33

Benchmarking in tool manufacturing of the automotive industry

W. Eversheim, M. Baumann, A. Haufe, M. Hellermann, and O. Moron
Laboratory of Machine Tools and Production Engineering
Steinbachstr. 53 B, 52056 Aachen, Germany
Telephone: ++49 / 241 / 80 74 05, Telefax: ++49 / 241 / 8 88 82 93

Abstract

Strategic planning in today's complex and dynamic environment requires more and better information to prepare and enable fast and right decisions. Strategic planning in tool manufacturing of the automotive industry, which is described in this paper, is characterized by similar difficulties. By the application of benchmarking techniques, decision support could be improved significantly. A clear structure and the limitation of the amount of indicative figures increased user friendliness of the benchmarking system and hence its acceptance in application. The described project resulted in a computer-aided benchmarking system allowing company-in- and external comparison. Future developments will emphasize benchmarking systems for information purposes as well as knowledge databases to make promising strategies accessible. Increasing computer power offers the chance to integrate both approaches in easily applicable but powerful systems.

Keywords

Automotive industry, benchmarking, decision support, EDP-system, strategic planning, tool manufacturing

1 INTRODUCTION

Enterprises of today are in competition with many rivals all over the world in dynamic, intransparent markets. Competitors often act with different environmental conditions, e.g. concerning wage levels or taxes. New enterprises dealing with better conditions enter the global business and fight for market shares.

Efficient strategic planning becomes the decisive key factor in this situation. Products and processes of the enterprise have to be analyzed and optimized, which is a short-term job for the present situation but also a future task to assure long-term competitiveness. Strategic planning includes a number of single decisions to be made. The range of products and services has to be determined, regarding different markets with various customers. Internally, the processes to produce desired products have to be designed in order to deliver quickly, in high quality and for a reasonable price. For single processes, the in- or external placing has to

G. Doumeingts et al. (eds.), *Modelling Techniques for Business Process Re-engineering and Benchmarking*

be analyzed and make-or-buy decisions, influencing the penetration depth, have to be made. These are only some examples. For long-term business success, the enterprise has to concentrate on its potentials, ending in promising new products or processes.
However, strategic planning is based on structured and well-founded information, which is frequently not available. The information gap between supply and demand complicates strategic planning tasks (Figure 1).

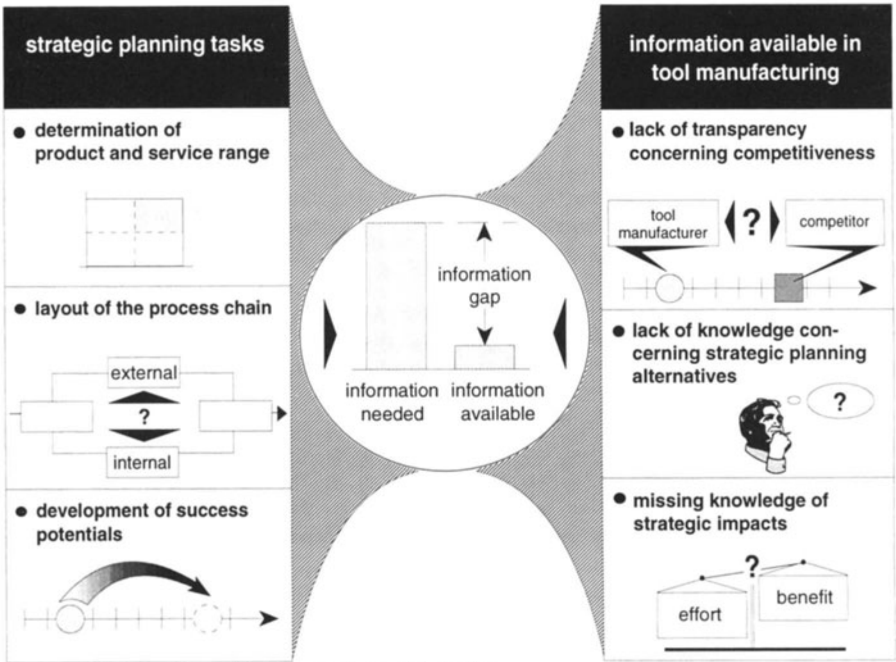

Figure 1 Information deficits in tool manufacturing.

