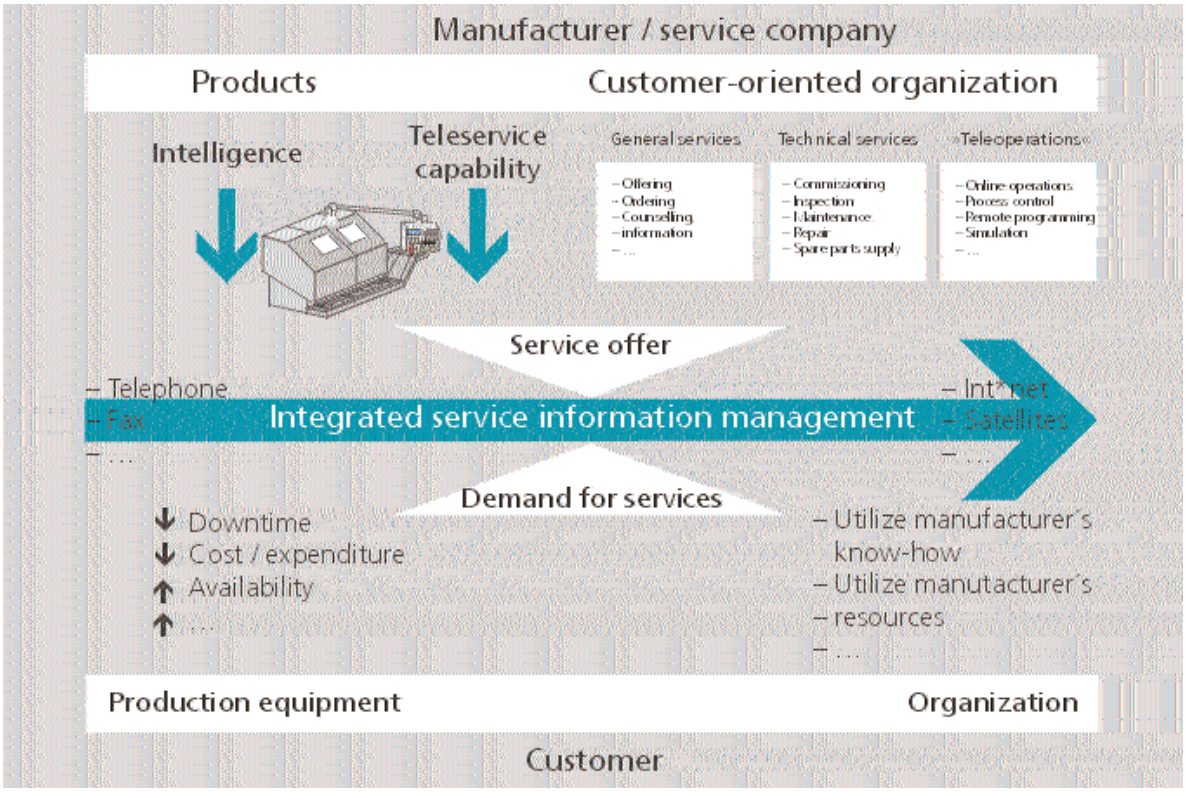


Fig. 2: Integration of telecommunication, informatics, media, electronics (TIME) as well as organization and processes

## Summary

The approaches used and developed for analyzing and evaluating existing service organizations as well as the approaches specifically designed for given companies to enable them to achieve the service targets set, have not only resulted, e.g., in a reorganization of individual divisions within the companies participating in the project, but, in view of sometimes drastic changes in regard of products and markets, rather caused that a greater emphasis is now being placed on service questions in the entire company.
Moreover, it has been possible, for example, based on the analysis of business processes and existing service potentials, to streamline intricate processes and inflexible company structures, to develop new strategic service-specific business fields or significantly improve the working conditions of in-plant and field service personnel.

## Outlook

The aims set at the beginning of the project have been reached jointly with the companies involved. It has become evident that, in spite of the different initial situations prevailing in the individual companies, the solutions developed generally apply to all companies so that they can be adopted in all enterprises intending to offer a customer-oriented and successful service. Service operations in the machine and plant building sector constitute in this connection a good example of the close relationship existing between physical assets and services. As regards the provision of services in future, it is important to combine a product-oriented approach with service-specific solutions, using the possibilities of modern information and communication technology, so that an attractive package is achieved that can be offered to customers all over the world (figure 2).

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# Organizational design and optimization of production lines for electronic boards

In-house Value Creation

Project Report Technical Innovation Management

## Initial Situation

In order to remain competitive, firms which are concerned with the production of electronic components and boards have to meet requirements of a changed market environment which is given by specific customer requests, shorter delivery times, and successful deadline meeting, together with rising quality levels. These steadily rising market requirements are taken into account by continuous extension and introduction of new production techniques.
Existing studies have shown that pure automatization of board's production doesn't guarantee permanent competitiveness and profitable production.
A high degree of flexibility and profitability can solely be achieved by coordination of technical and organizational factors. In order to find relevant technical and organizational factors and to design guidelines which help increasing the affectivity of the integrated plant, a questionnaire was created and sent to firms for answering purposes. By linking data provided by the questionnaires to practical investigation of the SMT-production and to experiences of the Fraunhofer IFF in the field of organization, conclusions with respect to the organizational design of modern SMT-production lines were drawn.

## Data Generation

For the current study, secondary data was supplemented by a field research which took the form of a written questioning of firms. That appropriate questionnaire, which was developed by the project group SMT of the Fraunhofer department IFF, contained three main foci dealing with the coverage and description of the actual situation of firms concerned with SMT-production. A first impression of the variability of resources different questioned firms have at hand is provided by the data given in the questionnaire's sections on structure, human being/worker, and technique (figure 1). Since November 1996, 200 questionnaires were sent to firms concerned with SMT-production. Many questioned firms were interested in the subject the SMT project group shed light on, which is confirmed by the high percentage of returned questionnaires: ca. 40%.

## Results

The theme of the current discussion are partial results of the study »Organizational Design of SMT-production lines«. The data from the sections structure, human being/ worker, and technique provided by the field research serves to describe the actual situation of firms concerned with SMT-production.
The goal of this study is to confront potential resources of firms with their actual productivity reflected in the affectivity of integrated plants (GAE), to draw conclusions where the initial situations is to be taken into account, and to deduce general organizational measures and recommendations for a stable and profitable production.

The analysis of the data on hand and many interviews with persons in charge with the current investigation show that 3 workers constitute the optimal number in order to operate a SMT-assembly line which features the sections given in figure 2 and has to be capable of performing the following tasks:

1. operation of dispenser, silk-screen printer, piecing automate, soldering stove
2. maintenance of dispenser,silk-screen printer, piecing automate, soldering stove
3. quality control of assembly after dispenser, silk-screen printer, piecing automate, soldering stove (monitoring by view)
4. preparation/ externalization of assenlies/ program testing
5. looking after the production of new products

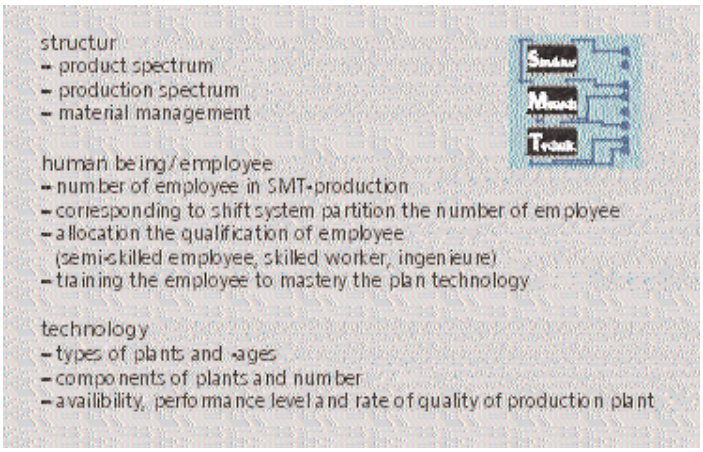


Fig. 1: Contents of the questionnaire used for capturing firms` resources

## Optimization Approaches in Production

Parallel to ongoing empirical data capturing, the project »We optimize with our SMT-production structure« is ran in a single firm. In order to guarantee a successful project work, all workers in charge with it are incorporated into the optimization process from the beginning.
For the capturing of problems arising in SMT-production, a catalogue of

measures was created and hung up in the production hall in order to increase lucency.
An active integration of workers into the decision making process lead to identification of relevant optimization potential in a short time and allowed for determination of the appropriate measurements. During the project, it became very obvious that resources and opportunities are available within firms which allow to work out less expensive solutions.
Thus, the information transfer in the production section was increased clearly by introduction of a shift book which recourse the structured capturing of problems and main error sources.

When developing indicators for SMT-production, it was found that a nonnegligible fraction of unproductive running time (time of nonuse) arose due to the difference between placement trials for components and actually placed components. Moreover, surveillance showed that difficulties existed in particular when the components were picked up with existing variants of pipettes. The purchase of a new magazine of pipettes increased the selection of available pipettes. The investment decision was motivated using the lucency of additional costs due to unproductive running time as well as reusable components.

The success of the invoked measure in SMT-production during the project is reflected in the rising course trend of the productive running time curve (figure 2).

The product TemPO³ was developed by the SMT-project group of the Fraunhofer institution IFF using many information and interviews with participants of the study for Organizational Design of SMT-production lines and practical experiences.

## TemPO³

The goal of TemPO³ is to create efficient and lucent production processes in order to pursue growth strategies.
This goal is achieved by implementation of optimal courses from production step to production step by integration of new production techniques or changes of production steps. For firms, this optimization procedure yields the following advantages:

- reduction of through-put-time by up to 50%
- cost reduction of up to 50%
- achievement of a production quality in ‰ instead of %
- doubling of output with a 30% increase in the number of employed workers

The main foundation for TemPO³ is lucency of every single production step which is achieved by the following analyses:

- machine analysis, e.g. equipment, breakdown susceptibility
- order analysis, e.g. through-put-time, cost center drain, tight deadline meeting, ...
- product analysis, e.g. number of pieces, batch size, complaints, variants, ...
- material analysis, e.g. stock, storage location, turnover rate, standards, ...
- tool analysis, e.g. costs, times of nonuse
- worker analysis, e.g. performance, flexibility, ability to work in teams

From the results of these analyses, measures may be deduced whose implementation implies optimization e.g. of the capacity utilization of machines and workers, of input factors or the use of equipment. According to the goal of TemPO³, strategies for the optimization procedure are worked out which are oriented towards the integration of new production techniques and rearrangement or change of production steps.

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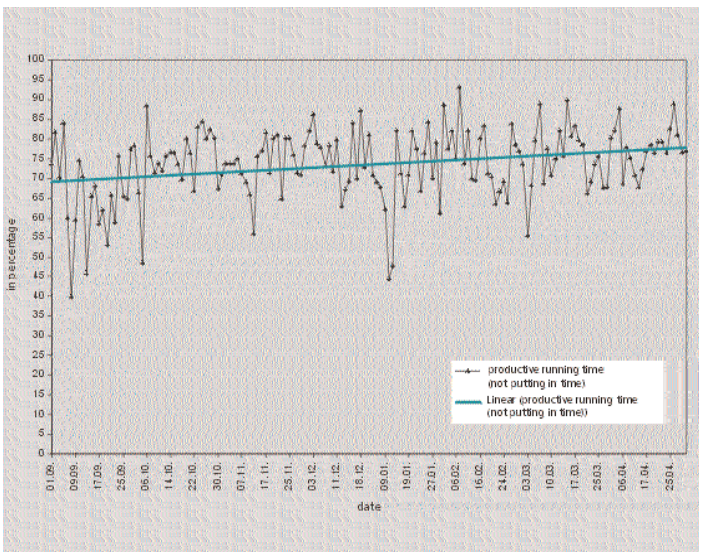


Fig. 2: Course of productive running time from September 1997 to April 1998

# Throughput time controlling - how to increase supply capability and reliability

In-house Value Creation

Project Report Factory Planning and Logistics


## Abstract

In a world dominated by change and dynamic competition in the markets, companies are constantly expected to be ready for and capable of innovations. However, this means that companies must be able to act quickly and be flexible and cost effective on a global scale.
Ever shorter delivery times and, consequently, necessary continuous improvement of supply capability present the greatest challenges companies are faced with today. Continuous improvements must go hand in hand with an appropriate methodology as well as measuring instruments for evaluating the business process.


## Initial Situation

Companies wanting to establish and maintain a firm position in the markets must develop the ability to quickly respond to future technical innovations and changes in the business environment and to critically analyze and constantly improve their processes. Despite the existing variety of PPS* and MIS systems, developing these abilities could be the greatest challenge to companies. »Eight out of ten top managers are unsatisfied with their present management information system and the performance indicators developed« because the information available is primarily focused on cost factors and not on critical success factors. Modern information systems should focus on recording core processes and their innovation potential in process variables such as the degree of improvement in throughput time and quality.
In the scope of a reorganization project of a business area of a large German group of companies comprehensive measures for improving processes and logistics were designed and their implementation observed. Simultaneously, a controlling system covering the entire business area was designed and installed by the IFF Magdeburg in order to facilitate evaluation of results.

## Procedures

Due to the fact that the project partner operates in a dynamic business environment with fluctuating sales and high product innovation speed, it is very important to permanently and continuously shorten throughput time in development and production (time-to-market/time-to-customer) in order to secure and extent a successful position in the market. For the project partner who operates in the electronics industry, the necessary change of paradigms, typical of employees and processes, from traditional capacity utilization towards fast and client-oriented units played an important role. The decision to use throughput time as the only process variable besides qualitative parameters is based on positive effects obtained in connection with a decreased throughput time. These positive effects include:

- Improving market position due to the positive effect of throughput time on the logistic variables delivery time and reliability
- Reducing stock risks (changes in demand, technical changes and aging) in case throughput time is longer than delivery time and delivery reliability can only be guaranteed through building up stocks.
- Reducing inventory costs since reduced throughput times always result in reduced current inventory.
- Reducing alteration risks because the starting date is closer to the delivery date.
- Reducing planning uncertainties because shorter throughput times normally result in less deviations from planned numbers.
- Reducing controlling and monitoring efforts because the number of orders processed simultaneously in the system is reduced.

When selecting a measured variable it was also important to establish firm rules for combining and presenting the measured variables with regard to the development of supply capability and reliability. Consisting of IFF personnel and the project partner's staff members, the project team decided on combining throughput times for a period of three months. Due to the fact that the varying mean value says little about the process variable's range, the parameter »90% throughput time« was introduced as an evaluation and control variable for delivery reliability of newly structured processes, i. e. 90% of all orders can be delivered within x days with a 100% probability.

Parallel to the introduction of the newly created units the existing BDE system was revised and simplified in such a way that the additional collection of data would not cause extra stress for the staff and guarantee that responsibilities would be clearly assigned across fields of work.
In the past it was common to make two entries per work place in the company's data collection system in order to record the manufacturing progress or document production parameters. Consequently, products were left undocumented between individual process stages.
By introducing the »bring principle« the flow of information and the material flow were synchronized and »black holes« between process stages

* Production Planning System and Management Information System

closed. The idea behind this principle is that the person responsible for a certain process step transports the machined part to the next downstream stage. There it is checked off and at the same entered for the following process.
The controlling tool for the existing network and process data collection system was designed by IFF in close cooperation with the project partner through an Access 2.0 database providing teams almost every minute with accurate evaluations of the 90% throughput time on various aggregation levels and a graphic rendering (figure 1). Through additional, independently definable displays of time horizons for products, processes and areas, teams will be able to quickly narrow down problem areas and problematic products and analyze the causes for such problems.

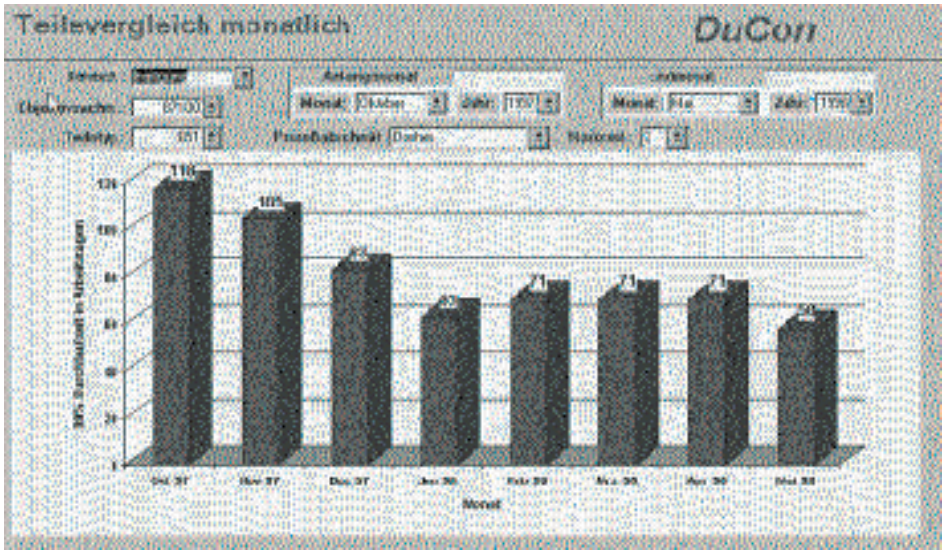


Fig. 1: Throughput time rendered with the throughput time controlling tool DuCon

## Conclusion

By introducing throughput time controlling (figure 2) it was possible for the first time to uncover the actual situation of the company with regard to throughput time on the basis of uniform standards. These trends, obtained by constantly visualizing throughput time, can help identify problems at an early stage so that appropriate counteractive measures can be taken. Continuous measurements and visualization of throughput time development do not only facilitate faster and more transparent manufacturing processes but also provide a performance indicator for the clearly defined quantification of processes and products each department contributes to the final outcome.

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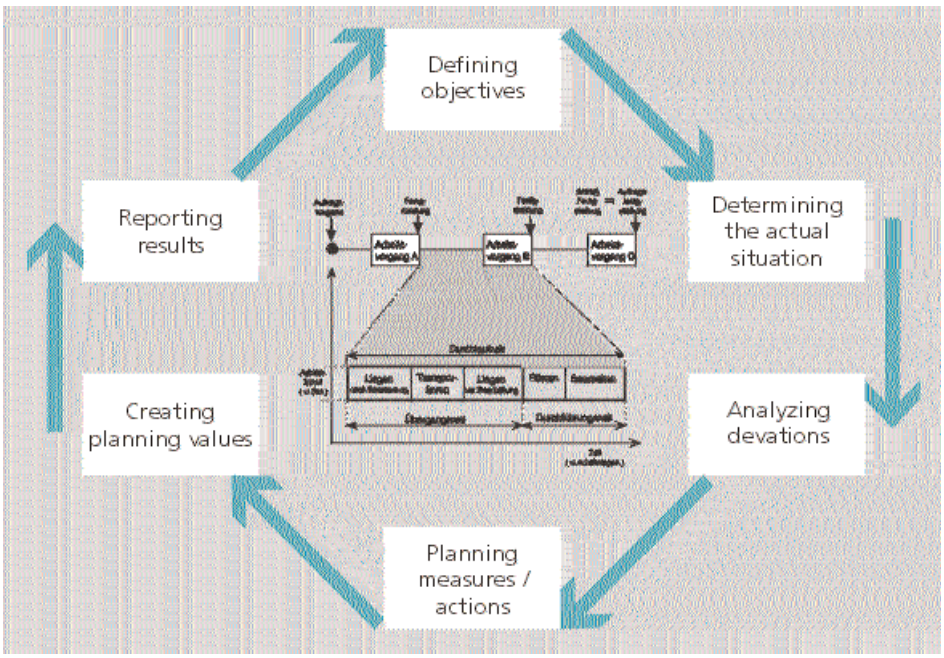



Fig. 2: Control loop for throughput time controlling

# Intelligent technique use in East German machine building enterprises

In-house Value Creation

Project Report Production System Planning


## Abstract

The effective mobilization of the available »tender strategy resources« for intelligent forms of technique use is in the emphasis of the project.


## Initial Situation

These project is supported by the Federal Ministry for education, science, investigation, and technology (BMBF). A joint venture of four East German institutes is the basis of the project, to increase the survival chances of small and medium-sized East German enterprises.

