ABSTRACT

The public demands a close cooperation between universities and companies in order to improve the quality of students’ education and to speed up the transformation process from theoretical ideas to products. This paper describes a successful cooperation between a university research project and a company. We show that both partners of the cooperation have numerous benefits. The following case study is the point of reference for an analysis of an existing cooperation. A data warehouse research project for higher education at the University of Bamberg (CEUS HB) exemplifies the university’s part of this cooperation. The business intelligence company Microstrategy is the other partner outlined in the paper.
1. INTRODUCTION

For most companies, cooperation with a university seems to be unprofitable. However, the views are changing slowly and many companies recognize the benefits they can gain from such a cooperation. Increasing research expenses and employee acquisition problems force especially IT companies to establish a close cooperation with university partners. From a university point of view such a cooperation is not only financially rewarding, but also the quality of education can be improved.

For this reason we exemplarily demonstrate a successful cooperation between a company and a business information systems chair of the University of Bamberg in the field of data warehousing.

During the last decade, data warehouse systems have become an essential component of modern decision support systems (ANAHORY and MURRAY, 1997). The data warehouse concept covers different aspects like architecture, physical optimization, tool support and modeling approaches. Both the industry and research community have paid a lot of attention to the project. Recently also public administration got involved in data warehousing and wants to benefit from this new technology. For this reason the Bavarian Ministry of Science, Research and Art funded the CEUS\textsuperscript{HB} project (“Computerbasiertes Entscheidungsunterstützungssystem für die Hochschulen in Bayern” / computerized decision support system for Bavarian universities) to support the decision making process by a data warehouse system for all Bavarian universities (BOEHNLEIN and ULBRICH-VOM ENDE, 1999; BOEHNLEIN and ULBRICH-VOM ENDE, 2000; SINZ et al. 2001). Members of this project are the Bavarian state institute for higher education research under the direction of Prof. Dr. H.-U. Kuepper and the chair of information systems, esp. systems engineering and database application under the direction of Prof. Dr. E. J. Sinz. This cooperation with a well-known business intelligence vendor was intended. Thus MicroStrategy became cooperation partner because their software fully met our requirements. Furthermore, they offered a superior university program.

In this paper, we present an overview of this cooperation and mention the benefits for both partners. The following section briefly introduces MicroStrategy as one of the leading vendors of relational online analytical processing (ROLAP) solutions (MICROSTRATEGY, 1995). We mainly focus on the company’s university program. In Section 3 we first outline the development of a data warehouse for Bavarian universities in the course of the MicroStrategy university program. Secondly we illustrate the use of MicroStrategy’s software products in order to implement the distributed architecture of CEUS\textsuperscript{HB}. The section ends with a comparison of the benefits for both cooperation partners. Finally this paper concludes with a summary and an outlook.

2. MICROSTRATEGY’S UNIVERSITY PROGRAM

In this section, we introduce MicroStrategy as a vendor of data warehousing products and explain its university program. First, we outline the company’s profile and describe MicroStrategy’s business intelligence software platform. Afterwards, the benefits of the university program in Europe will be shown.

2.1 MicroStrategy’s company profile

MicroStrategy was founded as a consulting company in 1989 by Michael J. Saylor. The company specialized in building customized decision support applications in the data warehousing market. By now MicroStrategy provides a business intelligence platform (MicroStrategy 7.1\textsuperscript{TM}) comprising solutions for query and reporting for advanced analytical needs (MICROSTRATEGY, 1999).

The history of the main elements forming the data warehousing product suite is as follows. In 1993 the MicroStrategy Agent\textsuperscript{TM} was introduced which provides a graphical window-based end user application enabling a sophisticated query and reporting solution in a relational data warehouse environment. It
was extended according to a comprehensive client/server architecture capable of multi-tier support through the MicroStrategy Intelligence Server™. With MicroStrategy Web™ in 1996 the company enabled end users to access a data warehouse via World Wide Web. A web-enabled data warehouse allows a cost-effective application based on well-known internet standards like hypertext markup language (HTML) or extensible markup language (XML) (KIMBALL and MERZ, 2000). In 1998 MicroStrategy presented the Narrowcast Server™ which extends the business intelligence area by proactively delivering personalized reports and alerts via email, wireless devices like phones, pagers, and PDAs and telephone networks based on a “publish and subscribe”-paradigm. By now MicroStrategy seems to be a strong player in the relational online analytical processing (ROLAP) market.