The information gap in tool manufacturing is caused by many individual problems. A lack of transparency concerning competitiveness can be observed. The tool manufacturer does not know about the abilities and hence the position of his competitor, which makes an assessment of the own position difficult. Additionally, other market information is not easy to acquire, information explosion cannot be equated with structured and useful input for strategic planning. Strategic planning alternatives are often not known, which restricts the freedom of choice or the opportunity to find the better solution. Nevertheless, it is also important to know about the impacts of strategic measures. An estimation of expenses and expected benefits must be supported and will serve as input information for every strategic decision. This knowledge is often not available, especially if long-term impacts are considered (Figure 1).

It was the objective of the described project to analyze the current shortcomings in tool manufacturing mentioned above and to find solutions in order to improve the situation. Benchmarking techniques are decisive tools to cope with the information gap. The project was conducted by the Laboratory of Machine Tools and Production Engineering (WZL) of Aachen University of Technology in Germany, in cooperation with three car manufacturers respectively their tool manufacture departments and two tool manufacturers that work as suppliers for automotive industry. Research, and later application, concentrated on sheet metal working for steel; special tool manufacturing and repair- or maintenance-processes were analyzed in detail.

2 CLASSIFICATION OF THE BENCHMARKING ACTIVITY AND PROCEDURE

Benchmarking can be subdivided into four different types (Camp 1989). Internal benchmarking implies evaluation within the company -competitors are not regarded. The consideration of competitors is the main target of so-called competition-oriented benchmarking, where benchmarking partners which compete on the market come together (Spendolini 1992). They act within the same industrial branch and therefore an estimation of a realistic market position is enabled, which cannot be fulfilled by internal benchmarking. Functional and generic benchmarking compare similar processes in different industries. Interesting and revolutionary ideas result from these two types of benchmarking, synergy effects are made accessible (Balm 1992). Competion-oriented benchmarking stimulates improvement by providing knowledge about the best in class and its practices. Due to the consortium of the described project the technique of competition-oriented benchmarking was applied.
The objective to design and realize a branch-specific benchmarking system was reached by the procedure presented in figure 2. First, company goals were determined. These goals allowed the buildup of an integrated goal system, including customer goals and shareholder goals. The next step contains the definition of single indicative figures that are linked to these goals. Those single indicative figures were accumulated in different ways, which distinguishes in three different points of view.

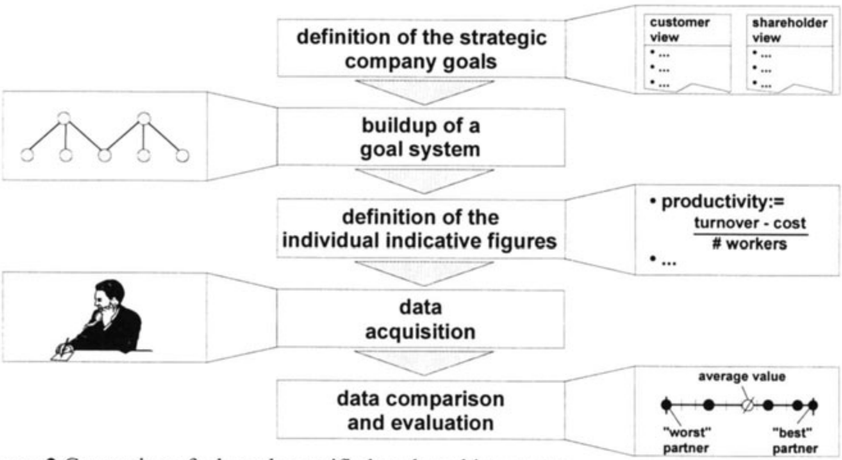

Figure 2 Generation of a branch-specific benchmarking system.