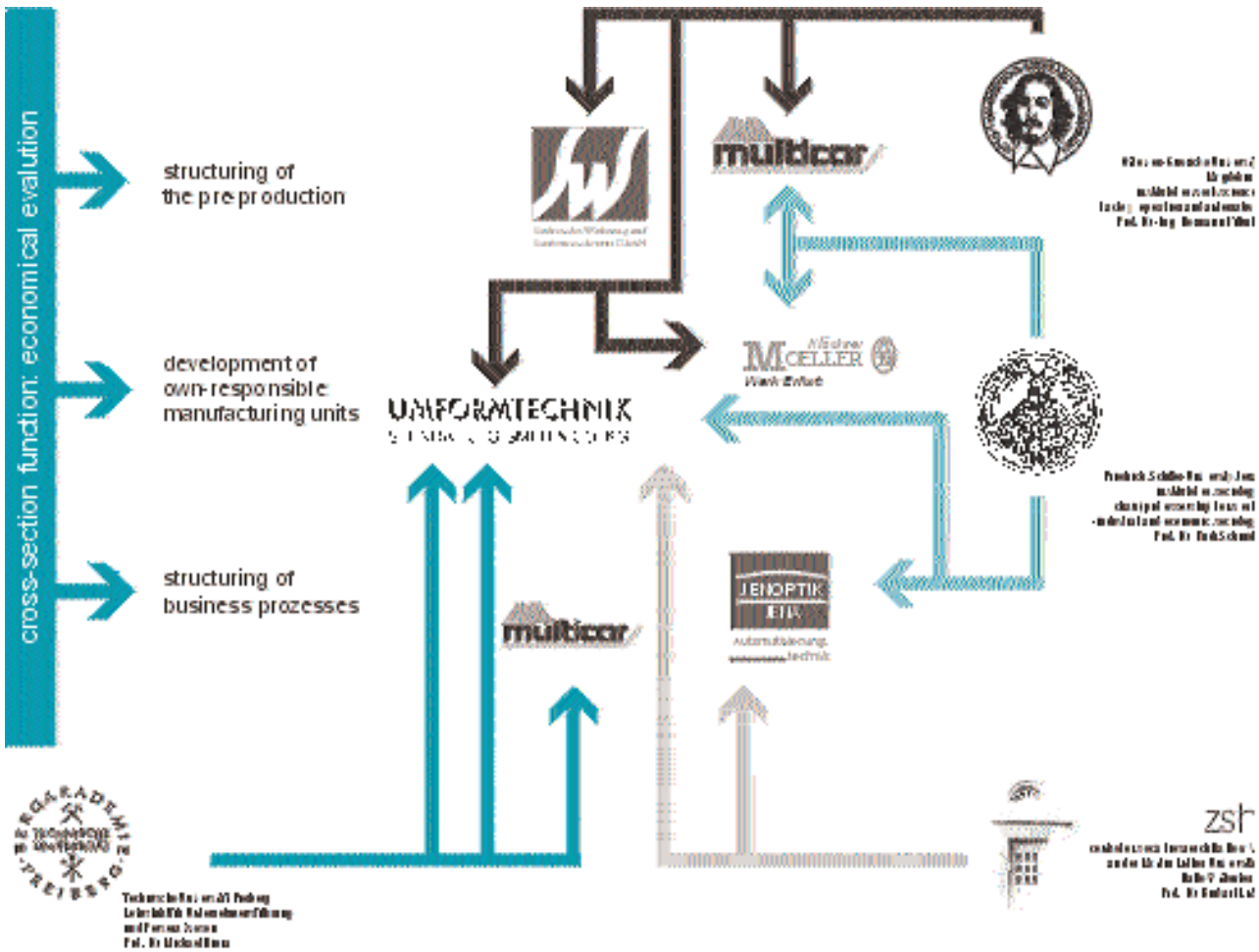
The involved institutes are:

- the chair for sociology of work, industry and economy in the institute for sociology of the Friedrich-Schiller-University Jena
- the center for social investigation on the Martin-Luther-University in Halle-Wittenberg
- the institute for Ergonomics, Manufacturing Systems and Automation on the Otto-von-Guericke-University Magdeburg
- the chair for general business administration on the TU Bergakademie Freiberg.

An determination of typical problems occurred with the management and the employees of five East German enterprises. The result should be organizational models adapted to the company requirement. The implementation starts in a pilot project. The market chances of the enterprises increase in this manner. The co-operation between the institutes and the enterprises is described in the following figure.

From the analyses and the conversations, it became clear that investments in the field of plant and automatic control were carried out in all companies exclusively. So there may be further possibilities for improvement in the »tender strategy resources«.
The structural approaches were sorted. Furthermore, the analysis of the actual

Fig.: Project partners



states occurred. The company internal goals were determined in workshops. The competence of the network users and the detailed knowledge of the respective company internal circumstances allows a coordinated combination of analysis procedures and organization procedures. This should guarantee that the competencies and experiences of as many as possible actors are included in the organization evolution.

In this case, that became carried out in the individual enterprises investigations:

UTS Ltd.
Analysis the technological processes and preparation of a capacity section qualification analysis, examination of alternative machine reservation, analysis of the customer categories, employee questioning, analysis of the segmentation possibilities, determination of the pilot field, layout planning, machine and personnel assignment, removal planning into new manufacturing area

SWS Ltd.
Investigation of the customer behavior, definition of complexity of the components, preparation of a capacity profile, evolution and evaluation of alternative variants for the restructuring, presentation of a decision basis, planning of the business units

Klöckner Moeller
Analysis of the business units and selection of a pilot unit, analysis of machining time, analysis of weak points, evaluation of the first results, decision about a project discharge, formation of project groups, layout planning, simulation, moderated team sessions of the project groups, presentation of variants

Multicar Ltd.
Analysis of the requirement and of the stocks, analysis of typical missing components, inspection and tuning of the minimum stock balances, suggestions for a control element, decentralized customer-oriented control of prefabrication

## Results of Analysis

The publishing results of general interests is a central project request. The following results are verified at the moment:
Logistical quality is among product quality and quantity a typical advantage of East German enterprises. So, the low wages are not the crucial argument for the placement in the market.
Further, the enterprises have a powerful prefabrication. As a result, the availability of the self-made parts is secured. This is an essential feature of East German enterprises in spite of the trend for outsourcing.
The integration of the prefabrication into the new redesign concepts is the destination of the future part of the project. In such a way, this obvious thickness of »East German engineering enterprises« should be linked efficiently.

Contact
Manager
Dr Reinhard Fietz
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# Telematics-assisted co-operation management in the machine and plant building industry

Virtual Cooperations of Enterprises

Project Report Quality Management

## Brief Description and Objectives

In the beginning of 1998, a project association consisting of 6 companies decided to try out new forms of partnership in the plant building sector, including the associated information and communication infrastructures. The main objective of the project is a reduction in the erection time of plants by at least 30 %. The savings in this connection are to be achieved in particular by a reduction of expenditures in the fields of engineering, revisions, administration and transfer activities. The participants intend to achieve their goal by combining the core competencies of all parties involved in such a way that a virtual system supplier is created. This process is to be supported by the use of suitable methods and tools for a joint, integrated organization and control of the active, simultaneous co-operation of all participants in the erection of plants. The work title of the project is »Telematics-controlled workflow in a customer-supplier network of the plant building sector«.

## Initial Situation

In the last few years, large efforts have been made in the plant building sector to optimize in-plant processes with the help of a wide range of measures. In spite of the significant improvements which have already been achieved as a result of these in-plant measures, the effects do not yet suffice for meeting the requirements of a market characterized by an ever growing competition. In particular in view of the fact that customers increasingly demand complete services and focusing on the overall costs of a plant, all partners involved in the performance of services need to change their co-operation philosophy. In this connection, it is necessary to tackle at a very early stage such questions as the depth of integration, the design of inter-company interfaces (in organizational and product-specific respect as well as with regard to EDP), the culture of trust and the distribution of risks in the network. Finally, the parties involved must be capable of rapidly establishing such a network

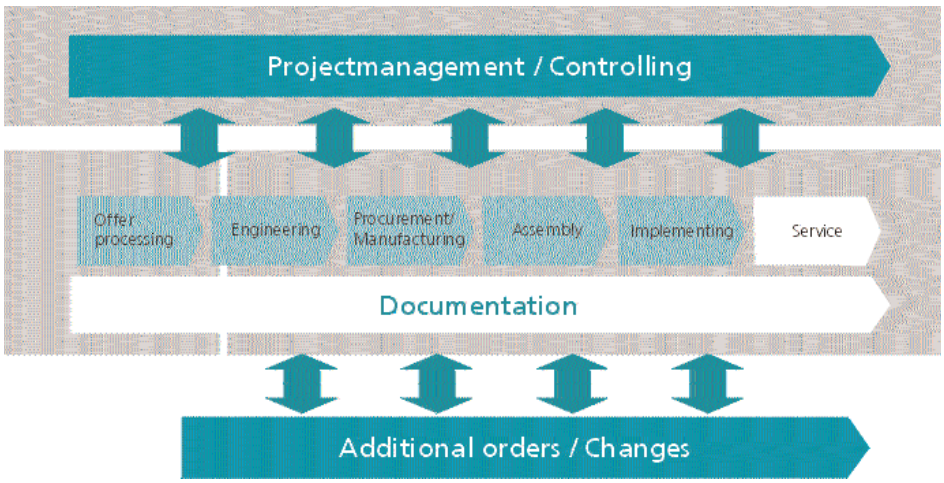


Fig. 1: Principal inter-company processes in the network

and of co-operating with a changing pool of competent and independent contractors. Only enterprises which master the flow of information required for such a division of work will be able to achieve a project handling efficiency ensuring their survival in the market in the long run.

## Implementation

As a basis for realizing the above mentioned objective, it was necessary to carry out an inter-company business process analysis for determining the ACTUAL situation in the participating companies by means of interviews and workshops organized to widen the data inventory. For visualizing the processes, the EDP tool FACETS, which is particularly suited for representing plant-specific business processes, was used. Apart from defining the actions required, this analysis served for creating a culture of trust and for determining the interfaces between the participating companies. In addition to this, the information and communication systems to be applied at the inter-company interfaces were determined.

After the determination of the current inter-company processes, workshops were organized to define the IDEAL composition of the network of companies. There, in particular, questions relating to the allocation of tasks between designers and disciplines, their required depth of integration as well as the supporting information and communication systems were considered. Since the implementation of a partnership is a long-term process, a DESIRED process model was developed on the basis of the ACTUAL and IDEAL process model. After the implementation of the associated measures, this desired process model is to be evaluated by the end of 1999. The following steps will thereafter be in the center of interest:

– An earlier involvement of

subcontracting disciplines in the planning process (e.g. optimum assignment of tasks to the parties involved, participation of the disciplines in the specification of the plant concerned, formation of teams including several disciplines)
- Simplification of inquiry/offer processing for the network (e.g. component calculation, joint product catalogues, unit rates, harmonization of product assortments)
- Operation of a joint project information server (e.g. structure, contents, administration/ management, document management system, definition of basic documents)
- Optimization of selected operational processes (e.g. generally valid workflow for the overall network and for the document approval process; automatic initiation of manufacturing processes based on the 3D designer data as well as of further designer-discipline processes; handing over of final documentation via EDP to operator)
- Information management (e.g. determining the information required by involved parties, agreeing on certain standard EDP tools, communication standards)

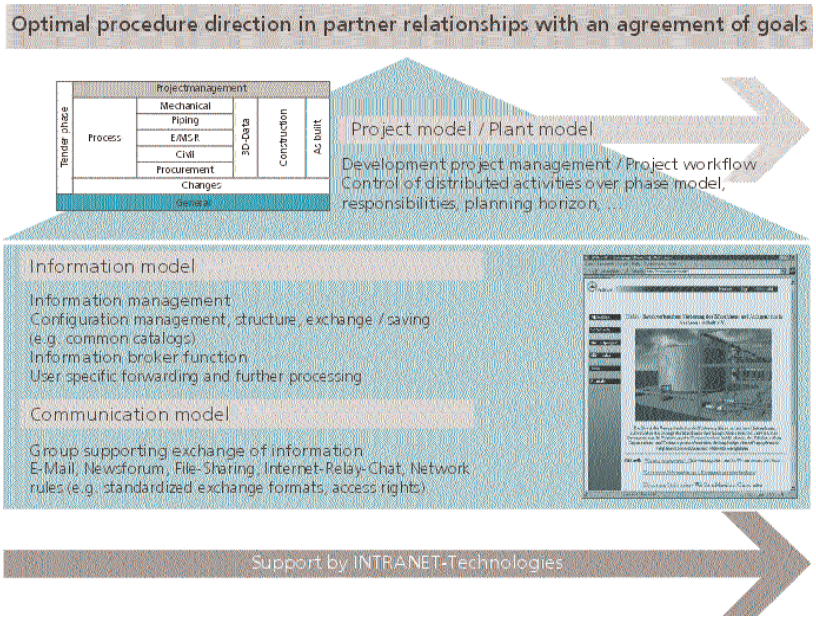


Fig. 2: Modules of inter-company Intranet

The inter-company Intranet to be established could look as follows when the project is completed:

Before the ambitious objective described above can be achieved, however, appropriate preconditions will have to be created. Apart from the fact that an appropriate relationship of trust and team spirit will have to be developed between the participating partners, technical obstacles will have to be overcome. This is because an efficient exchange of information will be achieved only on the basis of common infrastructures. Thus, e.g., unified interfaces for the transmission of data and project information will have to be created. Automation possibilities for the generation and transmission of data, in particular in the field of progress control, and reactions coupled to certain events will have to be defined. Documentation will have to be transparent so that the possibility of errors is largely eliminated when changes have to be incorporated with all the associated effects in downstream processes. This will provide for the retraceability of all phases of the history of essential processes and for continual improvements via cost control and, last not least, facilitate gathering of experience.

## Outlook

From the results, which will also be accessible via the home page in the Internet (http://www.fasa.server.de), all involved parties as well as companies participating in future plant building projects in Saxony-Anhalt are to benefit. After all, a company which wants to be successful in future will have to concentrate on the requirements of customers without first conducting extensive negotiations on the reception and handing over of project information and data.

Contact
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# City Logistics Magdeburg



## Abstract

City Logistics Magdeburg is a project which aims at developing all local and regional city components required for further future-oriented urban development. Based on complex environmental analyses and the concept development derived therefrom, the City Logistics project for Magdeburg was implemented. At present five haulage contractors and one transport company work together under a cooperation agreement. Goods are picked up at the haulage contractors and delivered on a collective tour to the recipient (customer). Future work will focus on extending the project (including disposal, goods delivery, telematics) and providing additional services.

## Initial Situation

Traffic and the level of environmental pollution increase in our cities and urban centers every year. This trend is not only intensified in Magdeburg due to inner city construction projects. Although such projects provide much needed business space at a large scale, they also further increase pollution levels and make the entire infrastructure more compact. Innovative city logistics concepts and their implementation must be developed in order to improve the quality of life in city centers without damaging the functional variety of the city.

## Procedure

For the city logistics project to be successful it is paramount that all parties involved, such as haulage contractors, trade companies, manufacturers and communities cooperate and get involved with the concept development at an early stage. In order to be able to develop solutions which are acceptable for all parties involved, needs, goods structures, delivery relations, etc. must be known in detail. Consequently, analyses of the characteristics and an assessment of developments in goods traffic within the city of Magdeburg were needed.
The objective of the first project phase was to develop scenarios for a future-oriented urban development concept tailored to the specific needs of the city of Magdeburg through strategic analyses and the collection of data, knowledge and information.
Procedures can be divided as follows:

Research
- characterizing and structuring Magdeburg
- assessing city logistics concepts and projects
- analyzing and evaluating previous studies

Analyses
- designing analyzing tools
- interviewing experts and collecting data
- creating awareness among the parties involved and forming a platform for discussions

Concept design
- identifying flexible segments with regard to future developments
- identifying future-oriented scenarios.

The potentials for practical implementation of the concept were discussed together with local retailers and haulage contractors .

## Concept Implementation

The objective of the second project phase was to implement the concept based on scientific research.
Companies involved in the pilot project included the haulage contractors Bahntrans, Dachser GmbH & Co., Emons Speditions GmbH, Schenker – Eurocargo AG and unitrans by Magdeburg GmbH.
The common objective in supplying customers in the scope of the city logistics projects was defined as follows:

- meeting deadlines and quality standards in processing orders
- reducing environmental pollution
- increasing the effective utilization of vehicles
- identifying and utilizing saving potentials
- reducing stand-still and waiting times at the ramps.

The transport company Mathias Vogel with business seat in Wolmirstedt agreed to participate in the project. With the so-called »City-Ent-Laster« goods were picked up at the specified haulage contractors according to recipient and delivered on a collective tour to customers participating in city logistics.

## Continuation of the Project

As early as during the pilot phase all parties involved showed increasing

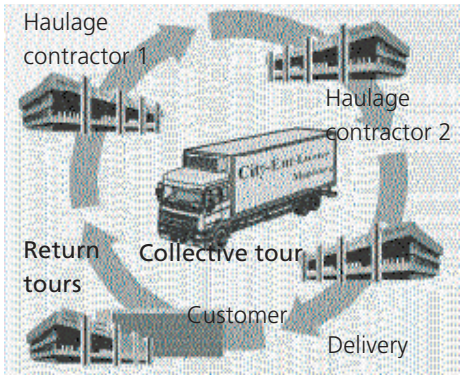


Fig. 1: Scheme of city logistics Magdeburg (collective tour procedure)

acceptance and willingness to further develop the project. Through a process chain analysis, business processes were evaluated and restructured. Deficiencies in structural and performance organization could be identified and remedied. With the aim to extent the project, the data of all haulage contractors was examined in order to identify common customers and their delivery characteristics. For a defined period of time, the analysis included all locations with a Magdeburg zip code, detailed with regard to recipients, delivery items, weight and auxiliary devices. Subsequently this analysis was broken down to individual streets (figure 2).

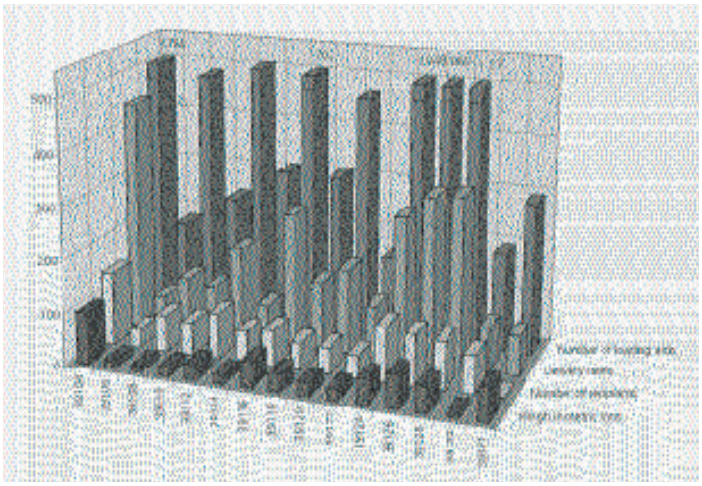

Fig. 2: Analysis of potentials for zip codes and streets within the city limits of Magdeburg

Thus it was possible to identify pooling potentials according to areas. For the further development of the city logistics project the following work is currently being done:

- preparation of a concept of additional services
- telematics concept (continuous electronic tracing)
- specific delivery and service concepts.

The use of additional vehicles also plays an important role in project extension. Various opportunities for using new types of city logistics vehicles have been identified and evaluated from an economic point of view.

## Results Produced so far

The number of tours through the city center by the haulage contractors involved has dropped from previously five trucks to just one truck (reduction to 20%). The number of kilometers driven decreased likewise which has helped saving fuel and has contributed to reducing environmental pollution. Through collective tours and tour planning the number of tours decreased by approximately 65% per month; waiting times for vehicles at customers ramps was reduced by approximately 30 – 40% and weight handled per unloading point has risen from 0.25 – 0.4 to 0.7t (metric tons). Utilization of vehicles could be increased from 35-70 to 95%.