To get a general idea about the company some actual figures are mentioned omitting profit measures. At the beginning of the year 2001 MicroStrategy had over 1000 employees and 46 offices worldwide. There is a direct presence in the U.S., Canada, U.K., Germany, Switzerland, Austria, Italy, the Netherlands, France, Spain, Argentina and Brazil. Additionally, a network of distributors and OEM Strategic Alliances ensure their presence in 25 other countries. The customer base of MicroStrategy comprises over 1000 customers and over 300 technology and integration partners.

2.2 University program in Europe

Microstrategy’s university program started in 1999 in Europe. Mainly two people have decisively contributed to the success of this program. These are PhD. A. Kurz (Production Consultant) and I. Moritz (Partner Manager). To get a better understanding of all aspects of the program a short overview about key elements of the program is given. In section 3.3, we show how these elements can be used to improve the quality of education and research at universities. The main elements of the program comprise:

- **Training on the products**: Members of the university program have the opportunity to take part in different courses. To avoid handling problems some of these courses are prerequisites for obtaining the products within the university program.

- **Product suite at no charge**: Universities and similar institutions can get the whole product suite for educational or research purposes for free. Only a small fee for technical support and material will be charged.

- **Certification**: Members can get involved in the Microstrategy certification program. The official title for a certified Microstrategy partner is Certified Decision Support Engineer (CDSE).

- **MicroStrategy’s Summer School**: In 1999 and 2000 about 60 students from different universities in Austria, Switzerland and Germany had the opportunity to participate in the MicroStrategy Summer School. This one week education course covered not only the training on the products but also theoretical aspects of business intelligence, decision support and e-business. During this week the students had free board and lodging in a monastery (Pernegg) in Austria.

- **Research cooperation**: Cooperation for diploma and doctoral thesis is possible.

- **Industrial lessons**: Further MicroStrategy offers lectures at universities about current and relevant topics in the data warehousing and decision support area.

At the beginning of 2001, the following institutions participated in the MicroStrategy university program:

- University of technology Aachen (Germany), chair of economical computer science, Prof. Dr. M. Bastian and Prof. Dr. M. Amberg
3. BUILDING A DATA WAREHOUSE FOR HIGHER EDUCATION

In this section we present the CEUS\textsuperscript{HB} project and the use of the MicroStrategy platform within the project. After a short introduction of building a data warehouse for higher education we will illustrate the resulting distributed data warehouse architecture of CEUS\textsuperscript{HB}. The end of the section deals with a list of benefits for both cooperation partners – MicroStrategy and the University of Bamberg.

3.1 Case study: a data warehouse system for higher education

Recently public administration has become aware of the benefits of data warehousing. This new technology enables interactive data analysis and ad hoc reporting (INMON, 1996). One area of interest for public administration is to control the higher educational system. In Germany, this system has a lot of characteristics in common with a distributed organization. The coordination within the system is a combination between market and hierarchy. Furthermore, each university acts widely autonomously and competes with other universities for students. Each federal state in Germany is responsible for setting the economical and political environment of the higher educational system.

In this context, for example, a data warehouse can help to provide a fair allocation of available funds or personal resources to the eleven universities in Bavaria based on a distribution key. A detailed analysis of the number of students at each university can be accomplished by a data warehouse system in order to build such a key.

Therefore, the CEUS\textsuperscript{HB} project (“Computerbasiertes Entscheidungsunterstützungssystem für die Hochschulen in Bayern” / computerized decision support system for Bavarian universities) was initiated by the Bavarian Ministry of Science, Research and Art. The project (project homepage: \url{http://ceus.uni-bamberg.de}) is realized by an interdisciplinary research group of the Bavarian state institute for higher education research (Prof. Dr. H.-U. Kuepper) and the chair of business information systems, esp. systems engineering and database application of the University of Bamberg (Prof. Dr. E. J. Sinz).

During the first period of the project, we made a requirements analysis and we evaluated different data warehouse and OLAP software product suites. Thereby we got in touch with different vendors and their opinion of a cooperation with a university. Thus MicroStrategy became cooperation partner as...
their software fully met our requirements. Due to space restrictions we do not mention these
requirements for the software evaluation in this paper. Additionally they showed great involvement
to a university program. For example, we could use all products during development and test period for
free. Of course when the data warehouse system will be established at the universities, licences have to
be purchased by the Bavarian government.