The product-oriented view allows to evaluate branch-specific product types, the process-oriented view allows to evaluate applied processes. Last, but not least, the resources are identified (resource-oriented view). These views are integrated into a single benchmarking system.

3 PROCEEDING WITHIN THE BENCHMARKING PROJECT

Definition of indicative figures

The definition of indicative figures is fundamental to every benchmarking system. Based on the entire enterprise objectives the subgoals need to be determined within a first step. These subgoals have to be described accurately in order to express their fulfilment by means of indicative figures.

The procedure becomes more transparent through an example. Customer benefits, which should be achieved by the enterprise, can be described by subgoals like the delivery capability, low price, change flexibility, service etc. Each of these subgoals needs to be defined accurately. E.g. the delivery capability represents the fulfilment of technical and capacity-conditions for order placing. The indicative figure for the delivery capability is consequently generated from the ratio of the number of offers divided by the number of requests. Other examples can be obtained from figure 3.

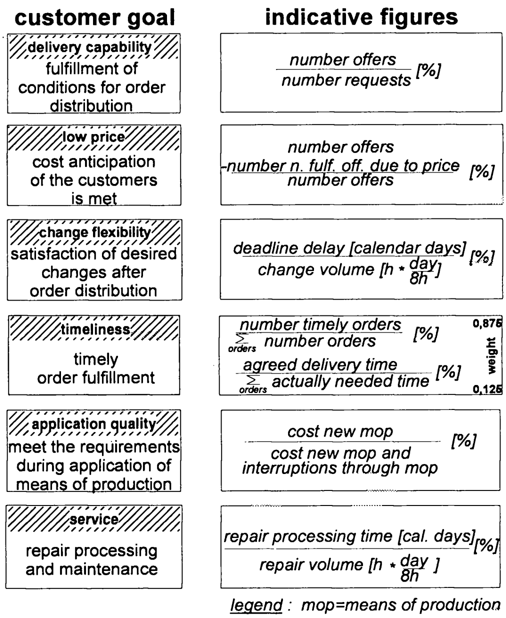

Figure 3 Examples: Indicative figures.

In a number of cases the first steps to derive indicative figures generate a large number of different figures, which are inconveniently to handle. The major aspects of criticism include the fact that too many indicative figures exist, that they are defined too vaguely, and that the data acquisition effort is too high. The benchmarking systems were too intransparent and complex to be used regularly and successfully.

As a result of an analysis of this project, the number of indicative figures needed to be reduced, their definitions had to be revised and improved and an efficient EDP-support was desired. These partial targets were considered to determine the next project steps in order to increase the practical relevance and comparability of the indicative figures and to reduce data aquisition efforts. Additionally, a time comparison should be made possible, which requires an ongoing data acquisition process within benchmarking studies.

Rectification of the benchmarking system

The analysis of single factors and indicative figures in the benchmarking system was successfully achieved with a significant reduction of data types. Within the project the number of indicative figures was reduced from 173 to 63. The transparency of the system was increased and an important partial target could be achieved.

The next step to support decision-making in tool manufacturing more efficiently by benchmarking was the conception of EDP-support for a well-structured and well-defined benchmarking system.

Conception of a computer-aided benchmarking tool

One target was to make data acquisition easier for the benchmarking system. This is the first aspect to be covered by the computer system. It embraces user-friendly input routines and interfaces, especially for routine-data. Methods for an automatic data derivation from existing information bases are to be analyzed in the future.