Further project partners
Magdeburger Hafen GmbH
METOP GmbH
City administration authorities
Ministry of Economics, Technology and European Affairs of the Federal State of Saxony-Anhalt
Chamber of Industry and Commerce of Magdeburg

Contact
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Fig. 3: Magdeburg's »City-Ent-Laster«

# Stabilization and development of regional co-operation combines - a survival strategy for SMEs

Virtual Cooperations of Enterprises

Project Report Fundamentals of Factory Operation/Organization of Enterprise Processes

## Short Description

Tool for successfully managing long-term cooperation combines

## Initial Situation

During the 90s, more and more small and medium enterprises sense the impact of the increasingly more dynamic market as a partially dramatic recession in sales. These enterprises have been consequently recalling their core competencies and, associated with this, reducing attempts to diversify. Moreover, they have evident weaknesses such as lacking capital resources and insufficient market access, which can be accounted for by their more recent history. However, they are also provided with fortes, such as personnel having high qualification and motivation and considerable technical competence.

Small and medium enterprises are faced with the following trends:

- Reduction of product life cycles and associated increase in innovation speed
- Integration of new technologies into manufacture and marketable products
- Increase in the servicing contents of industrial products.

The entirety of these forces results in a developmental dilemma for the SMEs, which culminates, as a rule, in the fact that the small and medium enterprises have to produce results, particularly in the sphere of product development, while having less and less resources. This just why these enterprises recently have entered into new forms of inter-enterprise cooperation, such as cooperation for product development, to an increasing degree. In this way it becomes possible:

- to compensate the company's often too low size in the cooperation
- to extend the marketable core competencies without dissipating energies
- to better utilize expensive working materials
- to improve one's market position for a long time
- to progress on the road to integration into international development and manufacture networks, without running uncontrollable risks.

## Fundamentals of Cooperative Modes of Operation and Deviations from In-house Sequences

Besides the elementarily important factor confidence, also open communication is a prerequisite for a successful cooperation. The fact that building and maintaining cooperation relations with other enterprises make special demands on the management of such systems that cannot be met using conventional management tools results finally from the specificity of the cooperation (see Table 1).
Previous cooperation management systems for small enterprises were mainly developed for finding cooperation partners or opening up a cooperation; managing the course of development of a cooperation was disregarded in many cases.

## Cooperation Monitoring - Fundamentals of a System for Managing Cooperations

Cooperation projects can be directed towards various cooperation objects. The latter define their demands on cooperation management mainly through their level of difficulty, such as complexity and innovativeness.

For managing a cooperation, both the objective/rational properties and emotional relationships of cooperation partners are likewise relevant. The sum of such object describing features is presented and an optimum position of a cooperation combine is demonstrated in /1/. These describing features

| | Cooperation - external | Business relationship-internal |
|---|---|---|
| Relations<br>– WHO<br>– HOW | – Often managers or executive employees, persons of the same hierarchical rank<br>– partnership on a par or of equal rank; decision and realization in a team | – Persons of different hierarchies<br>– Decision and realization seperated |
| Decision finding<br>– WHO<br>– HOW<br>– WHEN<br>– WHAT FOR | – All cooperation partners<br>– In a team<br>– At the time of objective necessity for archieving the cooperation goal<br>– For the benefit of the cooperation object | – Management<br>– Expert judgment<br>– Left to decision<br>– IIn the enterprise´s interest |
| Performance features<br>– WHAT | Often know-how; problem solutions as a rule | Times, capacities, accounting units, prices, etc. |

Table 1: Exemplary comparison of demands on management resulting from inter-company cooperative and in-house operative characteristics

are basically always present, however, they are effective in different forms and thus determine the type of the respective cooperation relation.

Objectively ascertainable cooperation properties, which are essentially associated with the object's required performance features, are used as fixed quantities for cooperation monitoring. Contrary to that, cooperation process properties are considered to be variables that can be varied through the process and are thus cyclically tested in the cooperation process.

Using indicators that were initially determined and result from properties describing the respective cooperations, recommendations can be given regarding the design of the course of cooperation. On the one hand, indicators represent the validity frame for the project progress of the cooperation. On the other hand, however, they determine, in enterprise-specific individual impresses, the critical factors or skills for the individual enterprises.
The mode of action of the management system to be developed is shown in figure.

The regular course of cooperation processes can be checked through observing weighted cooperation process parameters.
Preventive measures are initiated when an indicator leaves its validity range. Principally, there may be two causes for this; on the one hand, 'caution' of single cooperation partners. This has to be analyzed, evaluated, and causes have to be eliminated using appropriate means such that the cooperation process can be continued in a stable way. In the extreme case, after finding that a necessary result cannot be achieved, an enterprise may be excluded. The performance required has then to be covered by another cooperation partner. The cooperation combine will use well-known means of searching for partners or, if possible, will solicit this performance as an additional service from a cooperation partner already involved.

On the other hand, the entirety of goals of the cooperation may be at stake. Cooperation monitoring indicates such a state when several cooperation partners contribute to cause single or more indicators to leave the validity range. At this point, cooperation object properties have to be subjected to an examination and to be corrected. In the extreme case, the continuation of the cooperation should be queried in principle.

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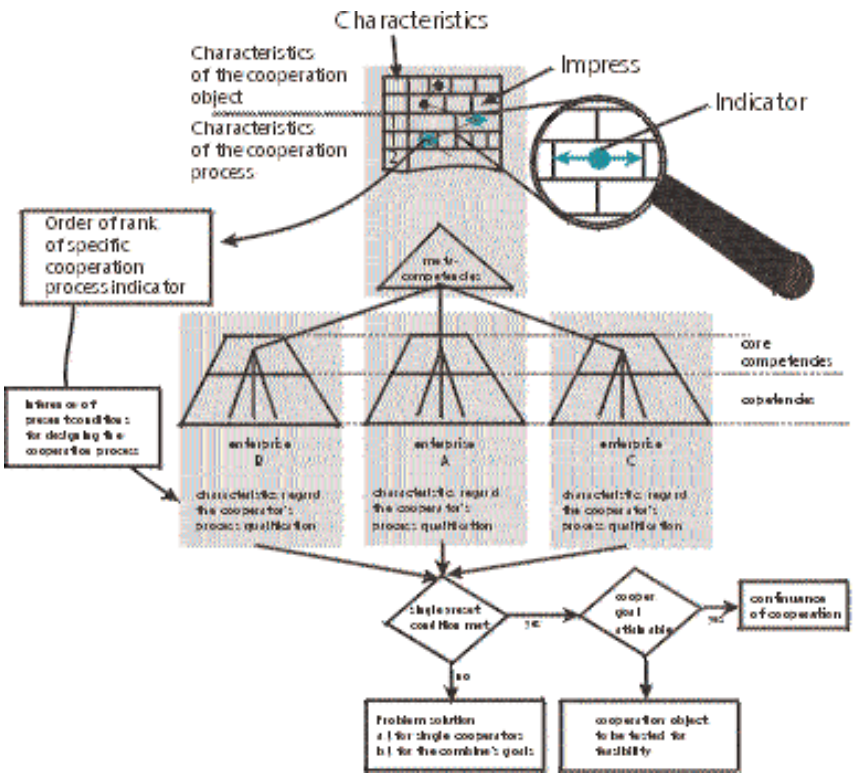



Fig. : Concurrence of indicators and control mechanisms in control management

# Server for cooperations in Saxony-Anhalt



Project Report Maintenance and Service Management

## Motivation

The high rate of unemployment in Saxony-Anhalt proves the importance that inhere foundations of new businesses, maintenance and support of small and medium sized companies. With a share of about 16 percent of the gross domestic product Saxony-Anhalt represents the third biggest economic region within the new federal states.

The economic situation is marked by sustained stagnation because of a lack of demand in the building industry reinforced by short public funds and the decline of the demand for consumption goods (through permanent exits out of the first labour market with its related consequences) which could not be compensated through upturns of other parts of the industry. Nevertheless there is a high amount of new firms springing up especially in the field of trade and service. One strategy to protect the own firm, to extend ones supply an consequently strengthen ones own competitiveness especially for small and medium sized companies is to cooperate.
Firms that have partners are much more powerful: they grow faster than others and secure jobs. Another reason to support cooperations between firms is that the partners can solve their problems together through simple and quick communication means - uncomplicated and time saving. However the search for a partner often goes along with laboured comparisons of prices and products as well as the waiting for offers. That is why the Fraunhofer Institute for Factory Operation and Automation IFF created a central instrument to promote cooperations in Saxony-Anhalt - the Server for Cooperations.

## Description of the Project

The project »Server for Cooperations within the Internet« was started 1998 (figure 1). The server shall support firms that operate in Saxony-Anhalt. Its main function is the possibility for companies to look for potential partners to cooperate with - other firms with specific qualities - by means of databases. That way firms that work within the desired field of business and manufacture the desired products can be searched for purposefully. Afterwards a contact via Internet may be possible. Each firm can register oneself within the database and consequently be found by others (figure 3). That way the »Server for Cooperation« is actualised automatically and can support the relationships between companies in Saxony-Anhalt.

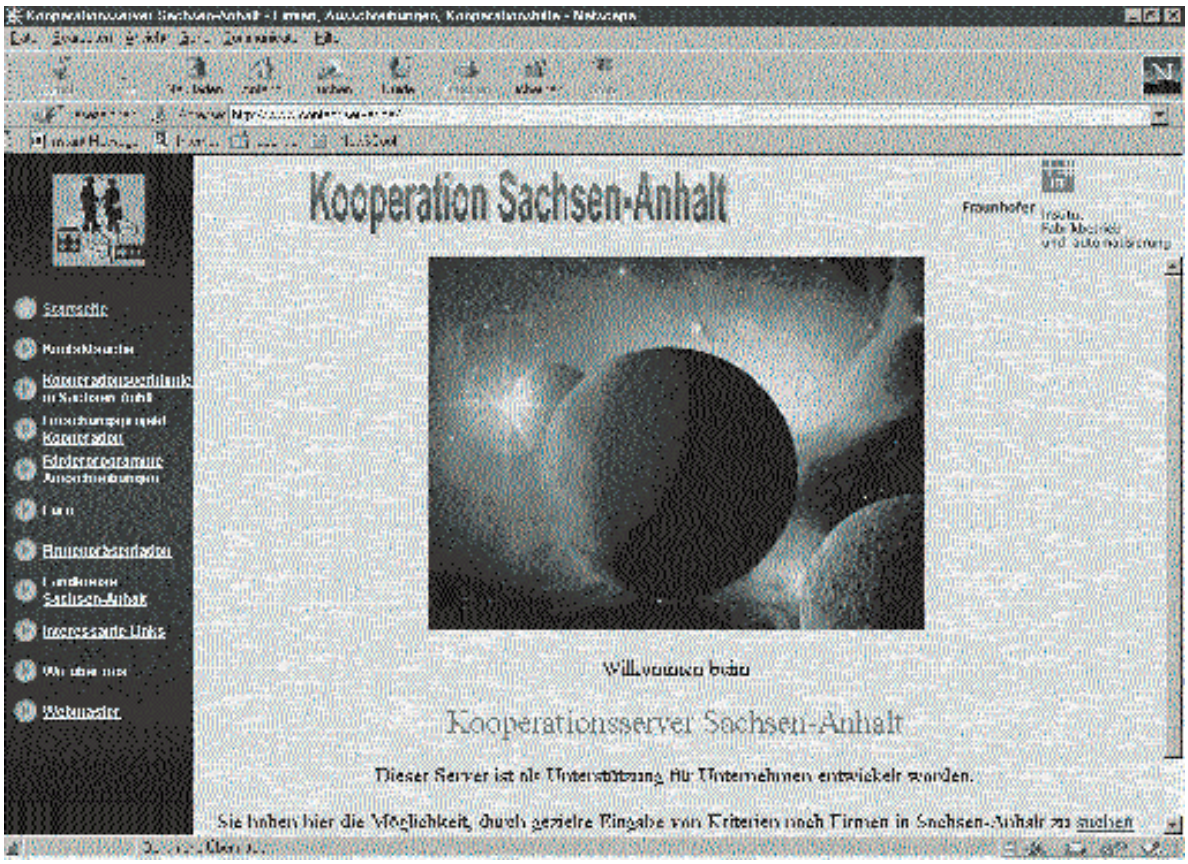



Fig. 1: Cooperation server of Faunhofer IFF

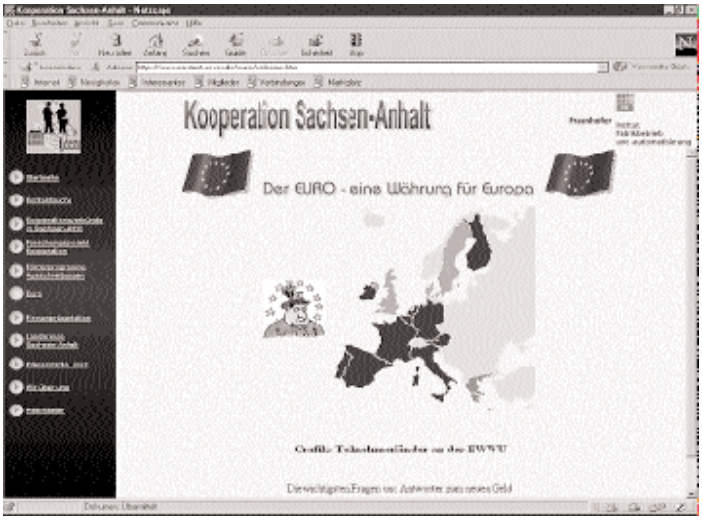



Fig. 2: More information about the EURO and the consequences for enterprises

In the case that a cooperative relationship is desired the Fraunhofer IFF can help young and innovative firms in Saxony-Anhalt to find the right partner and afterwards give accompanying advice.

Presently more than 1.700 firms are registered by branches and products within the database. Through an intelligent inquiry mentioning detailed criteria a recherche for potential partners is possible.

Besides that the »Server for Cooperation« offers a great variety of services. Scientific analysis as well as examples of working cooperation networks present a deep insight in the topic. One research project developed by the Fraunhofer IFF dealing with cooperations is made accessible to the user, too.

Important, especially for small and middle sized companies, are the references to announcements an support programs. Here among others support programs by the federal state Saxony-Anhalt, the government and by the European Community are presented. Besides this we offer the possibility for the firms to present themselves in the Internet. A short e-mail or fax to the Fraunhofer IFF and we will contact the firm regarding its Web-appearance on the »Server for Cooperations«.

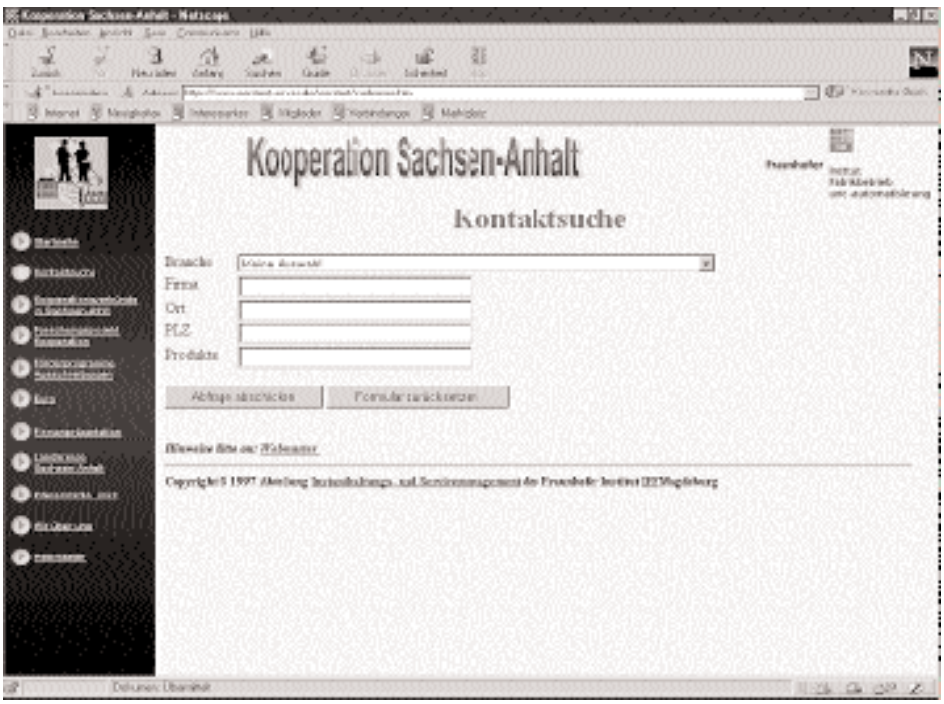
Detailed information regarding the Euro-conversion are to be found on the server, too. Precise hints for the proceedings during the currency-union are presented as well as general information about the Euro (figure 2).

A whole collection of useful Internet-Links concerning a great variety of topics interesting to firms awaits the visitor of our Web-Sites. Firms don't have to waste their short time for long lasting searching in the Internet but get all essential references summarised on one address.

For the satisfaction of our growing number of users we try to continuously extend our service.

Contact
Dr Curt Freund

Fig. 3: Input mask



# Fit for Europe with a site-combining competence center concept

Competition Strategies and Products

Project Report Enterprise Strategy and Structures

One of the biggest future challenges within entrepreneurable environment is the globalization of the markets. This is not new and it has also been discussed over a long time. But the focus lays mostly on the risks and difficulties for German enterprises. The following example describes a successfully way in order to manage the challenges growth and re-configurability and therefore to take actively the chance of long-term success on markets.

## Growth is a Successful Basis for a Chance-oriented Enterprise Development

The enterprise – its way to an international alignment will be described – is a metal processor and has roughly 1200 employees European-wide. The Metal GmbH (name changed) is focussing on manufacturing electronic packaging systems. Metal GmbH is market leader in Germany and wants to achieve this position also in Europe. They want to achieve this ambiguous goal by implementing a growth strategy based on given core competencies as well as by defining a clear market-orientation. Following are the goals of the Metal GmbH:

- high growth rate
- changeable and performance oriented organization
- world-class cost structure
- highest customer-orientation
- highly innovative products.

The challenge now is to derive a proper enterprise strategy and structure to be able to achieve these goals.
The definition of a mid-term and long-term alignment was done in the strategy discussion. To do so, selected Manager and the IFF-Moderators came together in so-called »Kaminrunde«. The operational day-by-day business was left out. Under this conditions, new strategies and a new organization concept grow up. With consideration of the defined goals and with consideration of the strategy discussion, the idea of a European-wide Competence Center was born. The concept manly focuses on the complete projection of the goals on three main processes.

## Growth Strategies are Supporting the Design of New Organizational Solutions

The detailed design of the main processes was done by introducing a broader range of Manager – ca. 45 Manager working in four hierarchy overlapping, inter-disciplinary and international working groups. In this stage it was realized that the formulated strategic direction and rough drafts of the main processes had to seen as important motivation for all attendancies. All manager realized that the highlighted potentials are the chance for long-term entrepreneurable success and therefore the concept also saves all current sites.

With the perspective in mind, the working groups designed the three main processes along the whole value-chain. However, the challenge was to re-design the traditionally grown order processing processes and to create three autonomous, process-oriented units. But contrary to the traditional segmentation approach, that just clusters given elements and assigns them to new segments, it was realized, that two out of the three processes have to be completely new designed. If one looks on the i.e. Standard process, marketing, logistics and sales had to be completely new designed. The goal, however, is »making business with us as simple as possible«. With the creation of the i.e. project business Metal GmbH got the ability to acquire and handle large orders, as well as to manage key accounts actively in an effective and efficient manner. The working groups finished their work with the presentation of a detailed structure model and a business plans for each process.

## The Achieved Re-configurability is the Result of a Permanent Learning Process

In 1994, the reorganization process was initiated by the Metal GmbH and couched by Fraunhofer IFF. Looking back, many projects with beneficial results for the enterprise have been finished and brought together under the »European Center Concept - roof«.

The process began with the implementation of the Fractal Company Concept in the production area at the German site. On top of this, the Production Fractals merged with dedicated indirect areas. The established unit is called Competence Center. Parallel to the progress in Germany, the sites in Britain and France also established Competence Centers by going through reorganization processes. Going through this reorganization process also on international level, Metal GmbH achieved an high level of change competence that results in an open enterprise culture and a permanent decreasing time for projects.