3.2 Architecture of a distributed data warehouse system

Data warehouse systems provide information for the managers’ decision-making process in a
consolidated and time-oriented way. Therefore, a data warehouse brings together data from multiple
operational (internal) and external data sources into a common physically separated repository
(INMON, 1996).

Currently, most existing data warehouses ignore the organizational and management structures of the
underlying company. Almost always a classical centralized data warehouse architecture with or
without departmental data marts is applied. This data warehouse architecture follows a widely
centralized and static organization and management structure of a company. Neither distributed
organizations comprising autonomous sub systems with competing organizational units nor changes in
the organizational and management structure over time are taken into consideration.

The management structure of universities can be understood as a distributed organization (SINZ et al.,
2001). Each university acts almost autonomously and competes with other universities for students
and for an outstanding reputation.

Figure 1 illustrates a corresponding architecture for a distributed data warehouse system. This
architecture is implemented by the CEUS project for Bavarian universities and the Bavarian
Ministry of Science, Research and Art. It follows the hierarchical management and organizational
structure of universities:

- Layer 1 comprises data warehouse nodes for faculties of a university. The faculties require
detailed information about the main university processes “higher education” and “research” as
well as external information about university applicants.
- Each data warehouse node on layer 2 comprises an information sub system for a specific
university. In addition to information from the faculty nodes these data warehouses especially

Figure 1: Distributed data warehouse architecture for higher education in Bavaria
contain information about service processes like “fund management” and “human resource management”.

- Layer 3 contains information about all universities of Bavaria in a consistent and consolidated manner. This information can be enriched by external data sources like information from regional statistical authorities.

Each node of the distributed data warehouse system is implemented according to the classical data warehouse architecture (figure 2).

![Diagram of a data warehouse system](image)

**Figure 2: Micro architecture of a single data warehouse node**

A data warehouse node has three different layers:

- **Extraction / transformation and loading layer**: This layer represents the interface to the operational and external data sources. It provides methods to extract, transform and load data incrementally into the data warehouse.

- **Data management layer**: The main task of the data management layer is to store consolidated data in an efficient and consistent way.

- **Data access layer**: The data access layer is the interface to end user applications and presentation tools. Generally an OLAP server provides a multidimensional view of the data stored in the warehouse.

An integrated metadata repository is used on all three data warehouse layers for administration and metadata management.

The MicroStrategy product suite can be deployed in this architecture as follows:

- **Extraction / transformation / loading layer**: There is no MicroStrategy product available to support this layer. We use SQL scripts and data transformation services (DTS) of Microsoft’s SQL Server 2000.

- **Data management layer**: A wide range of relational database servers is supported. At the moment we focus mainly on Microsoft’s SQL Server 2000 (optionally ORACLE and Informix servers can be used).
• **Administration and metadata management**: We use MicroStrategy Architect™ to specify metadata for the data warehouse structure. This metadata particularly provides a multidimensional view on the data. The MicroStrategy Administrator™ handles system management, load balancing, security issues and user access.

• **Data access layer**: The core of the data access layer is the ROLAP engine which is based on the MicroStrategy Intelligence Server™.

• **Presentation layer**: There are two different options for end user access to the warehouse. MicroStrategy Agent™ is a graphical end user application enabling a sophisticated query and reporting solution in a relational data warehouse environment. Additionally MicroStrategy Web™ provides end user access based on well-known standardized web technologies (KURZ, 1999).

We tailored the MicroStrategy products to our needs. For example we customized end user access based on MicroStrategy Web API. For a detailed discussion of the data warehouse architecture and its implications see (SINZ et al., 2001).

### 3.3 Symbiotical relationship between a company and a university

In the following we outline the major benefits of the cooperation between a university and MicroStrategy. We mention the different viewpoints of both cooperation partners.

• **Benefits for the chair of business information systems at the University of Bamberg**: We distinguish benefits for research and for education.