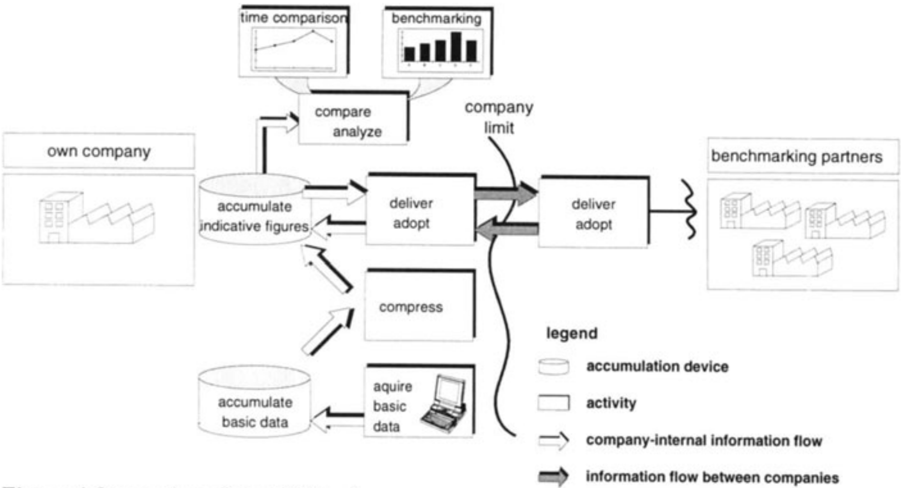

Figure 4 Conception of the EDP-tool.

Output functions of the computer-aided benchmarking system also need to be comfortable and quickly understandable. Methods for achieving graphical representation of the indicative figures were evaluated.

Finally, the underlying definitions of indicative figures should be accessible on the computer-aided benchmarking system, which leads to a data dictionary.

The demands were integrated into the conception of the EDP-tool for benchmarking, where necessary functions, data bases, and information flow are made accessible (figure 4).

The architecture of the EDP-tool also shows possibilities to link the company-internal information flow with company-external data sources. Accordingly, security problems need to be discussed in order to allow competition-oriented benchmarking and data exchange between competing companies. An additional aspect of benchmarking, a kind of "intermediate" benchmarking between in- and external partners, can be shown here:

Larger enterprises with a number of plants can establish EDP-support for the collection and evaluation of basic data in their individual plants and the accumulation of this data step by step for plants, divisions and the whole enterprise. On the top accumulation level, giving the overview of the entire enterprise, the interface to external benchmarking is placed.

The described architecture was realized through a PC-based EDP-tool. The integration into the MICROSOFT-WINDOWS environment assures easy use of the EDP-tool within companies. Using this implementation base, the companies did not need to acquire new software products and the users were already experienced in practice with the user interfaces (figure 5).