## Conclusion

The ambiguous growth goal is the cause but also basis to implement and operate a reconfigurable high

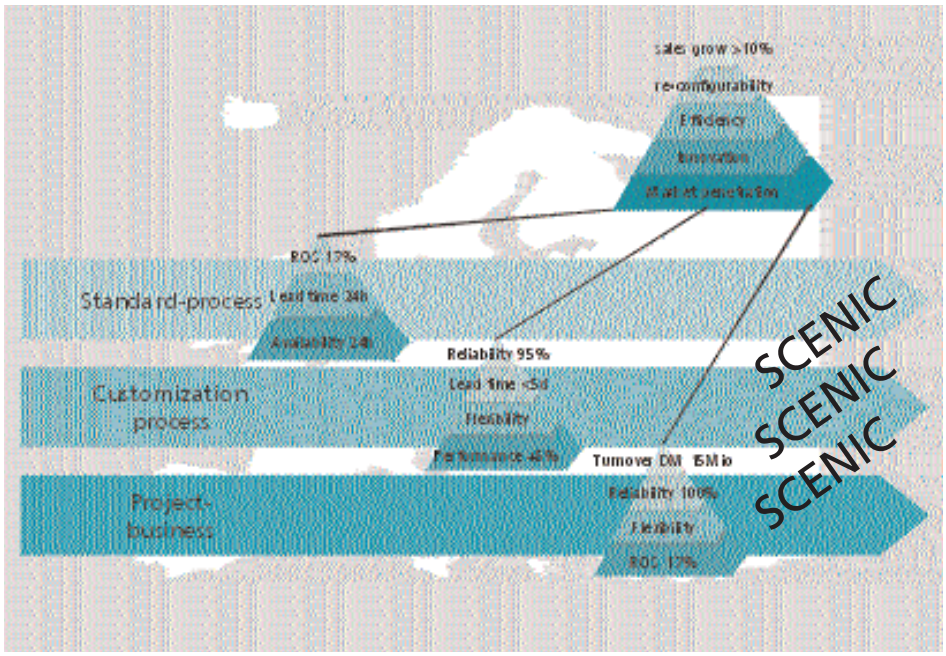



Fig.: Core processes and general goal system of the Metal GmbH

performance structure European-wide. The initialization of this change process was crisis driven. But Metal GmbH achieved such a high level of reconfigurability that the are now able to act chance-driven on their markets. The enterprise is now able to react fast and flexible on a changing entrepreneurable environment. Such a reconfigurability, united with the consequent implementation of a growth strategy, however, makes the enterprise fit for Europe.

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# Interactive visualization applications for the training of maintenance technicians

Competition Strategies and Products

Project Report Planning and Visualization Techniques

## Initial Situation

Global competition and high complexity of products lead to strong demands for abilities and knowledge of service suppliers. Traditional training methods using slide-shows and paper documentation for theoretical education and teaching practice by using the real equipment have a lot of disadvantages. Compared to the teaching of theory, new information technology brought only minor benefits to practice training, but increased globalization and international engagement of manufacturing companies as well as higher variety of products by shorter lifecycles has important impacts on practice training. Problems of practice training using real equipments are:

- engineering knowledge for training of practical skills is only locally available, trainers need to be sent to customers site or vice versa
- different cultures and mentalities make training more difficult
- real equipment for training purposes is only locally available
- the final user often possesses a customized set-up or even an unique custom-made product
- blocking productive equipment for training purposes is very expensive.

Also training on real equipment could be dangerous for trainees or the equipment itself.

## Project Goal

The technique of virtual reality provides new media with new possibilities for the practical training methodology. The objective of our development is the architecture of an authoring system concentrating on the demands of the engineering expert who provides the knowledge which has to be imparted to the maintenance technician.

In September 1998 we started a project funded by the European Union in the Esprit IV-Programme. The work will be undertaken by a consortium of French and German industrial end-users (from aerospace-, military and printing machine industry) and research partners from Spain and Greece dealing with pedagogic aspects and networking/CSCW aspects.

Development of interactive, three-dimensional computer applications on the one hand and increasing digitalization of process and product data management on the other hand open up new possibilities to design and support of processes during product life-cycle.

Increased globalization, growing

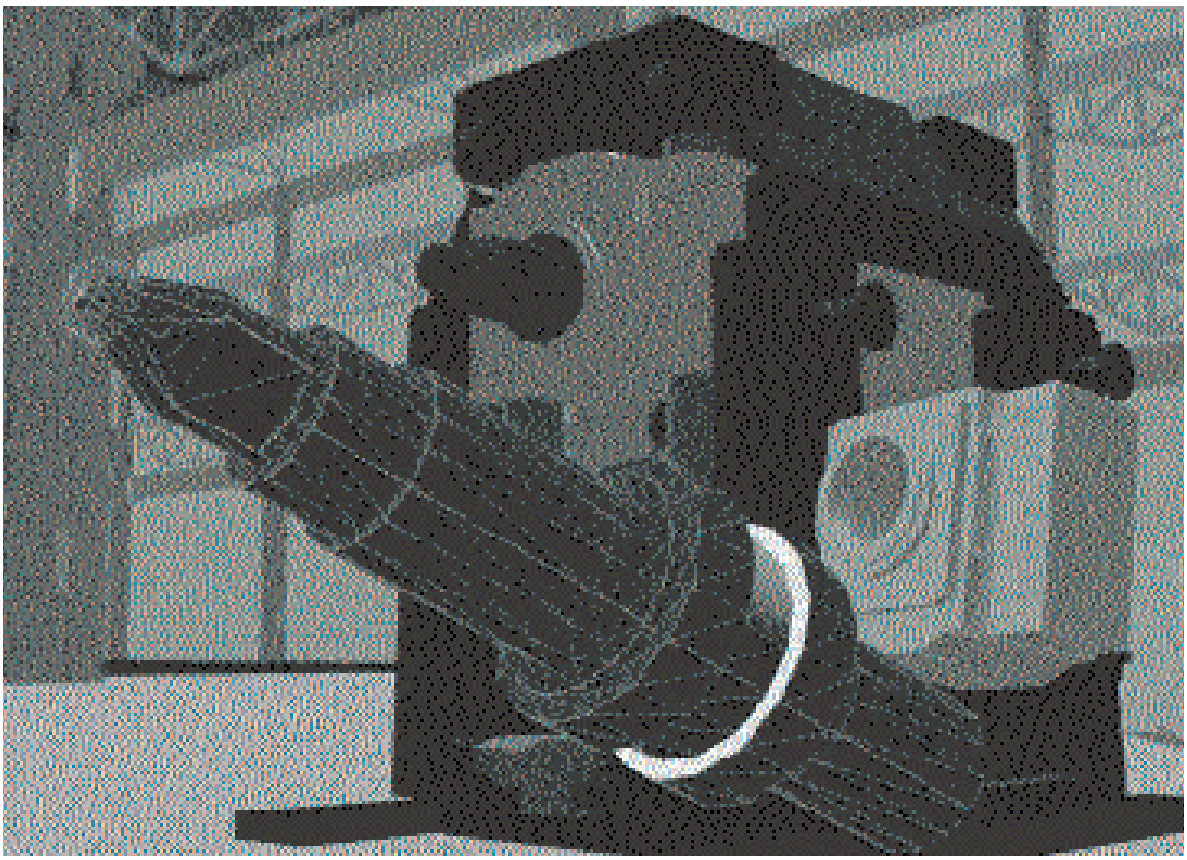

Fig.: Dismantled rolling mill stand

complexity of technical systems and higher demands on the areas of availability, quality, environmental protection, industrial health and safety standards and orientation towards customers needs lead to higher significance of service processes in general, becoming considerable relevant for investment decisions. Related in parallel is the necessity to the system provider to consider service processes in an early stage of the product development. VR-based, interactive simulation environments can serve as experimental platform to support the systems engineering. They can be used to find new design solutions as well as to evaluate design variants. A side effect which is welcome is that such an experimental platform allows the sales department to give the customer insight into the operation of a planned system before even a prototype is built. This means that examinations of the system can take place before the hardware exists. Compared with todays situation, the high efforts needed to make major changes to product design and specification after first components are already realized in hardware, can be avoided. The experimental platform supports also the design of service processes which allows the provider to educate and train the relevant personnel (operators, service and maintenance personnel) in parallel to the design and production phase. The evaluation of the mentioned aspects shows, that a significant parallelization of processes leading from an idea or a contract to a reliably operating system (system is operating and operator is able to run the system under normal conditions, service staff is qualified and able to solve problems in time) can be achieved. The parallelism therefore reduces time-to-market significantly.

Besides the time saving there are other advantages especially in the area of training:
reduced costs due to:

- reduced immobilisation and loss by damage of the real hardware for/by training purposes
- reduced need for assistance from manufacturers staff in user´s facility by using network - better use of instructor's time
- simplification of the development of training means and tools to match them with the progress made on the real system
- lower risks for the personnel (safertraining conditions, prevention of accidents)
- better efficiency of the learning by training in interactive virtual environment:
  - self-learning
  - learning by doing.

Based on the mentioned framework and the expected benefits we built a consortium to develop a prototype of an interactive, multi-user and multi-site 3D-training system. The participating end-users come from different industrial areas and have different demands from their daily training business. Considering the different aspects we intend to develop a system which meets the needs of many potential users .The project is funded by the EU within ESPRIT in the 4th framework programme.

Contact
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Dr Axel Hintze

## Results

# Laser sintered inserts for die casting tools

Competition Strategies and Products

Project Report Product and Process Planning


## Abstract

The reduction of development time and costs is regarded as a focal point of action in the field of product design. Especially high expenditures arise from making preproduction models by die casting. Using laser sintered inserts for tools leads to a considerable time and costs reduction. The broader use of this technologie for die casting was mainly prevented in the past by restrictions of the laser sintering procedure in respect of the part size. At the Fraunhofer IFF a new procedure was developed to realize much bigger components in better quality than before.


## Initial Situation

Despite of the advanced simulation technologies numerous preproduction models of functional and safety parts made in the serial material and procedure are required for performance tests. To fabricate those pre-production models appropriate tools are needed. On account of the iteration bows of necessary changes between product test and modification the fabrication time and cost of large-scale preproduction tools have a high importance for the efficiency of the hole product design process. Tools for die casting appertain into this category. For production of die casting steel tools for complicated parts extensive preparatory works like generating shaping programs or the manufacturing of eroding electrodes are required. This makes these tools quite expensive.

In recent years there was a trend to outsource product development tasks. The car line is leading here. Therefore subcontractors as experts on their fields are forced to take more and more responsibility in choosing the best technology to provide the desired result. To the expansion of their competitiveness subcontractors should be able to show alternative production methods during the conception of preproduction models in order to offer the most economical solution.

In compliance with the demand for economical alternatives for the production of die casting tools the potentials of rapid prototyping technologies - the rapid, to a large extent automatic generation of most complex geometries – shall be developed for die casting suppliers. Up to now there have only been pilot applications with limited practical benefit in this field.

## Procedure

After determination of the criteria that have to be fulfilled by procedures of rapid prototyping processes concerning their suitability for production of die casting tools the required fulfillment degree per criterion was determined by means of literature research and expert conversations. Insecurities in the determination of discreet boundary values were considered by the introduction of a tolerance zone. Parallel to this relevant process chains of rapid tooling were identified and clustered. The state of the art was raised by literature research and the table shown in figure 1 was filled. The cases where the fulfillment is below the boundary values are marked. After outlet of the process chains with not filled criteria as well as those which are subject to strong restrictions (investment casting is restricted to small parts and coatings do not reach slim depressions), the process chains of laser sintering remain as the best procedures among those for rapid tooling for die casting. The literature research for this procedure yielded that there were already some pilot experiments with die casting tools. However, they have been made with relatively small, simple tools that didn't leave lasting impression in the line. In accordance with the own claim, to produce tools with convincing benefit a data record with 3D-CAD data of a suitable reference tool was undertaken by a automotive supplier for own experiments.

**Grobbewertung relevanter Verfahrenscluster des Rapid Tooling**

| | | | | | Schwellwert | Haltbarkeit | Entformbarkeit | Schwellwert | Genauigkeit | Wirtschaftlichkeit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | gut + | > 800 | >50 | < 10 | > 600 | < 0,1 | |
| | | | | gering - | < 400 | < 30 | > 50 | < 400 | > 0,3 | |
| | **Kurzname** | **Schritt 1** | **Schritt 2** | **Schritt 3** | **σ** MPa | **Härte** $HR_C$ | **$R_z$** µm | **T** °C | **Tol.** mm | **Aufwand** Zeit |
| | konvention. | Fräsen | Erodieren | | > 1200 | 50 | 10 | > 800 | < 0,1 | ca. 5 Wo |
| Lasersintern | SLS Metall | SLS Met. | Polieren, Bohren | Erodieren | > 480 | 30 | 80 | > 800 | 0,3 | 2-3 Wo |
| | SLS PVD | SLS Met. | Pol., Bohr., Erod. | PVD, CVD | > 480 | 55 | 75 | 600 | 0,3 | 3-3,5 Wo |
| Dickschicht | HVOF pos | SLS | HVOF pos. | mech. Handarbeit | +o | 60 | 20 | > 600 | - | 2-4 Wo |
| | HVOF neg | LOM | HVOF neg. | Sintern | > 600 | 60 | 20 | > 600 | o | 3 Wo |
| Guß | Feingießen | ModMak | Feingießen | | >1000 | 40 | 20 | > 800 | 0,3 | 3 Wo |
| | Gießen I | SLS Sand | Gießen | mech. Handarbeit | + | +o | > 100 | + | - | 3 Wo |
| | Gießen II | div. | Sandformen | Gießen | + | +o | > 100 | + | o | 3 Wo |

Fig. 1: Truth table for the selection of rapid tooling process chains for die casting

The own experiments were made according to the standard procedure for the indirect laser sintering. In this case, it was found that a component at the selected size could not be made faultlessly. As figure 2 shows, cracks appear which are to be traced back to a strong, not linear contraction. Moreover, it comes for deformations with the result of strong dimensional errors and geometry errors, especially at level tiers.

Systematical investigations of the causes and of possibilities for improvement yielded that the entire process beginning at the material composition via the temperature control up to single details in carrying out the process had to be modified. Figure 2 shows the success of these measures.

## Result

Laser sintering offers a low-cost alternative to conventional production methods and leads to amazing economic effects concerning costs and time savings for the fabrication of preproduction model tools. Depending on complexity of shaping geometry up to 30% of the costs and 70% of the time needed for conventional fabrication methods may be saved. The effect is the larger the more complicated the products outline is.

Tool inserts up to about 50 kg and an accuracy of approx. 0,2% can be produced with the laser sintering procedure developed at the Fraunhofer IFF at present. Future studies will be carried out to develop tools for the production of small series.

Contact
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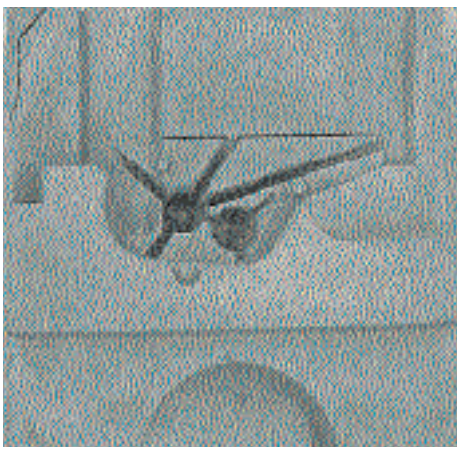
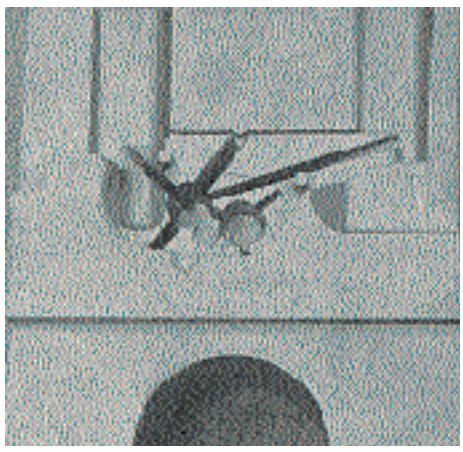


Fig. 2: Laser sintered tool inserts for an oil-pump housing.
On the left: produced according to the standard procedure



On the right: produced according to the IFF procedure

# Interactive 3D training simulator using high level architecture

Competition Strategies and Products

Project Report Planning and Visualization Techniques

## Short Description

Utilizing complex technical facilities, machines, and vehicles imposes high requirements on the knowledge and capabilities of their operators and maintenance staff. Training programs on the site of the already-existing facility are often risky and decrease the capacity of the system. Therefore, interactive computer-aided training systems are increasingly applied in this high-tech field. To explore new approaches that allow small and medium sized enterprises to utilize these kind of technology is a research goal of the project.

## Initial Situation

With the introduction of the harvesting system »Harvester«, a considerable increase in efficiency has been attained in forestry. Harvesting machines consisting of the four assemblies chassis, driver's cabin, crane, and harvesting unit, are mainly utilized for thinning out forests for ecological and forest cultivation reasons. Integrated computers optimize the harvesting process according to customer-specific criteria.

Due to the complexity of the technology and their working environment, »Harvester« operators face both physical and psychological strain.

In cooperation with the Tilmann Borchardt Engineering (TBM) in Annaburg, a computer-aided »Harvester« simulator will be developed in this project that will allow for a close-to-reality, visual-interactive training of operators to prepare them for practical training.

The following goals are aimed for in simulation utilization:

- Reduction of training time
- Increase in efficiency of »Harvester« utilization
- Enhancement of productivity in the harvesting process
- Reduction of ecological strain
- Decrease in ergonomic strain.

## Problem Solution

The concept of the simulator is to provide the trainee with typical actions and decisions containing feedback in a close-to-reality environment. Thus, all elements within the driver's cabin that are relevant to the operation of the harvester (seat, joystick, keyboard, computer) are recreated using original parts from TBM. The environment outside the cabin (crane, harvesting unit, landscape, and trees) is modeled through a computer simulation.

In addition to the prototypical solution of the simulator on the basis of a specific type of harvester, a flexible and easy-to-configure adaptation to changing technical and training-methodical pre-requisites is required. Resulting characteristics of the simulator are

- simple creation of specific application scenarios,
- platform-independence of software components,
- distributed simulation to increase performance,
- reusability with changing components, and
- flexibility with regards to the training concept.

New methods and tools are required, which significantly decrease development costs and times for training simulators. Especially in the field of system modularization, a new approach is applied.