  **Research**

  • **Discover future research topics**: Our knowledge of a real-world data warehouse product suite enables us to discover further needs for research in data warehousing. We are able to identify deficits of data warehouse products which are available at the market. For example MicroStrategy, like almost all commercial data warehouse product suites suffers from deficits in the modeling area. There is no distinction made between conceptual, logical and physical modeling. The classical well-known star and snowflake schemas belong only to the logical modeling layer and are not suitable for modeling the analytical requirements of the end user. A new conceptual modeling technique based on multidimensional data structures used for decision support applications is needed. Therefore we initiated a sub project called JDWToolsuite to build platform independent Java based tools as research prototypes to handle this problem. At the moment three applications are available ([http://ceus.uni-bamberg.de/jdwttoolsuite](http://ceus.uni-bamberg.de/jdwttoolsuite)) which are tightly integrated with MicroStrategy’s product suite:

  - A tool for modeling data warehouse requirements on a conceptual level using the Semantic Data Warehouse-Modeling (SDWM) approach.
  - A query and reporting tool based on graphical modeling and
  - An extraction, transformation and loading tool handling periodical maintenance of a data warehouse attending versioning and incremental updates.

• **Diploma thesis**: The cooperation enables us to enrich diploma thesis by practical and urgent problems. We mention one diploma thesis exemplarily. Its goal is a tighter integration between data warehousing and data mining efforts which is often proposed in the data warehousing and knowledge discovery research community. Data mining activities based on a consolidated and time-oriented database like a data warehouse save time and lead to high-quality results. The closed loop approach between data warehousing and data mining adds a feedback component to the warehouse to insert received data mining results into the database. In that way we can not only propose new concepts concerning the closed loop approach, we are also able to show an integration approach based on a real-world data warehouse product.
Other jointly supported diploma thesis cover topics like metadata management or evaluation of data warehouse product suites.

**Education**

- **Enrichment of student education by industrial lessons**: The topics of university lectures can be enriched by industrial lessons. MicroStrategy offered lessons on current subjects in the data warehousing and decision support area. In fact MicroStrategy’s industrial lessons also covered a lot of theoretical background. Thus students can easily form an opinion about current buzzwords and bring them in context with their university knowledge.

- **Transformation of theoretical knowledge using real-world applications**: In exercises students solve small business problems by transferring theoretical knowledge in working prototypes. Thus MicroStrategy products helped to enhance practical experience and prepare the students for professional life. In our experience practical exercises were very popular among students and using real-world applications improved the quality of students education.

- **Achievement of further skills**: Students can achieve further skills by attending the MicroStrategy SummerSchool in Austria. The certification “Data Warehouse Engineer” was awarded for one week of practical exercising in building a data warehouse solution. Furthermore the members of the chair can participate in training and education programs to get skills on the MicroStrategy platform. For example to become an official MicroStrategy partner a three week training and certification is required. This is called the Certified Decision Support Engineer (CDSE) program.

**Benefits for Microstrategy**:

- **Diploma thesis**: A diploma thesis dealing with a current and urgent problem can become a competitive advantage for MicroStrategy in a fast moving and innovative market. For example the already mentioned diploma thesis about a tighter integration between data warehousing and data mining solutions can help to solve problems at business partners. Normally a diploma thesis provides a solution or the core of a solution which can be extented by the cooperation partner.

- **Publicity of the company as an employer**: A cooperation with a university increases the publicity of the company to students at this university. The company is well known as an employer in a market where not enough employees are available at the moment.

- **Publicity of the product suite**: A cooperation also increases the publicity of the company’s product suite. After leaving university some students remember the experience they had using the products. Some get in positions requiring decision-making about purchasing data warehouse solutions for their companies in the future.

- **Competititve advantage by research**: Research projects can help a company to discover deficits of their current products and provide ideas for new or enhanced products. This can become a competitive advantage for MicroStrategy.

- **Research projects becoming products**: Products stemming from research projects can become a new source of income for the company.

### 4. SUMMARY AND OUTLOOK

In this paper, we described a successful cooperation between a company and a data warehouse research project for higher education at the University of Bamberg. MicroStrategy, as one of the leading vendors of relational online analytical processing (ROLAP) solutions, is the industrial partner. First, we outlined the company’s profile and its university program. In Section 3, we briefly explained the development of a data warehouse for Bavarian universities in the course of MicroStrategy’s
university program. The major focus of this paper was a comparison of the benefits for both cooperation partners. We showed that such a cooperation can be valuable for the partners - both for a university’s research and education as well as for the company’s publicity and competitive advantage.

We hope that this example can help to change most companies’ attitude towards cooperation with universities. It also points out benefits for universities to improve the quality of education and research. This results to a closer relationship between universities and companies as demanded by the public.

REFERENCES