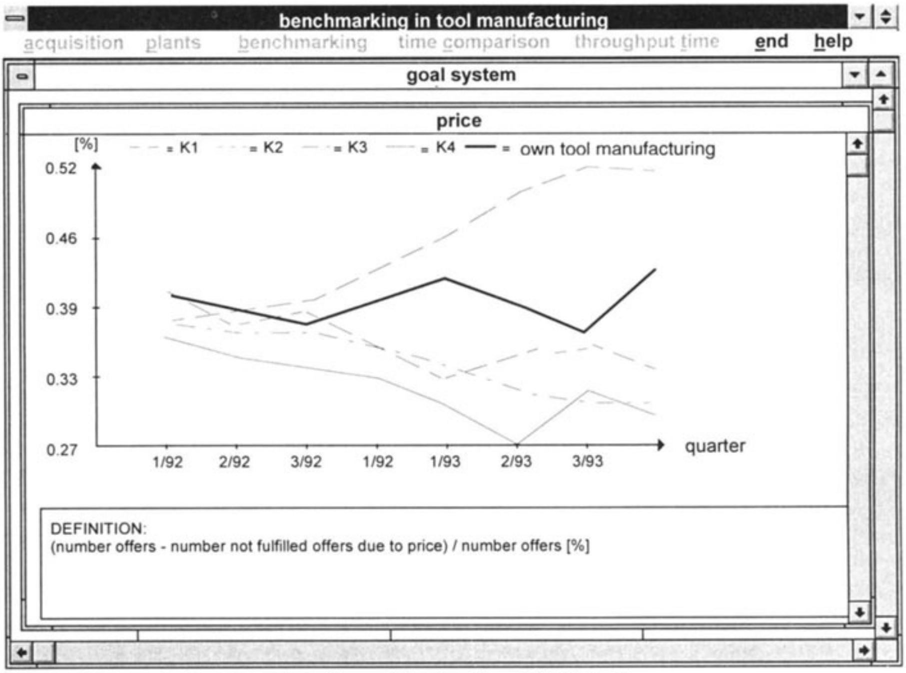

Figure 5 Example for a user interface of the developed EDP-tool.

4 EXEMPLARY RESULTS ON PROCESS ANALYSIS

As a basis for the comparison of process chains, the domain processes of tool manufacturing were analyzed and indicative figures for the description of different strategies were set up. The process chain on the domain process level was divided into nine elements:

Within methods-planning, the following stages of metal-sheet-processing are defined. The tools can be designed based on this manufacturing concept. Process engineering prepares physical tool manufacturing and generates the information necessary for production. Due to the importance of an integrated CAx-concept, NC-programming can be regarded as separate domain process for production preparation. For components with complex geometries which are not processed on NC-machines, pattern need to be produced. Then, the processes of physical manufacture can be started, containing metal-cutting, finishing&assembly, and try-out (figure 6).

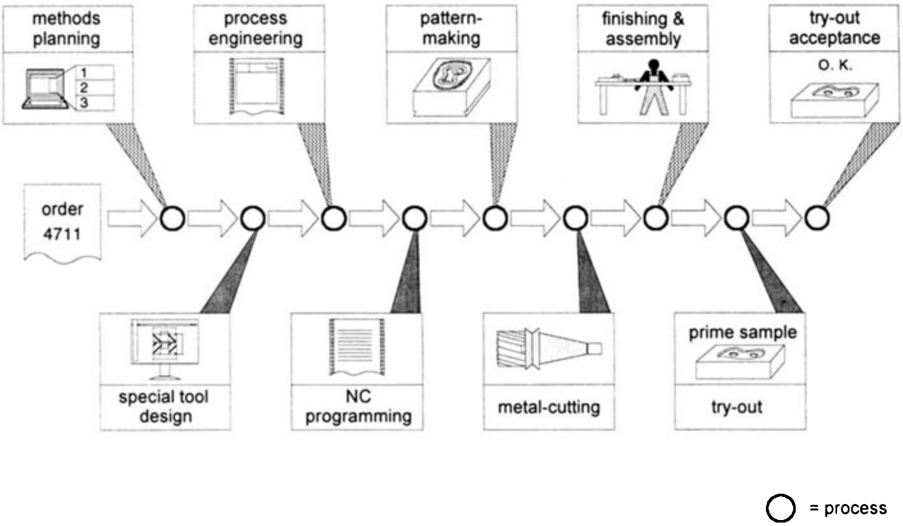

Figure 6 Domain processes in tool manufacturing.

For evaluating different process strategies, the costs for each single process were determined. The comparison of the indicative figures showed unexpected differences in the money spent for each process. For methods-planning and tool design, a strong variation was caused by different manufacturing depths. Further, large differences in the CAx-strategy became obvious. Some companies strengthened their CAx-chain and almost eliminated the process of pattern making, whereas other companies concentrated on pattern-based manufacturing. In consequence, the relation of cost caused by metal-cutting and finishing&assembly showed strong differences. The focus was either laid on metal-cutting or on finishing&assemby.