Utilization of the High Level Architecture allows for the distribution of software components on different hardware platforms. Three software components will be distinguished within the harvester simulation:

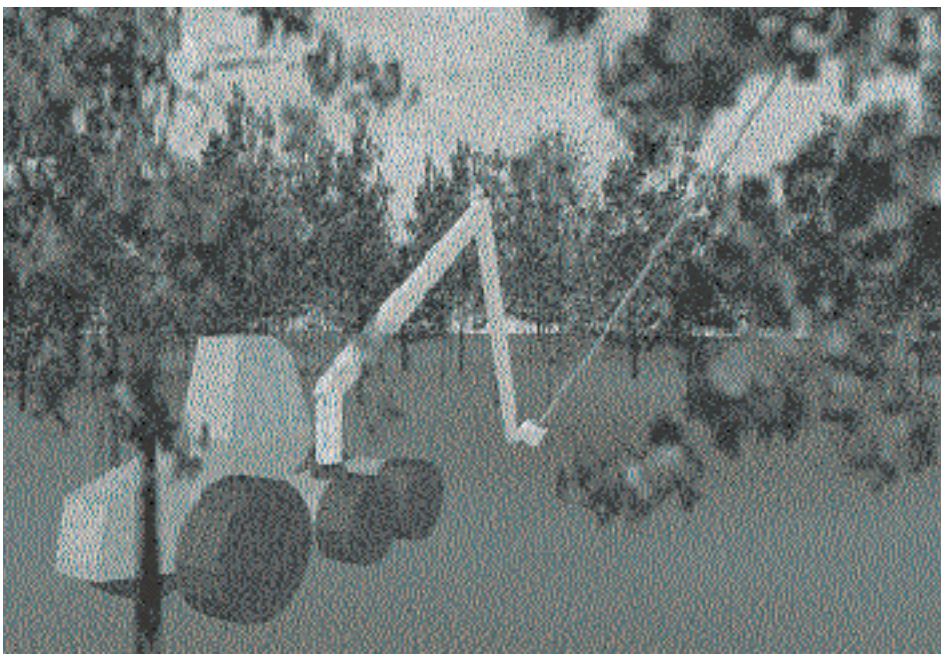


Fig. 1: Virtual Reality Harvester model

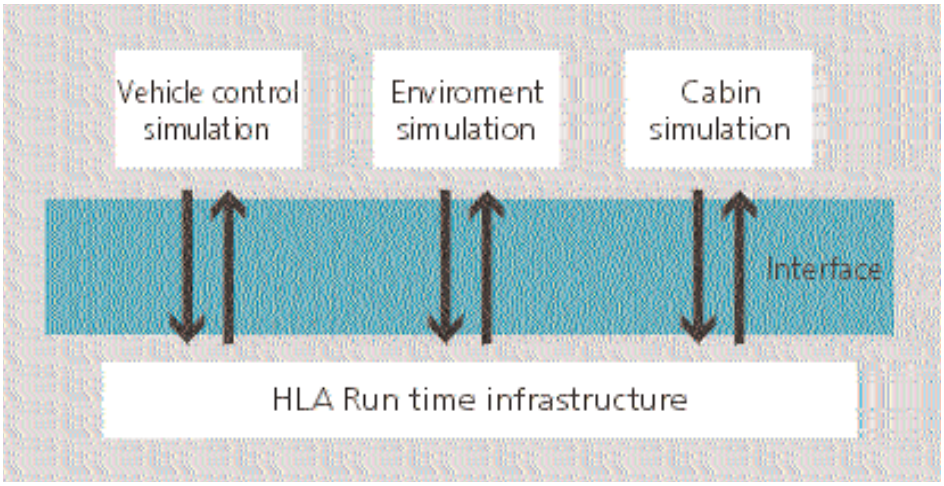



Fig. 2: Structure of the harvester simulation

– Cabin simulation
– Vehicle control simulation
– Environment simulation (landscape).

The cabin simulation is responsible for the acceptation of the input signals from the controls in the cabin interior and for the communication with the operator. These input signals are processed within the vehicle control simulation, which controls the driving characteristics of the vehicle. The landscape is modeled in the environment simulation. The simulation models exchange information about the simulated objects through an interface that is defined by the HLA.

The advantage of applying HLA is an increase of flexibility and reusability in the case of customer-specific configurations. Each software component can be easily exchanged because of the standardized HLA interface. It is therefore possible to tailor the environment simulation to the computer performance available at the customer's site. In certain cases, it might make sense to abandon the complex model of the cabin's interior and to utilize much less complex input devices, e.g. a standard computer keyboard. This, however, does not require any changes to the other simulation components.

**Outlook**

The created prototypical solution of a harvester simulator on the basis of HLA allows for a flexible composition of customer-specific training environments featuring the flexible integration of hardware and software components. As a result, the training simulation can be easily configured according to the existing technology, as well as to the environment, at the request of a customer.

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In co-operation with
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# Product development and optimization in the field of medicine technique

Competition Strategies and Products

Project Report Product and Process Planning

## Short Description

In the field of medicine technique an innovative acupressure instrument has been developed by the department of product and process planning until it was fit for function. In cooperation with the IMS GmbH the moderation and planning of the product development process as well as the constructive realization of the principle patented by the initiating doctor has been effected by the Fraunhofer IFF. To support the processes of finding out the best design, evaluation and optimization of product variants as well as the functional testing some prototypes were provided by the RMC which were produced on the rapid prototyping machines of the IFF.

## Initial Situation

The acupressure is a very old method of the far eastern medicine. Selective stimulation of certain reflex centres of the human body can lead to vitalizing and soothing effects. The stimulation is made by pressing on these acupressure-points. For about a few years the acupressur is used in Europe too to support health cures and alternative treatments.
As the stimulation of the acupressure-points is effected from outside of the body a considerable strain is putted on the skin of the patient. To minimise this strain some instruments were already developed which realize the introduction of pressure by a free movable ball which is fixed at the top of the instrument. This principle is shown in figure 1 in the left view. The strain of the skin resulting from oscillating motions gets reduced by unrolling the ball during the stimulation. But during the treatment the bearing of the ball touches and chafes the skin on marked regions. The already by initiating doctor patented product idea is scheduled to solve this problem by a coronary formation of smaller secondary balls. (look figure 1 / view right). Furthermore a secondary effect shall be obtained which is effected by rotating the instrument about its longitudinal axis and achieving an unrolling of the coronary balls on the patients skin.

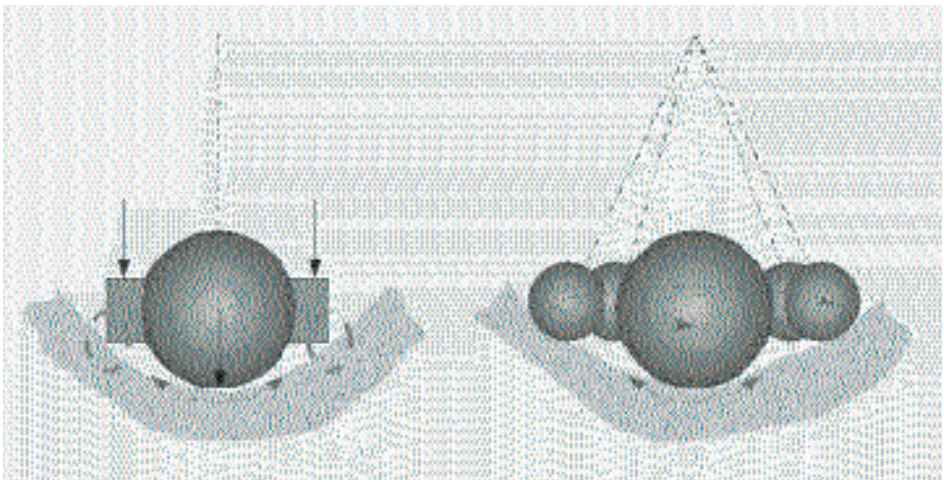

Fig. 1: Function principles for the realization of an acupressure instrument

## Realization

The realization of the product idea contained essential phases of a typical development process. Serious differences are consisting in the efficient design and parallelization possibilities by the early usage of functional prototypes. In a first workshop primary functional demands for the prototype were collected which had to be created. Basically was this the principle shown in figure 1 on the right. Furthermore restrictions resulted which came from the specific purpose. So the instrument should be used similar to a pen. Therefore a handle had to be created which fulfils for example the following demands:

- total weight: about 100 grams
- smooth surfaces
- creation of finger holes
- shift the centre of gravity to the place for the thumb.

From the medical point of view there was the demand to pay especially attention to an easy dismantling and disinfecting of the acupressure stick. The desinfection medium will be alcohol. A further demand was to build the prototype only of non allergic material.

Corresponding to the duty list of the first workshop the first drafts were designed. In the second workshop the results of the concept phase could be discussed and evaluated with the help of concept models. The needed concept models were build using 3D-Printing, a relative new rapid prototyping technology which distinguishes itself by its high speed and low costs. The evaluation of ergonomically and aesthetically aspects of the drafts got very clear and effective by the possibility of experiencing the construction by holding a model in ones hand. The

result of this workshop was a compromise found between the functional and designing demands as well as possibilities of producing the prototypes.

Consequently a final functional prototype could be developed in accordance with the demand that the construction can be adapted to a later serial production technology. Already for assembling the functional prototype should be used cost-effective standard components. This mainly referred to the balls which can not be produced by any rapid prototyping process concerning the demanded precision and costs. To guarantee a free and independent movability of all balls a slide bearing had to be realized. Focusing on the possibility of complete dismantling this slide bearing had to be realized divided. As the today available RP processes only have a limited reproducible manufacturing precision of about 0.1 mm this had to be considered by a machining allowance. The correct internal slackness for the balls could only be obtained by the manual adjustment of the separate parts. The production of the functional prototype using stereolithography took about 8 hours including all manual adjustment and surface finishing.

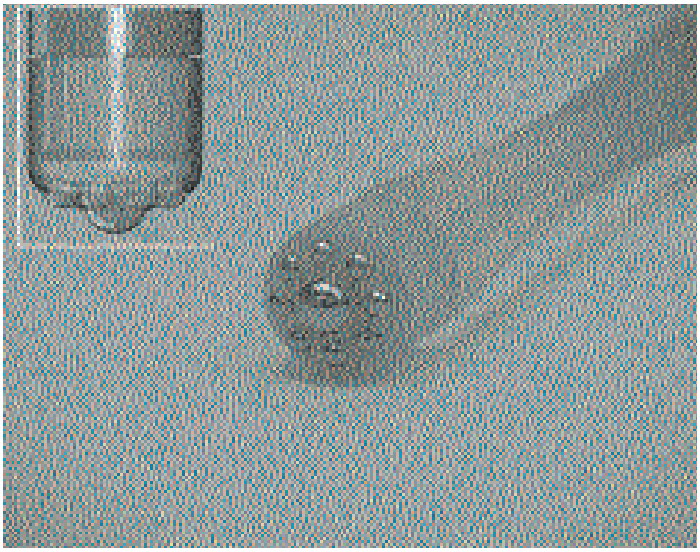

Fig. 2: Functional prototype of the acupressure stick

## Further Actions

At the moment the functional prototype is to be tested. The goal of this is to prove the medical effectiveness of the idea. After this phase the IFF will accompany the product development process up to the market introduction. Therefore the following steps are planned:

- market segmentation and identification of potential customer and user groups
- development and realization of the results of a conjoint-interview
- detailed product adaptation (selection of the serial production technology, preparation of market introduction).

Contact
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In co-operation with
The project is performed in cooperation with the IMS GmbH, the initiating doctor and an engineering office.

# Process-oriented quality management in the field of logistics

Competition Strategies and Products

Project Report Quality Management

## Initial Situation

Manufacturers and sellers of products of any type are facing the challenge of meeting the ever increasing requirements existing in connection with the establishment of comprehensive quality and service management systems as well as the product liability act.

In this respect, a number of different group-constrained solutions have been developed in the past in the field of identification and evidencing, using a wide variety of tools.

To be able to adequately satisfy the requirements put forward by the legislative bodies, it is no longer sufficient to create independent solutions for individual areas. On the contrary, it is essential to develop an interdisciplinary and inter-company identification and evidencing system which, using a unified software, is compatible with the higher-order system so that time and costs are saved.

## Approach to Solution

Fraunhofer IFF has developed a system which makes available on the product itself the most important data throughout the entire logistic process chain.

In this system, RF (radio-frequency) Identification Chips provided on the products are used for directly storing information on their entire life span, starting from fabrication via transport, storage, use, maintenance up to recycling. In addition, the chip contains important cross-references to further essential sources of information (data bases).

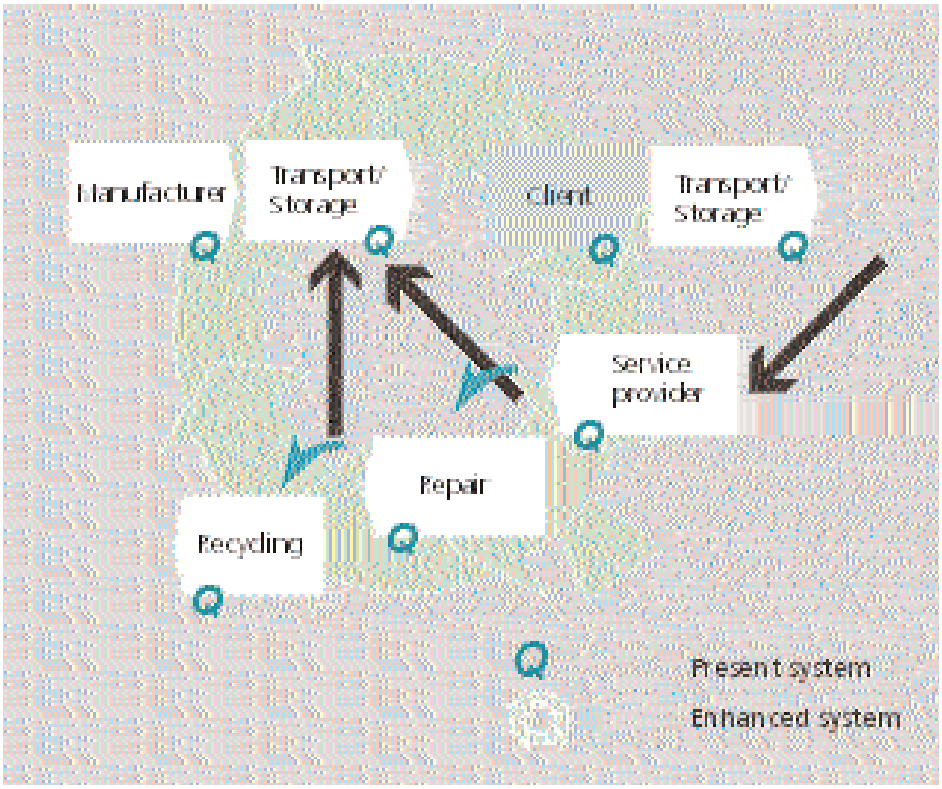



Fig. 1: Intercompany process chain

## System Description

The microchips used for tracing products via logistic process chains are part of a contactless system with integrated read/write transponder. It allows to dynamically describe features (e.g. test results, ...) via the product life cycle. To avoid improper use of the stored data, the data may be accessed only by users authorized to read and/or write.

Thanks to compatibility with higher-order IT systems and data bases, the expenditure involved in regard of the entry, processing and searching of data is considerably reduced. More over, each company participating in the process chain may use certain data and information. Due to its high reliability, the system is particularly suited for use in a rough environment. Apart from product tracing via logistic intra- and intercompany process chains, potential fields of application include:

- time acquisition and access control
- management of identification, test/inspection and service data
- process monitoring and control
- resource management
- marking of safety components
- prevention of spare parts piracy.

## Advantages

In comparison with conventional storage systems such as Barcode or OCR letter, the system is characterized by a number of different features.

- data can be changed at any time by authorized persons without any associated destruction or replacement of the original data carrier

Fig. 2: Microchip with
read-write station

– a large number of data can be stored on a small area (Æ 5 mm)
– high data safety
– information is readable in spite of dirt thanks to contactless data retrieval
– resistance to extreme temperatures as well as to aggressive chemical substances

If the computer systems used fail, all data stored on the chip are preserved and can be utilized for the reconstruction of processes.

## Procedure

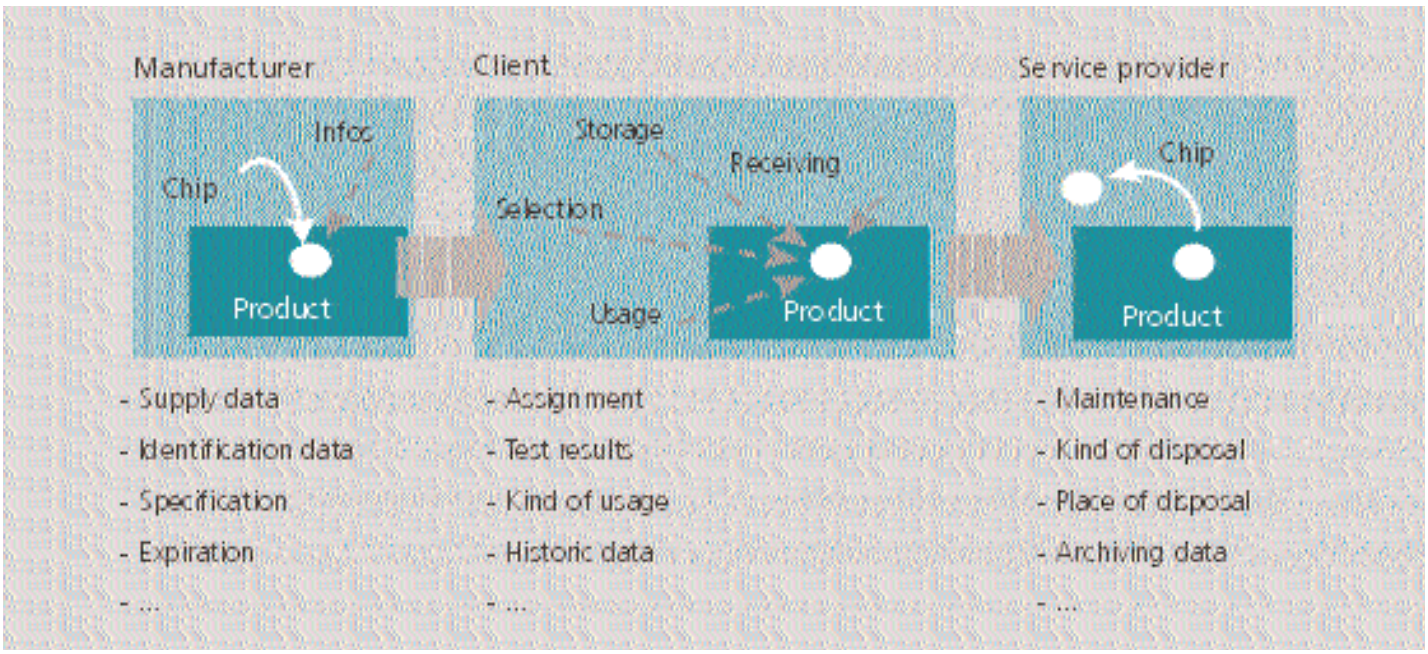
1. Preliminary study
   e.g. assessment of fields of action, defining of objectives of system and expenditures

2. Analysis of existing situation
   e.g. information gathering events, analysis of boundary conditions and process analysis including analysis of information required in each individual area under study

3. Conception and implementation
   e.g. system, integration, system design and safety concepts, input/transformation of relevant data, design of interfaces, training, implementation, test run and proposals for system extension

Contact
Dr Horst Lewy
Mr Steffen Fröhlich

Fig. 3: Inter-company
product life span



# Development of a fluidized-bed gasification plant

Sustainable Development

Project Report Factory Ecology

## Initial Situation

According to the regulations applying in the Federal Republic of Germany in regard of the disposal and deposition of waste, methods for the final thermal treatment must ensure that ignition losses of ≤ 5 % by weight will not be exceeded. This relates to all waste fractions which are not suited for direct recycling.

With companies and communities having to provide complex disposal services in the face of continually decreasing waste quantities, one may observe a trend towards smaller plant capacities as an alternative to large central plants with a high transport/ logistic expenditure. It is necessary, e.g., to properly utilise used wood fractions on a regional scale, but unprocessed wood from forests and wood left over from wood processing operations, being a regenerating raw material, is also of ecological and commercial interest as feed for the generation of electrical energy and heat.

## Objective and Project Implementation

A project for the development of gasification plants with a thermal capacity ranging from 500 kW to 3 MW, which can be used close to the fuel source, is being implemented by DIM Dessauer Instandhaltung und Montage GmbH as plant manufacturer in co-operation with the engineering office VIGORIS. The project is promoted by the Federal Ministry of Research and Technology and is to be completed by the year 2000. The entire development takes place in close scientific co-operation with the Institute of Apparatus and Environmental Technology of the Otto-von-Guericke-University of Magdeburg.

The principal objective in the development of the plant is the thermal utilization for the purpose of electricity generation. This objective can be achieved in an energetically effective way by the understoichiometric conversion of the input into a fuel gas, and conversion in a gas engine installation.

The gasification in the stationary fluidized bed is characterized by:

- a simple design where no moving components exist in the combustion chamber
- the usability of a wide range of fuels
- very good mixing and very high heat and mass transfers
- high conversion rates
- the use of catalysts to minimise the formation of tar in the fluidized bed is possible.

In view of the capacity envisaged and the purpose of the plants, it was decided to use the stationary fluidized-bed technology.

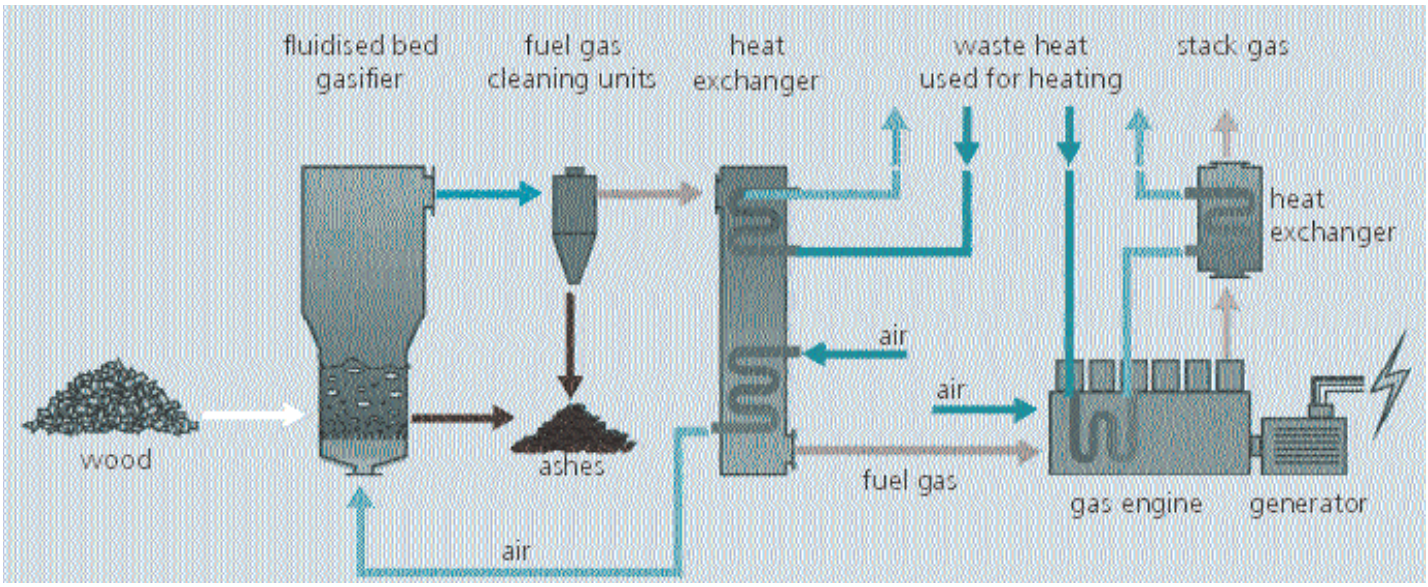



Fig. 1: Process chart of wood gasification unit with integrated engine power unit

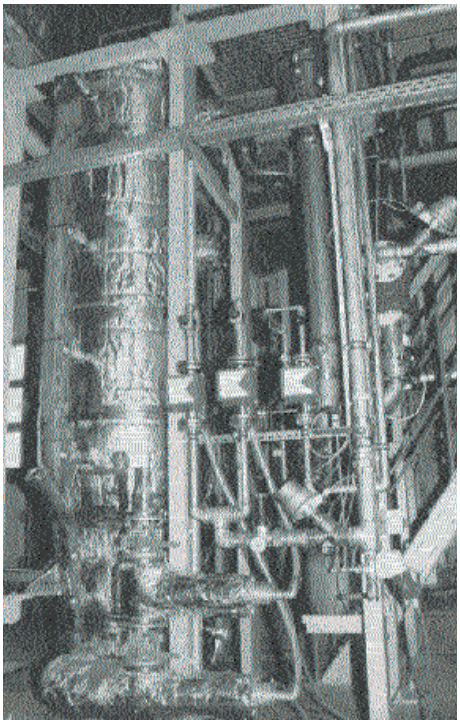


Fig. 2: Test plant of Fraunhofer IFF in fluidized-bed Polytechnic of the Otto-von-Guericke-University of Magdeburg

Since the process and equipment to be developed for this purpose are to be characterized by a considerable degree of innovation, large-scale research activities including a high experimental expenditure are required. The project is implemented in several stages:

I. Development, engineering and design of the test plant
II. Manufacture and erection of test plant including functional test
III. Test planning, test execution and evaluation
IV. Scale up for the pilot plant
V. Process design for a pilot plant to be erected at a certain location

Phases I and II have already been completed so that a serviceable test plant with a thermal power of 150 kW is now available on a semi-industrial scale.
The works to be carried out up to the end of the year 1998 will concentrate above all on the execution of tests and their evaluation.
The tests will at first involve above all the use of untreated residual wood and contaminated used wood, which as a regenerating energy carrier is increasingly of interest in the field of energy generation.
First tests with residual forest wood have shown that fuel gases with an inflammable constituents content of 25 to 31 % by vol. (CO 15-18 % by vol., hydrogen 5-8 % by vol., methane 5 % by vol.) are produced, which corresponds to calorific values of 4,000 to 5,000 kJ per standard cubic metre.

The main problem existing in the generation of electricity in an engine-type combination heating-power plant is the quality of the fuel gas produced from the waste or used and residual wood. Here, engine manufacturers have specified concrete limit values for the individual pollutants and pollutant groups, which have a decisive influence on the life of the gas engines and, thus, on the overall profitability of the gasification method. At present, large scale test cycles aiming at the optimization of the process control and parameters as well as the efficient cleaning of the fuel gas, in particular the removal of tars, are being carried out. At the same time, suitable measuring systems are being developed for this technology. Various bed materials are analyzed with respect to their catalytic effects, and in the downstream modules a wide variety of materials are examined with respect to their suitability for a simple and cost-efficient cleaning of the fuel gas.
These examinations include tests of other fuels for their suitability for fluidized-bed gasification.
The results achieved so far are encouraging and will form the basis for the construction of a pilot plant.

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VIGORIS GbR, Biederitz
Otto-von-Guericke-University of Magdeburg

# Use of Geographical Information Systems (GIS) in the service sector and in environmental protection

Sustainable Development

Project Report Factory Ecology


## Summary

The use of Geographical Information Systems is continually gaining in importance. Analyses have shown that spatial relationships exist in a large number of business processes both in the field of administration and in the economic sector. For an appropriate decision-making process, thus, it is also necessary to duly take into account the spatial dimension.
With the help of a practical example from the field of logistics, the possibilities offered by a GIS are to be demonstrated.


## Initial Situation / Requirements

Politicians, executives in industry and trade or in administration, actually in all spheres of social life, have to make decisions the quality of which is depending to a large extent on the consideration of information related to space. The capability of conventional factual-data based DBMS solutions to reflect spatial relationships is limited, however.
This deficit can be compensated for by the use of Geographical Information Systems (GIS). Geographical Information Systems make it possible to acquire, process, manage and present factual and geometrical data with due consideration of their complex, logical, content-wise and spatial relationships.
On account of the availability of digital spatial basic data, on the one hand, and of the falling hardware prices, on the other hand, the range of application of geoinformation technology has considerably increased over the past few years.
Whereas this technology was primarily used in the fields of surveying and environmental protection in the 1980s, the current applications range from line documentation via logistics optimization, location searching, real estate marketing, tourism, sales network planning, cadastral surveys of contaminated sites up to complex spreading models, as are required, e.g., in the case of emergency management.
In the following example, a practical application from the field of logistics will be described.

## Task

According to § 8 (waste management concept) of the waste law of Saxony-Anhalt (AbfG LSA), every public waste disposal agency is obliged as per § 19 sec. 5 of the recycling and waste law (KrW-/AbfG) to prepare a waste management concept for the area for which it is responsible.
The task was to clarify by way of an example from the rural district of Ohrekreis (area abt. 2,000 $km^2$) all collection and transport-logistic questions to be taken into account within the framework of the waste management concept, using the GIS product ArcINFO / ArcVIEW.

## Implementation

The result of a GIS project, regardless of its contents, depends to a decisive degree on the nature (quality, up-to-dateness, accuracy, completeness) of the digital spatial data. The data for this project was provided by the Surveying Office of Saxony-Anhalt. It came from a completely digitized data base which has been generated within the framework of the ATKIS project (Official Topographico-cartographical Information System).

During the first phase, this digitized data, which is output in an exchange format (EDBS), is converted into a format which can be read by the system. This is followed by a partly automated error elimination (overlays, open polygonal structures etc.).
It turned out that these steps can be very time-consuming. One should not forget, however, that these preliminary activities have a decisive influence on the quality of the subsequent overall solution.
The adjusted topographical data base which is now available for the Ohrekreis district now includes realistic details on the characteriszation of areas (e.g. lake, river, built-up area, industrial estate etc.) as well as information on the characterization of lines (e.g. road network, rail network, limits of administrational districts etc.).
An open relational data base structure makes it possible to add individual attributes such as demographic data (e.g. number of inhabitants) or waste quantity data (e.g. household waste, waste which is covered by the DSD scheme and is separately collected for recycling, bulky waste) that can be directly assigned to the respective spatial objects (e.g. communities).
As regards the usable attribute types, the system is open so that also graphic representations and pictures as well as video or sound recordings can be incorporated.

Based on this data base, which was adapted to the specific task to be tackled, it was now possible to carry out the required space-related analyses and inquiry.

In this connection, the following principal objectives were defined:

- Visualization of the distribution of waste quantities in the area considered (incl. prediction up to 2010),
- Determination of partial waste priorities,
- Determination of overall waste priority,

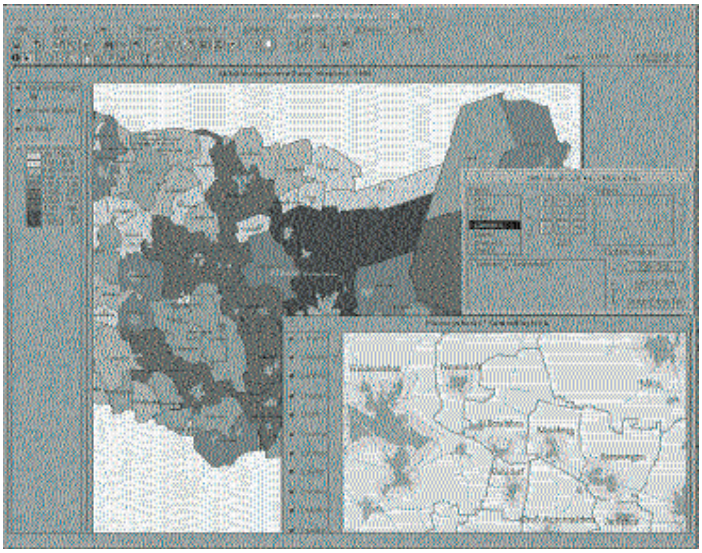

Fig. 1: Example of community-specific waste quantity distribution as well as aggregation of municipal road kilometres in the Ohrekreis district

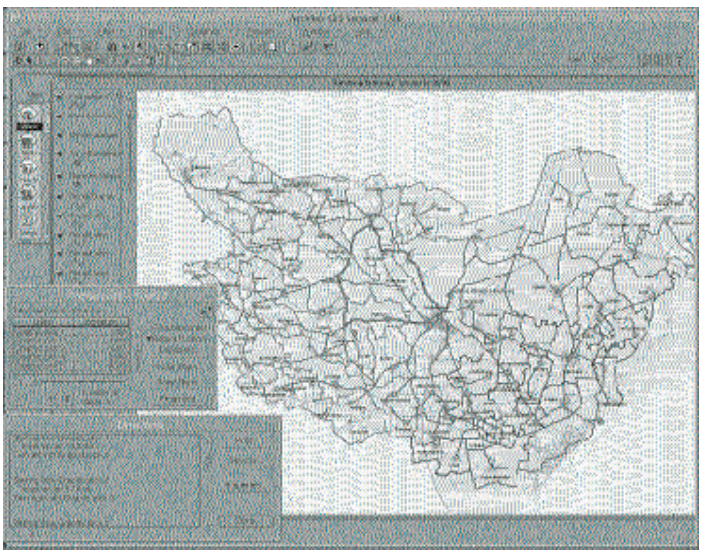

Fig. 2: Transport optimization with the help of Network ANALYST

– Aggregation of municipal road kilometres (collection logistics),
– Establishment of collection districts (based on the type of waste and collection times), as well as
– Route planning and optimizing on the basis of specified collection points.

Thanks to the modular construction of the system, it is possible to make use of already programmed, optional modules for solving a wide variety of tasks. In the case of route planning, for example, the NetworkANALYST was used. This module is particularly suited for optimizing networks of any type. In addition to this, it is possible to adapt the functional scope and menu structure via system-inherent programming tools to the respective specific customer requirements.

## Resume

The quality of decisions can be considerably improved by using geoinformation systems. By incorporating the spatial dimension, relationships and interactions can be identified, represented in an easily comprehensible form and taken into account when looking for solutions to certain problems.

Developments currently going on in the Internet-Map-Server technology sector will make it possible to also make use of the potentials of the INTERNET in the solution of space-related questions.

Contact
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# STRUGTO - methods and tools for structure formation and evaluation

System Dynamics

Project Report Fundamentals of Factory Operation/ Organization of Inplant Processes


## Abstract

STRUGTO, Structure-Generation-Tool, is a combination of methods and supporting software for structure formation and evaluation for new planning or reorganization at manufacturing enterprises. The 4 module-tool is a software-transfer of the basic steps for generation of production structures. The single modules support individual steps in structuring projects. The software generates (by using all modules) structuring suggestions for a defined production area and defaulted goal entities.


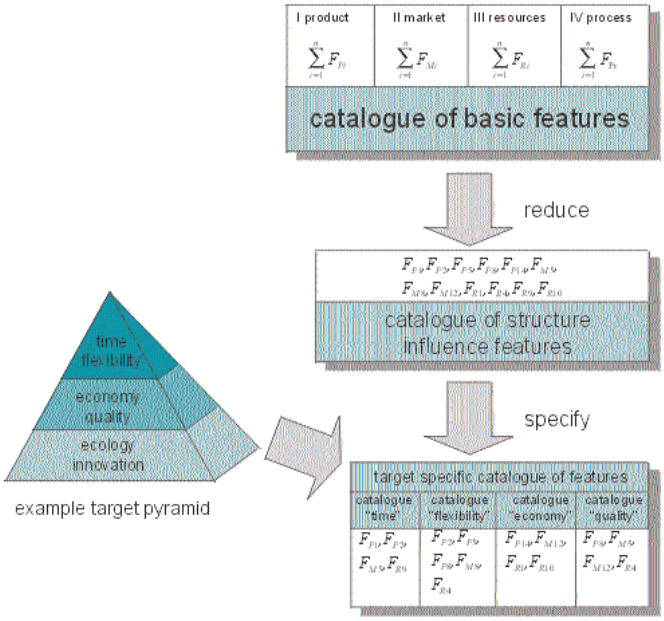


Fig. 1: Goal hierarchy and structure of catalogues of features

## Initial Situation

The evolution of the tool started parallel to a practical structuring task. Different demands on structure consisted in the past at different times. Individual reflexes to different requirement in sections performed for partial solutions. They were not synchronized with each other. The enterprise complete lost continuity and transparency in the material flow. Now it was necessary structured the production process again for a series production. The unidimensional destination system »productivity« had no more validity. The existing structure was not a satisfactory answer for actually question for short machining times and low supplies. Changed customer requirements and increasing printing the rivals led in addition to one change the goals of the enterprise.

Use of STRUGTO already supported by software the goal discussion in the team. The result is a transparent demonstration of all goals in a goal pyramid. After the user select from the goal specific catalogue criteria, which influence the structure. The catalogue of the structure influencing features and the goal pyramid generate the goal specific catalogue of features. Last-named catalogue offers a fast aid to the customer for the fast and clear selection of the features. They are collect in a maximal catalogue, the basic feature catalogue, like in a database (figure 1).
This contains all structure influencing components with their markedness and consists of four parts:

- product, to identify product influences on production structure
- market, to identify market influences on production structure
- resources, to identify the production structure as structure between resources and
- process, to identify the material flow relationships in production structure.

Result of the considerations and calculations in module 1 is a weighted criteria list of 3-5 criteria. These are the relevant criteria and limited conditions for the structuring task.

Module 2 is the element for set the product formations on the basis of identified criteria and their characteristics. Product lines are traditionally product families. They are based exclusively on features of the products, like geometry or technology. In STRUGTO is a product formation a collection of products, selected by features of market. Criteria like price or numbers are considered besides. In this way, the tool reflects the practical illustration of the relationships in just one data model between product, market and production system. Product data, resource data and process data can be often accepted from the databases employed in the enterprise. Also medium-sized companies plan, control and check today very often with computers. Numerous statistics showed that. This fact legitimizes the described working method.
The result of the considerations and calculations of this module are the product formations. They are compiled goal-oriented and will form a unit in the future structure (figure 2).

The central module and most important one is module 3, the module for combination of resources and formation the structural units. The very

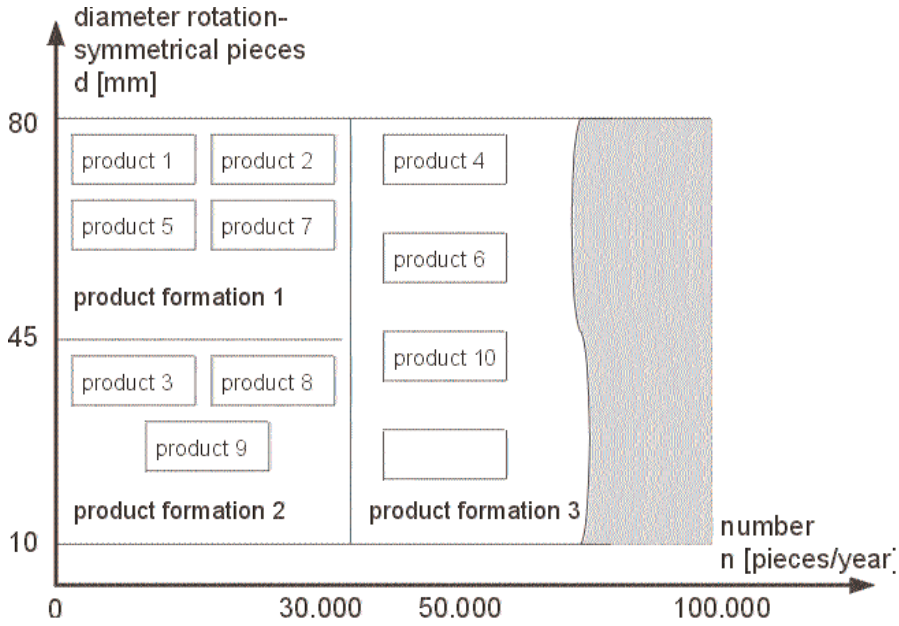


Fig. 2: Product formations (example as function of 2 criteria)

fast structure generation permits approaches of game theory. It is possible because of the character rough structuring and the use of computer technology. The formation of different structure variants is possible by the variation of the master data. The basic thought is following: Every modification of individual features demands a modified structure. Detailed copies of technical subsystems and partial material flows in existing structures are secondary. Central modelling aspect had to be the illustration and evaluation of complete system structure. The units are reflected by assignments of process elements to resources and assignments of resources to organization units. The reduction of the regressive material flows especially from rework occurs during the investigations of machine arrangement. This is also the next step. The most operations in this module are already strongly automatized. It is possible to generate several variants at shortest time.
Result of the considerations and calculations in the 3rd module is at least one variant of rough structure. The structural units are over weight compared with product formations and support the goals of enterprise and market.

In module 4 you can choose a structure evaluation optionally. A graphically supported simulation is always very extensively and not very cheap. Therefore is this tool specifically arranged to the production structure simulation. An evaluation of structuring solution orientates on goal pyramid. The shared project partners appreciated the possibility of the absolute evaluation. They evaluated the absolutely evaluation positive, more than a relative evaluation. The »good-or-bad-decision« works more goal-oriented and removes thinking blockades. The traditional »better-than/ worse-than-decision« identified only local optima and this required short cyclical restructuring processes or controlling intensive operating solutions.
Result of considerations and calculation of the 4th module is a goal-oriented evaluation of structuring solution.