Due to these results, the question, which strategy leads to a maximum productivity, had to be answered. The comparison of productivity as well as discussions and plant visits showed that higher expenditures in metal-cutting do not only lead to savings in post-process work, but that they also reduce overall cost. Especially companies using high-speed-cutting machines were able to reduce finishing cost to a higher degree than the machine costs increased.

A further analysis of the impacts of different strategies basing on comparison of indicative figures was not possible. Higher productivity of a company could not be lead back just to a few strategic-design-alternatives. Therefore, multivariate statistical methods were used for more detailed analysis. With a combination of different methods, the impact of all design-alternatives on goal achievement was examined. As an important result of the analysis, the influence of the time usage for each process on overall productivity could be specified. The expected result showed lower productivity for rising time usage in most processes. The only exceptions were NC-programming and pattern-making. The mulitivariate regression pointed out that higher working-time input in these processes will lead to overall savings. Obviously, the additional cost spent will not exceed the savings in following processes (figure 7).

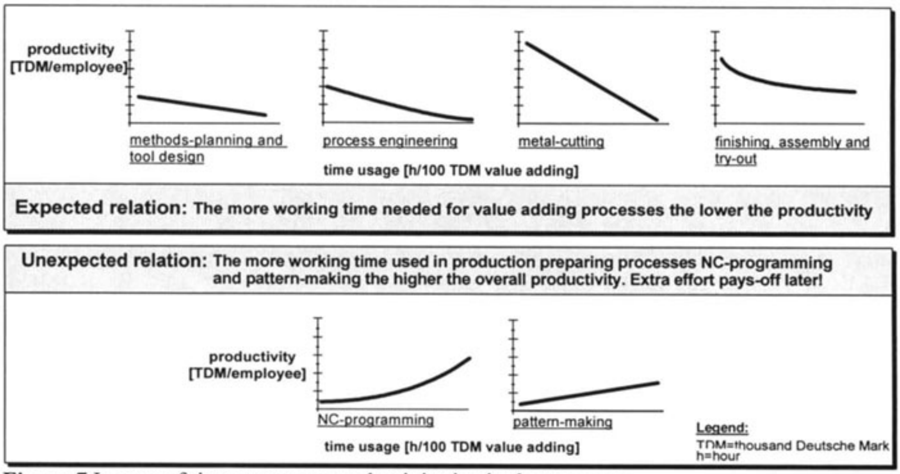

Figure 7 Impact of time-usage on productivity in single processes.

5 SUMMARY AND OUTLOOK ON FURTHER ACTIVITIES

The described benchmarking project is characterized by the participation of direct competitors as the most important aspect. These companies have succeeded in reaching the necessary frankness for competition-oriented benchmarking. The barrier caused by the fear to lose own advantages was eliminated and the positive aspects of learning from others and improving as a team became accepted.

Because of this frankness it was possible to design a common benchmarking system and put it into use. Various comparisons lead to productive discussions and plant visits. Further, the acceptance of the benchmarking results by the internal staff could be accomplished. The development of a powerful benchmarking EDP-tool enables a further benchmarking by the companies without external consultancy. The indicative figures already show positive effects from the positioning in competition and analysis of strengths and weaknesses.

From the research-oriented point of view, the project pointed out the possibilities and boundaries of current benchmarking approaches. The difficult evaluation of the most successful strategies have shown the need for a further analysis of strategies effects on goal achievement, a simulation of different scenarios, and a support for decision making (figure 8).

In result, research activities at WZL deal with the development of a benchmarking system that can easily be configured for different branches and benchmarking objects. This system supports the implementation of a model containing important goals and design-alternatives as well as the corresponding indicative figures.

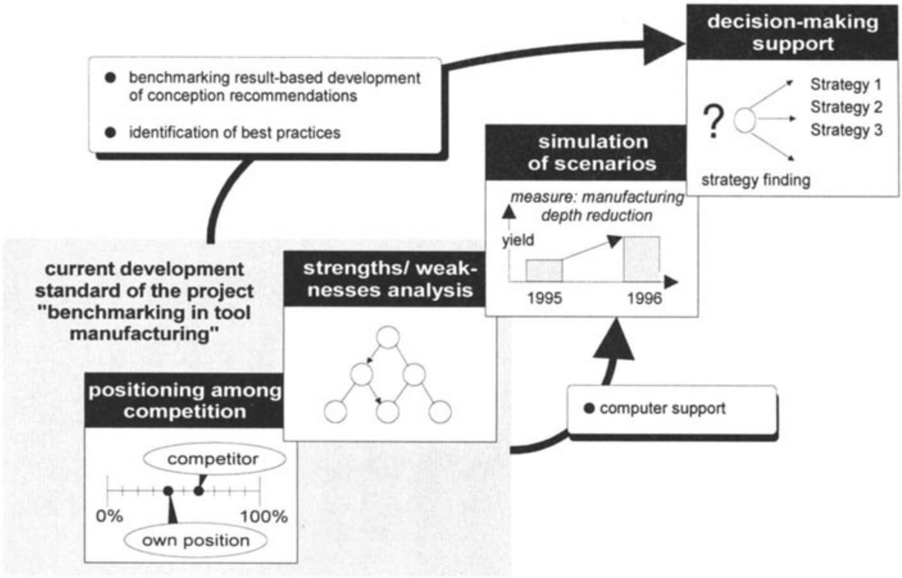

Figure 8 Development stages of benchmarking systems.

The system itself than can generate the data acquisition forms. Benchmarking studies and time comparisons are supported and enable the identification of strengths and weaknesses. Automatically working analysis algorithms and parallel expert knowledge acquisition will be integrated into one knowledge database. On the basis of identified weaknesses, the knowledge database supports a simulation of design alternatives and the search for adequate measures (figure 9).

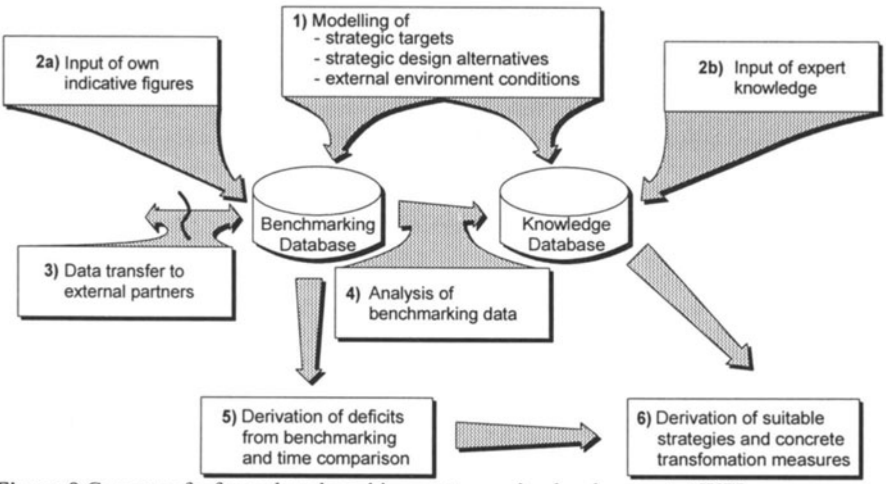

Figure 9 Concept of a future benchmarking system under development at WZL.

Due to its concept, this benchmarking-system is on one hand an important executive-information-system, on the other hand it contains intelligent and learning decision-support algorithms.
EDP-support is not limited to the "user-related" functions described above. Research activities at WZL also concentrate on ways of data transmission which enable data exchange between companies and hence permanent competition-oriented benchmarking. The architecture of such a system is presented in figure 10. The benchmarking system kernel itself is located on a central server, which also contains the knowledge database. Modern communication techniques, e.g. Integrated Services Digital Network (ISDN), allow easy linkage of company-internal networks with this central server. Enterprises which participate in the benchmarking-system send their data to the central server, where it is processed and evaluated. Results are presented in tables, graphics or decision proposals which can be provided on demand. Such a benchmarking system is especially flexible concerning the integration of new partners, data exchange is very easy and companies with a high geographic distance can communicate with each other without difficulties.