## Project Results

The time of planning process will be shorter because of the electronic data acquisition and data editing.
The planning process becomes better plannable itself. First practical, industrial projects showed already clear effects: A supreme of the software STRUGTO could cut the project time by nearly 30%. The machining time was reduced by 20%, in partial processes more than 50%. Additional was shown a cut of supplies around 40% and a halving of rework pieces by 2%. Deliver of products was punctually in 94% of cases.
Numerous positive results could also be achieved on soft facts. A clear improvement was achieved of transprarency of material flow. Some work plans were reworked in the project. That allowed a variant generation in workflow organization. This fact added to an improvement of flexibility and was very good for market oriented and goal oriented working.
The Software STRUGTO represented a big support for every project team in structuring projects. Last but not least it provides for motivation by showing quick and concrete results.

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In co-operation with
DAL-Werke Haldensleben Ltd.
(until 1995: Rosco-Metallwerke Ltd.)

# The SHAPEFINDER™ Technology
# A new method of combining 3D-scanning and data processing

Customer Adapted Automation

Project Report Smart Sensor Systems

## Abstract

The following paper describes a new 3D-scanner for digitizing and/or scanning of small objects. While it was common in the past to use a bivariate point distribution or polygonal objects, the new method generates direct surface descriptions in the form of NURBS-surfaces. To this end the system combines an optical 3D measuring instrument, which works on the basis of the split-beam method, and a software package to generate the NURBS-surfaces. This quasi automatic process ranging from 3D-scanning to the output of a CAD-compatible surface description is called the SHAPEFINDER™ Technology. This technology was developed in co-operation between Fraunhofer IFF Magdeburg and the firm e|media.

## Initial Situation

Many methods of optical 3D-scanning are known to us. In general, their result are random three-dimensional bivariate point distributions. The users of our system, i. e. product and technical designers, quality assurance engineers and 3D-animators, who work in the film and multimedia industry need, however, 3D-objects which can be easily manipulated to be used for design purposes or to compare them with the required status of CAD-drawings. Until now the bivariate point distributions had to be converted into polygonal objects which was quite a labor-intensive process. The data sets generated this way are normally quite large and it is difficult to cope with them, even on powerful computers. They cannot be used directly in the manufacturing process (CNC), and due to their angular surface they represent the original object in rare cases only.

## Procedure

The SHAPEFINDER™ Technology is a combination of an optical 3D measuring instrument, which works on the basis of the split-beam method, and a software package to generate the so-called NURBS-surfaces. This process ranging from optical 3D-scanning to the measured result in the form of a CAD-compatible 3D-object is performed automatically. In practice this means that the user positions the object to be measured in the measuring space of the instrument. Then a button is pressed and the object is scanned and without any interaction from the side of the user, a three-dimensional NURBS-surface is computed which perfectly describes the surface of the digitized object.

In the current first version of the measuring instrument the split-beam method is used as the optical measuring principle. An optical split-beam sensor consists of minimum one (1) CCD-matrix camera and one (1) diode laser with a cylindrical lens. To facilitate the scanning of object surfaces, a relative movement between the object to be measured and the split-beam sensor is required. A rotary table, a translation axis or a combination of the two are used for this purpose. The current instrument set is designed for measuring objects with maximum dimensions of approximately 1000 x 1000 x 1000 cubic millimeters ($mm^3$) so that both the split-beam sensor and the handling device are accommodated in a self-contained casing. The result of optical three-dimensional measurement is a 3D-bivariate point distribution which is stored temporarily as an ASCII file. Subsequently, while providing a maximum admissible deviation, a NURBS-approximation of the original object surface can be carried out. The result is then stored in the IGES format, thus it may be imported to all common 3D and CAD software systems.

Anyway, many different object shapes can be scanned and measured three-dimensionally within this self-contained system. The limitations are provided by the size of the object to be measured and the transportability of the measuring instrument. Figure 2 shows an example of a measured object (3D-bivariate point distribution). The video picture of the original object to be measured is shown in Figure 1.

Fig. 1: Video picture of the original object to be scanned

Fig. 2: 3D-bivariate point distribution of the measured object

Geometrical measurement of real objects and their transformation into virtual worlds (3D-CAD graphic files) is not new to industry. However, the current problem is that the memory requirement of most polygon-based data files is quite big because they consist of thousands of 3D dots/ polygons. Although this allows a very accurate representation of the object, it is nevertheless very unwieldy. This is the reason why with NURBS a mathematical surface definition has been generally accepted. A NURBS surface is described parametrically with the help of a certain number of control dots. This results in clearly smaller data volumes and objects which are easier to be manipulated. Conventional methods of transforming a 3D-bivariate point distribution into a parametric surface description is very time and labor consuming. Consequently they are a cost factor that should not be underestimated.

The software package developed for generating the so-called NURBS-graphics reduces this work load considerably. The graphic file is computed in an automatic process. Proceeding from a well-ordered 3D-bivariate point distribution, i. e. each individual split-beam generates a line of intersection of subsequent 3D-dots, the so-called (primary) NURBS-lines are generated. This means that an approximated curve with n support points is generated from a line-type distributed set of dots. Subsequently, the primary NURBS-lines generated are connected by so-called secondary NURBS-lines which - to a large extent - are arranged orthogonal to the primary ones. Thus a three-dimensional NURBS-mesh is created which graphically represents the measured surface of the object.
The memory required for saving the data files for the graphic display of the object can be freely scaled. The user can freely select the desired resolution, beginning from the maximum resolution which the method of measurement may reach, up to a rough presentation of the shape of the object. The computed NURBS graphic of the face of a gypsum sculpture is shown in Figure 3.

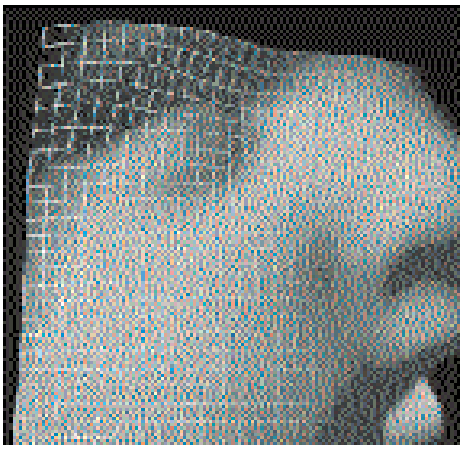

Fig. 3: NURBS-mesh / shaded surface

The software allows an interactive selection of the resolution. Having selected partial surfaces of the object, the accuracy of the NURBS fitting may be separately set. For example: Assume you have measured the head of a human being and now you'd like to make a character animation. The software reconstructs the NURBS-surface of eyes and mouth parts very accurately and generates a denser NURBS net for these areas while areas of less importance such as the rear part of the head are reconstructed by a sparse NURBS net.

The SHAPEFINDER™ Technology developed by us will free you from data sets consisting of thousands of polygons. What you get instead is a NURBS-description of the scanned object which can be freely scaled in accordance with your requirements: from the maximum possible resolution required for scientific research to a rough approximation for real-time applications. Due to the fact that we perform our measurement at maximum resolution, the approximated NURBS-curves can also be brought in highly accurate agreement with the real geometry of the object.

Memory-optimized representation of the object by means of NURBS facilitates integration of digitized 3D-objects into your current projects without any difficulty.

Contact
Mr Dirk Berndt
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In co-operation with
e|media Magdeburg

# Measuring device for automated soil exploration by penetration tests

Project Report Smart Sensor Systems

Customer Adapted Automation

## Summary

Soil exploration by penetration tests is a standardized method for exploration of load carrying capacity of building site soils. With this method, the penetration depth of a probe is measured in dependence of the number of impacts of a falling weight. This explorations are mostly performed manually and are rather time and power consuming. Due to the manual registration the measurement values are very fault sensitive. Therefore, a device was developed, which performs an automatic registration and processing of penetration tests for all kinds of penetration test devices. In connection with a PC-program a quick result display and management is possible.

## Problem Description

Each building project requires an a priori exploration of the load carrying capacity of the soil. Permitted testing procedures are defined in the DIN »Exploration and investigation of soil«. A most commonly used approach is the so called impact testing approach according to DIN 4049. In this approach, a standardized falling weight strokes from a defined height onto an anvil, which drives a standardized measuring bar into the soil. The number of strikes necessary for a 10 cm or 30 cm penetration is counted. Graphical presentation of this numbers over the absolute penetration depth gives the soil density profile (figure 1). To obtain this profile up to a depth of about 6 m there are required some hundred impacts; this tedious and power consuming procedure leads to observation errors. So the development of a measuring and registration device became necessary, which is suitable both for manual and mechanized (pneumatically, electrically or hydraulically driven) test equipment, which is easy to use and suitable for the rough building site conditions.

## Solution

To select an appropriate distance measurement system preliminary investigations were performed in order to understand the acting forces and accelerations during impacts. There were registered accelerations from 10 g (sand) up to 5.000 g (rock); the signal spectrum contains frequencies in the range from 10 Hz up to 25 kHz. Basically, the penetration depth for one impact can be calculated by double integration of the acceleration. But unfortunately, due to the low frequency components, particularly in »soft« impacts, the computing error becomes too high and an error accumulation occurs.

Taking into account real building site conditions a temperature compensated ultrasound measurement principle was selected. The device itself is located on the ground and measures the distance to a reflection plate attached to the anvil of the penetration test equipment. According to the device geometry a measurement range of 20...150 cm was required. This can be achieved by using separate ultrasound transmitter and receiver. Figure 2 shows the setup of the measurement device.

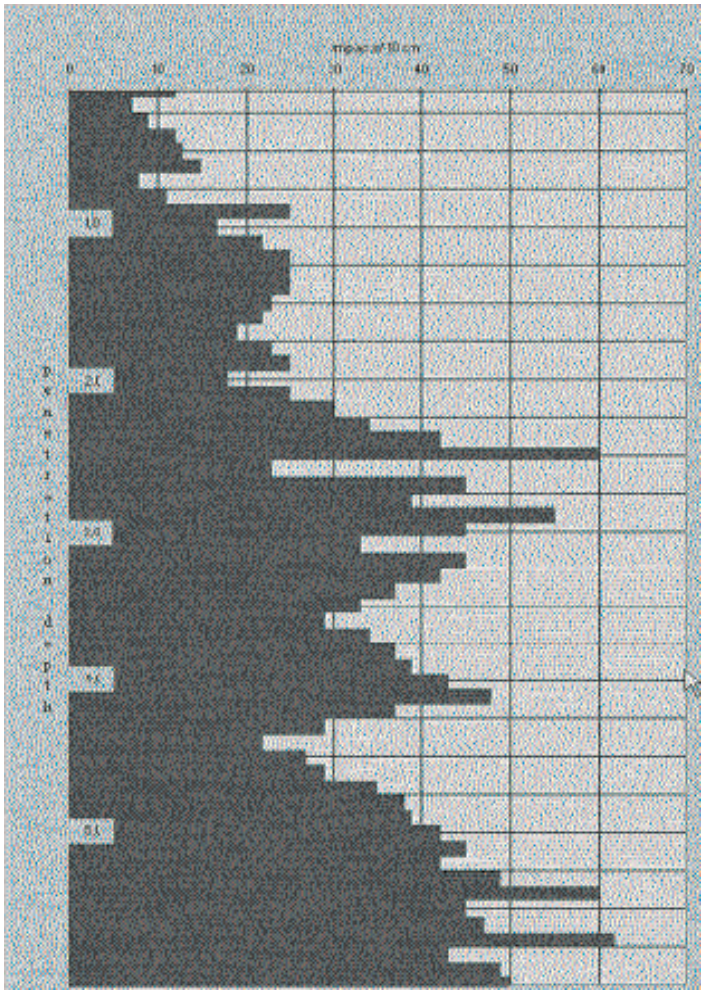

Fig.1: Soil density profile according to DIN 4049

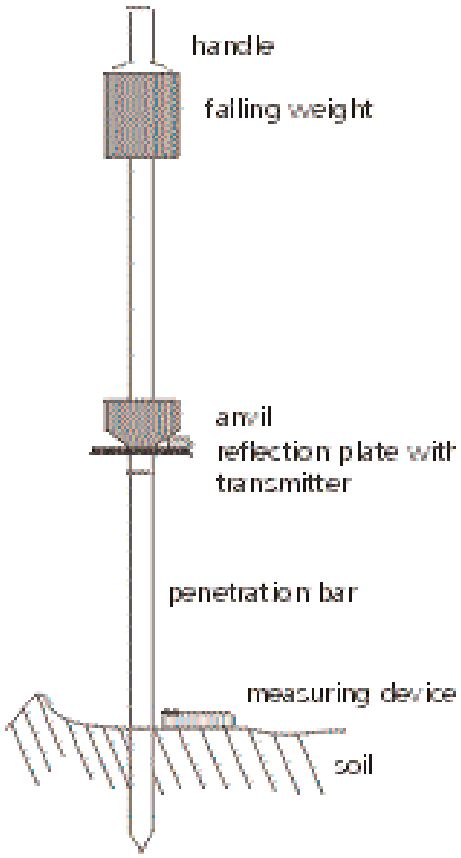


Fig. 2: Principal setup of the measurement system

To detect the moment of the impact there is used a small and robust low cost shock sensor, which is attached to the anvil together with a miniaturized radio transmitter in a weather proof box.

After switching on the device automatically assigns a number for the next measurement. Following, after each impact, which is detected by a radio receiver inside the measurement device, a distance measurement and calculation of actual penetration depth is performed and the values are stored. To attach the next penetration bar the measurement can be paused; switching off the devices terminates the measurement. This way, only a minimum number of buttons is required. An LCD display shows the actual measurement results. Processing and graphic presentation of the measurement results can be performed by a PC, which connects via a RS232-interface to the device. A simple data bank system allows to store and handle all measurement sets for documentation purposes.

Presently, the performance of the device under real building site conditions is being investigated. After this, a series production will be installed with the help of the IFF.

Contact
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# Cleaning robot for vertical glass facades

Customer Adapted Automation

Project Report Robot Systems


## Abstract

The Fraunhofer Institute IFF has developed and tested concepts and prototypes for automatic facade cleaning. Especially vertical glass-facade buildings have frequently very similar facades with homogeneous surfaces. For this reason, the IFF has developed a modular robot system for automatic cleaning of vertical facades which soon will be tested at a building and subsequently optimized.


## Initial Situation

A new generation of service robots is conquering the service market. Now that robots have revolutionized industrial manufacturing, they are also beginning to conquer the service sector. Wherever monotonous, dirty or dangerous work must be done, service robots are used more frequently. Robot systems are particularly suitable for vertical facades which are flexibly applicable due to their modular structure. The aim of the development were kinematics which can be used on a multitude of vertical facades with or without any requirement for adjustment. Therefore, the concept is based on the demand to move with suckers along the facade surface and not to use any guide rails at the facade. Thus the robot design is largely independent of the shape of the facade. The development focused on the practical application of such a system.

Subsequent to extensive studies at the beginning of the project, the following conditions for the robot system were defined:

- full- and semiautomatic operation
- application at the largest possible number of buildings
- robustness of the system
- movement of the robot on the vertical course downward and upward
- permanent contact with the largest possible number of vacuum suckers
- quick movement at the facade
- continuous and discontinuous movement at the facade
- correction of motion direction during vertical movement
- securing the robot from the top of the building with ropes, use of gantries
- overcoming obstacles perpendicular to the facade (protruding shading devices, frames, capping, etc.)
- surmounting obstacles at the facade such as louvers, capping, etc.

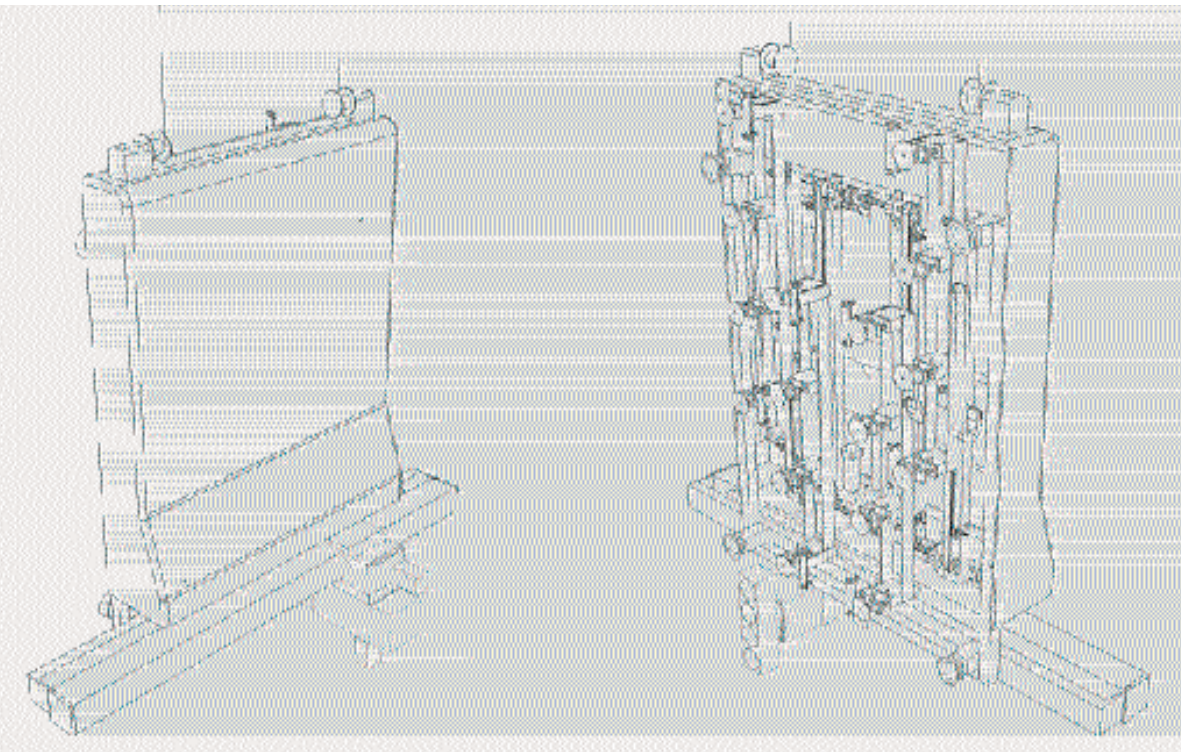

Fig. 1: Construction model of the cleaning robot

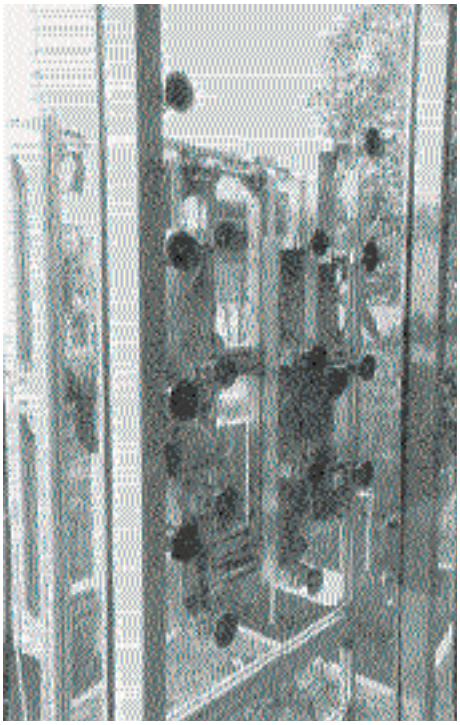

Fig. 2:Cleaning robot without cleaning units

## Description of the Robot System

The core problem of modular kinematics is to guarantee permanent contact between the robot and the facade, the possibility to surmount a multitude of typical obstacles and a quick movement at the facade. Generating a sufficient contacting force to the facade with the robot hanging at long ropes is to be particularly considered in order to exclude a detachment of the robot from the facade. Vacuum suckers are the best solution to generate safe contact with the facade. Usage of vacuum suckers makes the robot independent from various facade designs and materials.

The complete robot system does not only consist of the robot kinematics. Our concept contains - particularly for fully automatic operation - a gantry at the building roof, since the robot has to be secured against falling. Usually the gantries are installed at high buildings to guarantee safe access for maintenance and inspection work. For automatic robot operation these gantries have to be provided later or must be expanded. The rope hoist, the lateral movement of the gantry on rails and the positioning of the cantilever have to be modified for automatic operation.

The kinematics are based on a structure of two pairs of linear modules with several vacuum suckers. The length of the module and the amount of suckers are parameters of the system which depend on the structure of the respective facade. The movement of the sucker perpendicularly to the facade is made by an additional degree of freedom (pneumatic cylinder). Each cylinder can be separately operated. Two linear modules form one pair to perform the same linear movement. This guarantees safe and stable contact with the facade. Each pair of linear modules is driven to move the system continuously or intermittently upward and downward.

The length of the linear modules at the prototype was 1.2 m, thus allowing the system to surmount obstacles of 1m. One pair of the linear modules can be rotated about a fixed point to compensate any drift movement of the robot during the upward and downward movement at the facade.

Contact
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# Modern education and extended vocational training at the training factory - create the basis for continuous learning

## The Learning Enterprise

Project Report Factory Organization

Qualified employees are the decisive success factor of an enterprise. Founded on a demanding concept to the integrated ingeneers` education a »training factory« was set up in the last year by the main department of Factory organization and the institute for Ergonomics, Factory automation and Factory operation, that on the one hand as a complex experimentation platform for investigation and on the other hand as a flexible experience field for basic and further education of engineers serves.

### Objects and Content

The basic idea of the training factory (see Fig. 1 - definition) is the complex reflection of various enterprise types with its features, typical business processes as well as typical competition-, sales- and procurement-market-relationships.
The aim of education and extended vocational training at the training factory is the enlargement and action oriented application of knowledge in the special fields of factory organization and automation.
The emphasis lies methodically at the extension of empirical knowledge and correlations in the form of practical training courses, workshops and map exercises as well as in the improvement of the individual learning and problem solving ability considering social competencies and team ability.

### Continuous Learning

In traditional training at universities learning is limited to cognitive knowledge transfer i.e. the passing on of scientific findings. The students get the possibility to gain experiences themselves only in a few isolated

*Definition »training factory«*

The training factory consists of basic elements of the flow of materials,
– Material and work aid
– Means of transport
– Means of storage

The training factory consists of basic elements of flow of information,
– Data acquisition furnishings
– Data processing equipment
– Data transmission facilities
– Memory furnishings

The training factory consists of facilities for illustration of market behavior by use of simulation techniques,
– Procurement market
– Sales market
– Refuse disposal and recycling market

This training factory system can be built modularly into different-market models of factories.

*Definition »factory-market model«*

Market model of a factory as the complex representation of the features, the regularities and the typical processes in procurement, production, distribution and of disposal as well as of the typical competition, sales, procurement and disposal and/or recycling market relationships of one selected enterprise type by adaptation of the training factory. The enterprise standardization into engineer-to-order manufacturer, make-to-order manufacturer or make-to-stock manufacturer occurs e.g. by the distinguishing features production type, kind of order, structure of finished products, product spectrum, customers influences, ....

Fig. 1: Definition of training factory

practical training courses. This causes to a limited ability to acquire an active problem solubility and leads after /1/ to the following consequences:

– One does not examine the causes of problems but describes those and reduces it to their symptoms
– Knowledge and field competence is isolated from action competence, that is the ability of active usage of knowledge. This leads to adaptation problems while using the knowledge when new challenges happen.

At the same time training was characterized by function specialized knowledge transfer in analogy to the enterprise division. In future however engineers wont be found fewer and fewer in the classical functional division of the fields development, construction and production but more in self-scheduling enterprise structures with customer proximity integrating diverse functions as procurement, marketing and technical management. This is based on the varied conditions under which an enterprise is operating at the market which require a flexible adaptation of the enterprise structures and processes. Tendency goes away from the Taylorism with classical demarcation of functions forward to the formation of decentralized enterprise structures. This leads to varied job definitions of the engineer.

In addition to technical know-how,

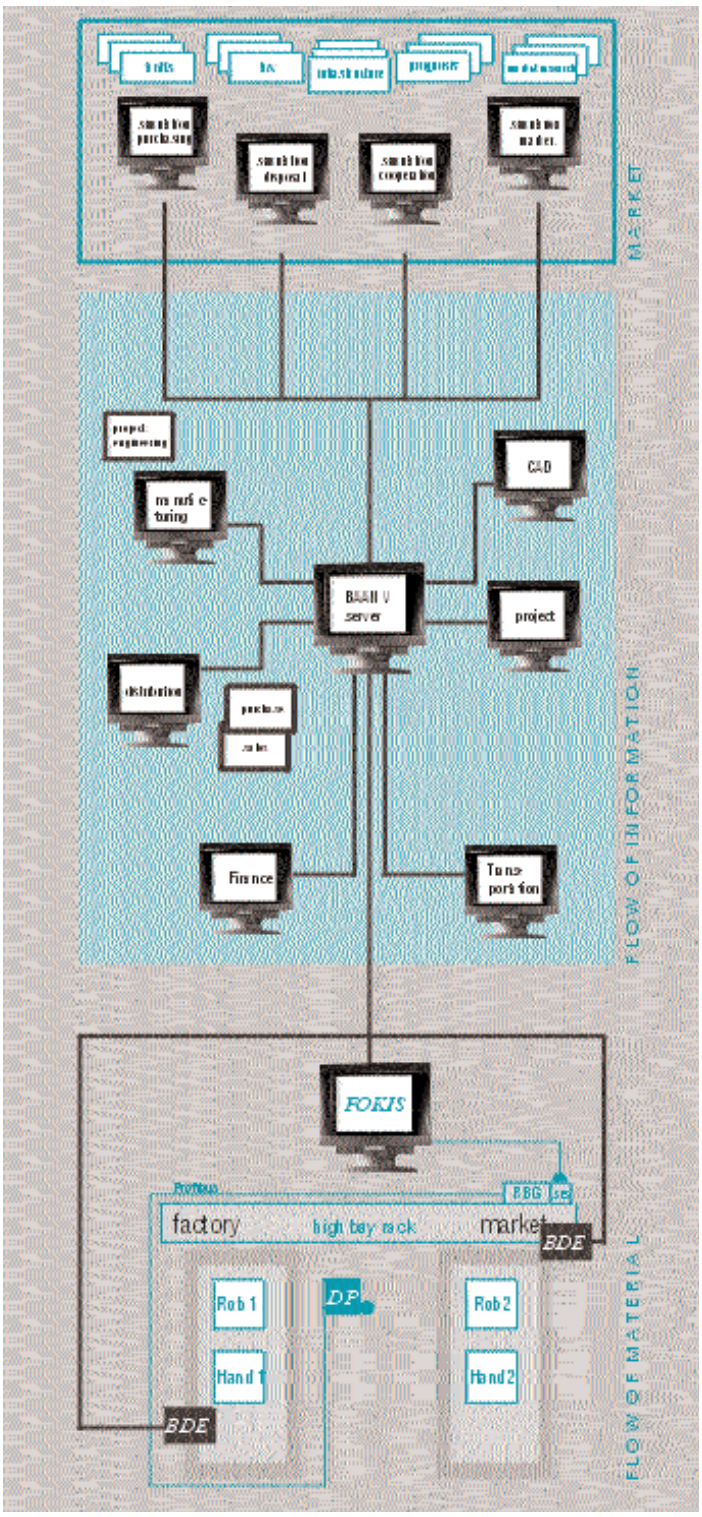


Fig. 2: Survey: system components of the training factory at the 1st configuration level

Factory Organization within the framework of the investigation field Basics of Factory Operation is the analysis of further education requirements and the adaptation of teaching methods in the field of engineering to current conditions of the economy.
The training factory Magdeburg with its system components (figure 2) offers outstanding conditions for further training as:

- Practical introduction to the organization, planning and control of production sequences
- Integrated production concepts - the way of the order up to the product
- Hardware and software tendencies
- Integration of automation components into production sequences
- Map exercises.

In this case, it is not a question to present single solutions but to consider enterprise processes as a whole. Interface problems are particularly emphasis of the investigations therefore.
A full description of the outfits, concepts, current and planned investigation projects as well as the further educational provision you find under http://iaf2.mb.uni-magdeburg.de/Lernfabrik in the Internet.

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financial sense, team and innovation abilities are also required. The engineer must learn to estimate the range of its decisions, to think and act for the welfare of the whole enterprise.
In this case, the professional primary training can be taken only as basis for continuous learning during the entire professional life.

One task of the main department

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Ms Manuela Kanneberg

# Learning from one another - European initiative on in-plant environmental protection

The Learning Enterprise

Project Report Factory Ecology, Quality Management


## Summary

In line with the realization that »thinking influences acting«, it is necessary to combine economic strategies with environmentally oriented ones. The idea to acquire knowledge through the purposive qualification of employees within the framework of the project »Integrated environmental protection« satisfies this requirement. The European Community initiative ADAPT constitutes an excellent basis in this connection. The project, which is promoted by the EU Community initiative of the European Social Fund (EFS) as well as by the Land Saxony-Anhalt, is designed to provide participants from small and medium-sized enterprises with special knowledge and practical guidance on the basis of legal requirements on the subject of »In-plant environmental protection as an interactive component of corporate policy«. By providing participants with information and training as well as motivating them, participants are to change their role and, instead of just being passively affected by the things happening around them, become active, qualified, personally competent persons. A lot has happened in the past few years in the field of environmental standards as well as environmental policy. To the extent that industry is stepping up its own efforts within the world-wide initiatives in the field of »sustainable development«, it will be better able to meet the expectations of a sensibilzsed public which has recognized that the quality of life is inseparably connected with environmental quality.


## Initial Situation

The use of new production methods and means of production, changed organizational forms and continually changing laws put additional and changing demands on the knowledge of the employees in every company. With the exponentially increasing states of knowledge, the availability of knowledge has become an important production factor and a decisive prerequisite for the existence of many companies.
With respect to the safeguarding of the future of an enterprise and to the improvement of its competitiveness, apart from the quality and safety of processes, the question of an environmentally compatible realization of the entire entrepreneurial activity is continually gaining in importance. In particular small and medium-sized enterprises must face this challenge and develop the competence for taking in their own responsibility appropriate environmental protection measures in their companies. By qualifying them in technical and methodological respect, companies will be better able

- to tackle actively in particular the questions of in-plant environmental protection in their enterprises and to independently develop initiatives in this respect,
- to distinctly improve their environmental protection schemes,
- to initiate a process of continual improvement of environmental protection measures,
- to utilize saving potentials, e.g. by adopting an appropriate energy management or a waste management policy geared at the reutilization and avoidance of waste materials, as well as
- to reduce ecological risks.

## Realization

The qualification concept has been developed in close cooperation with the industrial partners from the region of Saxony-Anhalt, taking into account the numerous suggestions put forward during the preparatory phase by the transnational partners from Austria, Spain and Germany. The enterprises use the qualification and continued education concept as a tool for an innovative personnel and organizational development. The main emphasis is placed on an increasing process orientation which systematically takes into account the changes taking place in organizations and activities and involves the learning employees in the identification of possibilities for problem solution.

It is important in this connection that interdisciplinary qualification is promoted by the qualification concept, because, apart from scientifico-technological, ecological and economic aspects, legal and organizational aspects play a role, too.

Already the kick-off events organized in the partner enterprises have sensibilised the employees and executive personnel in regard of the company-specific in-plant environmental protection efforts as well as the corporate environmental policies.

An evaluation of a poll conducted for the purpose of determining the level of qualification and qualification requirements of enterprises has shown that employees are highly interested in seeing how the legal environmental regulations work in practice, figure 1 shows the training requirements of the enterprises.

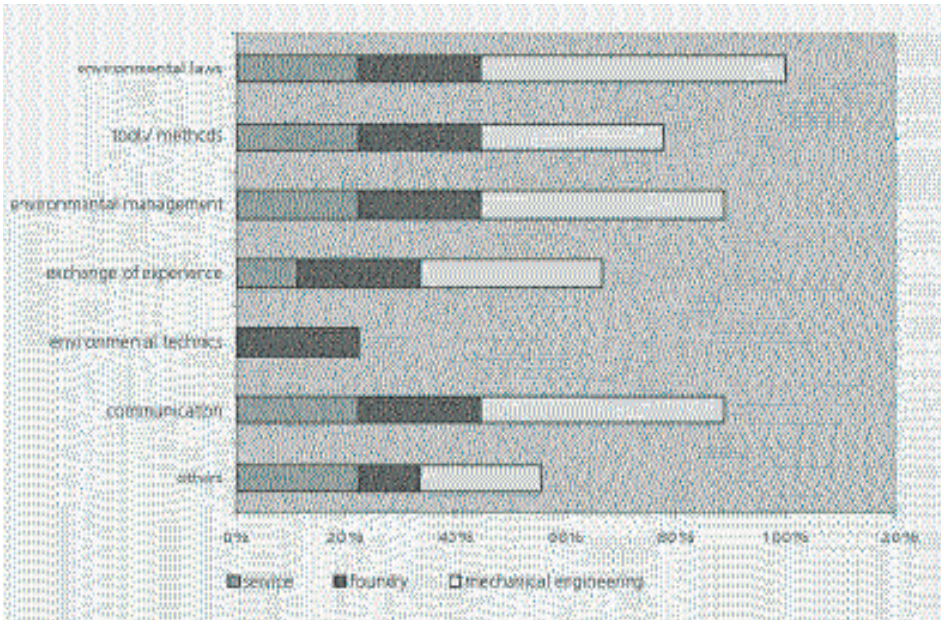


Fig. 1: Training requirements of the enterprises

The qualification program, in addition, addresses the following primary topics:

- Methodical introduction of environmental management systems
- Tools and methods of in-plant environmental protection
- Communication and presentation techniques for in-house training courses and workshops.

## Transnational Project Work

It is the aim and, at the same time, aspiration of ADAPT to promote a transnational co-operation and transfer of innovative approaches as well as transnational exchange of experience. The European partners came together for several days in a transnational meeting in Graz/Austria to report on the start of the ADAPT project in their respective regions in spring. During this working meeting, the partners used the opportunity for presenting their national projects. Of great importance in this connection was the demonstration of the use potentials existing for the other projects such as the Internet platform enabling small and medium-sized enterprises to introduce their companies and to advertise in the European market. Here, the partners also had the idea that in addition to the exchange of experience, it would be worthwhile to transform the individual innovative project contents into a joint product. The partners will develop a multimedia product for information and for implementing cleaner-production strategies as well as for establishing and applying environmental management and environmental characteristic number systems in enterprises, fig. 2 shows the homepage of the internet presentation. The presentation of topics in the Internet via the World Wide Web will make it possible for all those interested to access and utilize structured information on in-plant environmental protection. Efforts will be made to supplement and extend conventional training methods in combination with new media.

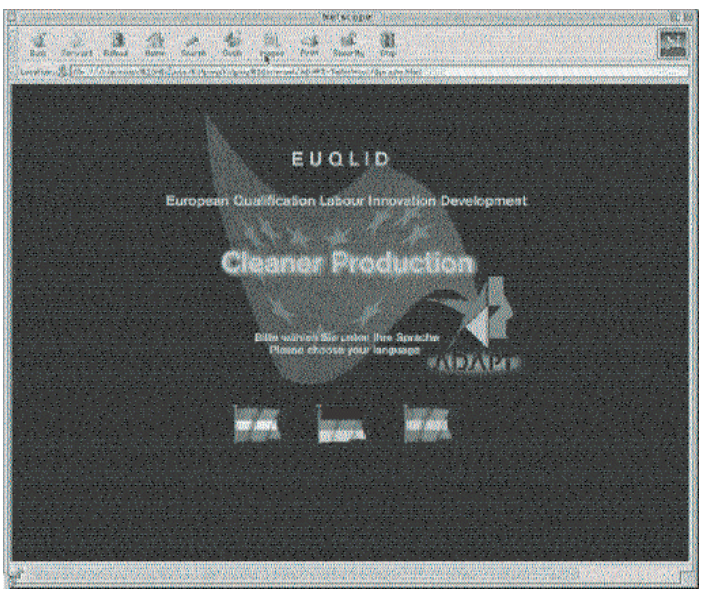


Fig. 2: The homepage of the internet presentation

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## Highlights 1998

### Guest of the Fraunhofer IFF's

The 13th of March 1998 Prof. Dr. Riesenhuber visited the Fraunhofer IFF. During his term as minister in the BMFT (Federal Ministry of Research and Technology) they came to a decision to locate a Fraunhofer-Institution in Magdeburg and to give it the status of an institute in 1993.

The first of April 1998 we were able to welcome the former foreign minister Dr. Klaus Kinkel. The third of April 1998 Wolfgang Thierse, vice SPD-party leader, has been a guest in our building.

The Virtual Reality Model of the Europa-Haus-Fabric, organizational solutions for the Europa-Haus-Fabric as well as the work of the Spin-offs of the Fraunhofer IFF »Institute for Manufacturing Strategies GmbH (IMS)« and »LOGIS GmbH« and »Rapid Manufacturing Center« in Magdeburg, which supports small- and middle-sized firms at the use of new technologies, were the focus of interest of guests at the Fraunhofer IFF's.

### Opening of the new institute building

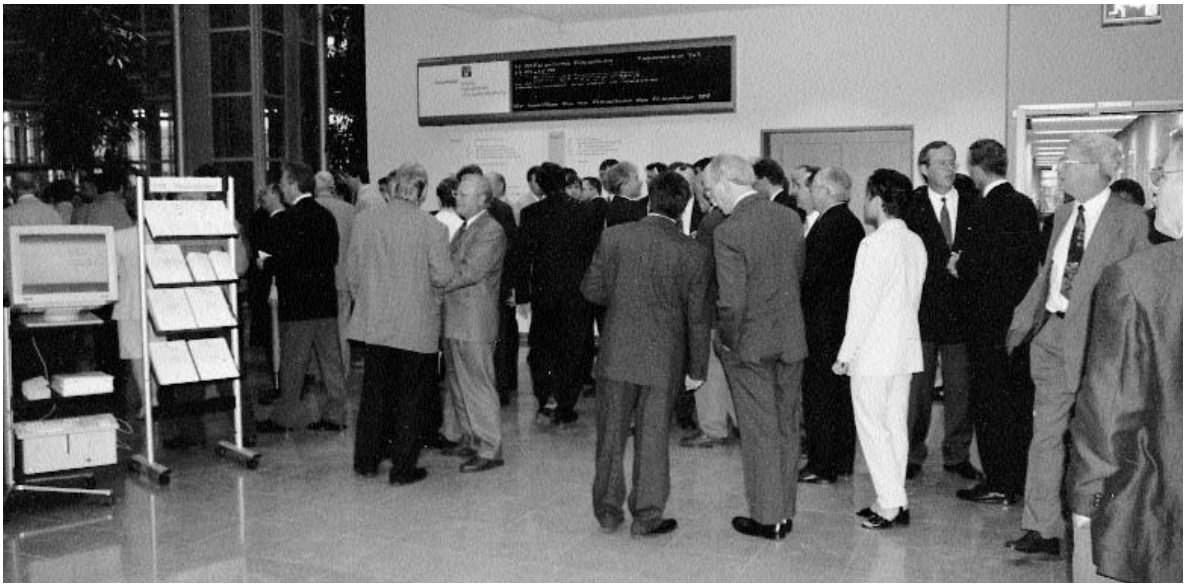
The highlight of the year 1998 was the opening of the new institute building on the 24th of June 1998.
On the 19th of March 1998 the new building with office space and »Technikum« at the Sandtorstrasse 22 has been handed over to the Fraunhofer-Institute as planned. The construction of the new institute took 2 years, from April 1996 until March 1998. The institute has now available a space of 5,000 m² and gives 200 employee's a working place.

The institute building was build after specific guidelines. These guidelines are equivalent to the future expected developments at the area of the factory fabric and of the central rating decentral and efficient total system solutions. The construction concept included that the theoretical and practical part was closely interlocked as well as technologies and know-how in labors and »Technikum« got adjusted and extended quickly and flexible. To the full equipment of the institute belong conference rooms with flexible and efficient distribution of the rooms and presentation equipment. The library of the institute is open to employees and other interested people.

The building was designed and guided from the HENN Architekten Ingenieure GmbH. The property was provided through free heir lease from the land Saxony-Anhalt. The building costs ran up to 50 Mio. as planned. We like to thank the land Saxony-Anhalt, the Fraunhofer-Gesellschaft and the Otto-von-Guericke-University for their support at the planning and realization of the new building.

Prof. Dr. Riesenhuber visited the Fraunhofer IFF


Symbolic key presentation



Opening of the new institute building

For the following themes please refer to the corresponding German articles.



## Scientific publication