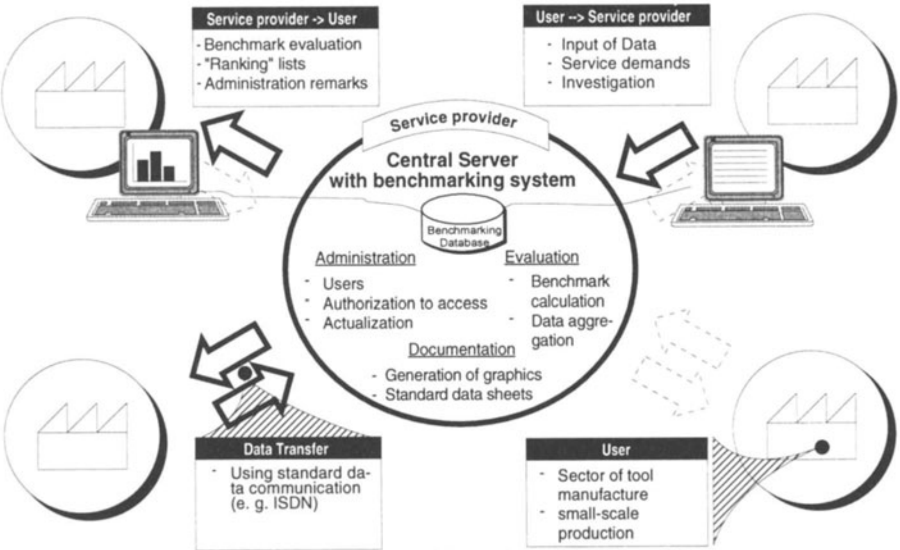

Figure 10 Network architecture for a competition-oriented benchmarking system.

6 REFERENCES

Balm, G. J. (1992) *Benchmarking: A Practitioner's Guide for Becoming and Staying Best of the Best*. QPMA Press, Schaumberg (Illinois).
Camp, R. C. (1989) *Benchmarking: The Search for Industry Best Practices that Lead To Superior Performance*. ASQC Quality Press, Milwaukee (Wisconsin).
Spendolini, M. J. (1992) *The Benchmarking Book.* AMACOM, New York.

7 BIOGRAPHY

Prof. Dr.-Ing. Dr. h. c. Dipl.-Wirt. Ing. Walter Eversheim, born in 1937; study of mechanical engineering and industrial engineering at Aachen University of Technology; director of Laboratory for Machine Tools and Production Engineering (WZL) and holder of the Chair for Production Engineering; director of Fraunhofer-Institute for Production Technology; since April 1989 director of the Institute for Technology-Management (ITEM) at the University of Saint Gall (Switzerland); since August 1990 director of Research-Institute for Rationalization, Aachen University of Technology

Dr.-Ing. Matthias Baumann, born in 1962; study of mechanical engineering at Aachen University of Technology; since 1988 scientist at the Chair of Production Engineering; since 1994 Chief Engineer at WZL, Chair of Production Engineering

Dipl.-Ing. Andreas Haufe, born in 1966; study of mechanical engineering at Aachen University of Technology; since 1995 scientist at WZL, Chair of Production Engineering

Dipl.-Ing. Michael Hellermann, born in 1969; study of mechanical engineering at Aachen University of Technology; since 1996 scientist at WZL, Chair of Production Engineering

Dipl.-Ing. Oliver Moron, born in 1968; study of mechanical engineering at Aachen University of Technology; since 1995 scientist at WZL, Chair of Production Engineering