Technical Concept of an Integrated Environmental Information System – Case Study Volkswagen AG

Christian Grünwald¹, Jorge Marx Gómez²

Abstract

Data sources in industrial enterprises are often used in various tasks, and the amount of business tasks even increases. Consequently, integrated data processing systems are required, that get essential information from heterogeneous source systems and aggregate and process it according to existing requirements. The described concept of an integrated environmental information system represents a distributed integrated system and allows using standard systems as well as individual software for the modules. Besides the modules, that are isolated in view of the respective fields of environmental tasks, the system scenario contains “cross-functional” components. The concept is related to practise in connection with a case study at Volkswagen AG.

1. Introduction

Limit values regarding the environmental behaviour of industrial companies as well as the public interest in reducing or even avoiding environmental impacts caused by companies (Roth 1992, 3) increase. As additionally environmental reports are demanded by the legislation for a documentation of the compliance with laws and regulations, environmental protection has become a business target. To achieve an automatic generation of legally demanded environmental reports, to save company-related environmental data in a central and structured way as well as to realize company-internal checks and evaluations, several Environmental Information Systems (EIS) have been developed (Haasis/Hackenberg/Hillenbrand 1989, 46). Business-related environmental information systems reduce costs of data management by structuring information application-specific and integrating information of several sources (Sick 1994, 39). In the context of the case study Volkswagen AG also uses various EIS to support several environmental tasks. Intensifying legal guidelines as well as the ambition to support as many environmental tasks as possible by data processing systems require a continuous development of existing environmental information systems to extend system functionalities and to increase efficiency. The extent of generated reports and processed information in companies have also increased. Linked information processing, adapted to the business environment allows business processes to be faster and of less costs. To ensure an efficient access of information in linked systems, a suitable infrastructure has to be provided. Manual data input, however, which is required when no automatic data transfer is provided, increases process time and costs. Besides the system-internal information transfer, data exchange with external systems, e.g. with suppliers, has to be considered (Hunscheid/Blicker 1994, 128) in further development. As the requirements of modern environmental tasks can not be met by separated systems any more, isolated solutions have to be avoided in future developments (Skauner 1994, 35).

¹ Volkswagen AG, P. O. Box 1837, D-38436 Wolfsburg
email: christian.gruenwald1@volkswagen.de
² University of Oldenburg, Department for Informatics, Ammerländer Heerstr. 114-118, D-26129 Oldenburg
email: jorge.marx.gomez@uni-oldenburg.de
The increased extent of processed data combined with a large amount of data links however makes a use of the processed information in new tasks possible. On the basis of this data structure, additional processes can be carried out time- and cost-saving.

On the other hand the implementation of an alternative architecture often requires an extensive reengineering of the involved systems to realize the intended coordination of system components and data flow between them.

2. Analysis of systems and process

Before the conception of the integrated system scenario, a comprehensive analysis of the actually used environmental information systems and the related processes was carried out in connection with the case study.

As a basis requirement all essential evaluations produced by the existing systems should even be generatable applying the new system concept. To provide the necessary information, partially base data stored in additional, non environment-related, systems has to be transferred. For that reason existing interfaces of the actually used systems were analyzed in terms of used technology, the category of transferred data as well as the transfer interval.

Besides the requirements the potential of optimizations was analyzed in this connection. First groups of main system users were identified in interviews with the respective employees of the system department. After that a comprehensive analysis and documentation of the existing system- and user-related processes was carried out by additional interviews with the determined main system users. The processes of the actual state were documented in eFPK-models using ARIS Toolset. With the help of this information parallels in working methods of different organizational units could be identified as well as differences in identical working methods of similar organizational units became transparent. Based on the generated process models, medium breaks as well as process sections, where additional system support would be advantageous, became recognizable.

3. Logical data structure

In the next section a logical data structure is described, being the basis for the system concept. As shown in figure 1, in the focus of this structure the elements of production plant, part, material flow, certification as well as aspects of operation, e.g. failure, are located.

In the case study essential information about data components is already collected in several systems of heterogeneous technical platforms. These data, however, is mostly stored isolated. Therefore comprehensive evaluations across business tasks are not realizable. A more holistic view of environmental impacts, as a target for the future, today is only possible in connection with considerable manual costs.

The required linkage of information does not exist in many cases. Especially a generation of environment-related statements, based on product- as well as process-based environmental data is not possible (e.g. the amount of CO₂-emissions that arise during the production of a front fender of a specified vehicle). A majority of the basic information to answer that kind of questions is stored strictly separate, either in process- or product-related data processing systems. As an aim in connection with the system concept, product- and process-based environmental data have to be integrated. Information about plants represents a central data link in this case. On the one hand the respective parts are manufactured by these resources, on the other hand material flows of the production process are directly associated with plants. Just like parts and plants, even material flows, in form of input- or output streams, e.g. emissions, are affected by environmental laws. In this way production plants have to be certified before initialisation not only in a technical view, but also under environmental aspects.
Fig. 1:
Illustration of logical data links
Furthermore, the conformity with environment-related limit values has to be proved regularly, even during operation, e.g. in form of the result of environmental audits. In this way additional impacts are identifiable. All the described information is directly related to plant data. These key data are related to several, more detailed information. The production of parts in this connection is realized using workpieces. Information about parts is directly related to their composition. Additional an aggregation of part data in the form of information about construction units or even vehicles is possible. Apart from products, process material symbolizes an important kind of plant-related material flow. In this connection, additional several kinds of waste and even emissions, such as gaseous substances, acoustics and radiation, represent material flows. Finally, information about pure substances symbolizes basis data for process material as well as parts. As users collecting and processing essential parts of exactly this information exist in every production site, e.g. the department for process technics, using the presented data structure as a basis for the system concept of the integrated environmental information system is considered.

4. Technical concept

The entire concept can be divided into two groups of system modules, as shown in figure 2: Products-based and process-based environmental information systems. Additional central environment-related components like a data warehouse and a common database store and process product-based as well as process-based information. A special environmental portal provides a central and uniform access to several specific software modules. This element not only represents a directory of links extended by a document management system. In addition, an integration of the functionalities of the applications in the form of a corporate portal (Utermann, 2001, 342ff.), e.g. by using web services, is considered in this context. For this reason a “hub-and-spoke” net structure (Utermann 2001, 160) has to be provided to be used as a communication channel for the information transfer between the individual modules.

Moreover, all system components are linked to a central user management via portal. That way system users only have to log-in once and then receive access to every application they are authorized for. User data as well as parameters of user authorization are stored in a central company-related user management system. The communication between user management and applications is ensured by specific java classes. The queried parameters will afterwards be mapped with the internal user-rights of the individual application.

The group of process-based environmental information systems contains, among others, an integrated environmental information system for immission control, water protection, contaminated sites management as well as environmental characteristic numbers as a part of the entire system. As there are many parallels in the required system functionality for the tasks of immission control and water protection, e.g. in the process of generating reports for BImSchG-authorization, functionalities in these fields will be realized by a common module. The module for the management of contaminated sites requires a component for the visualization of geographical information (GIS), a connected database as well as a web frontend which is used for data input. According to the requirements of the environment-related departments, the GIS component is also used for the fields of immission control and water protection. As each of the three fields manages information about measuring points, essential elements of the displayed forms in the GUI will be similar or identical.

In this concept non-geographical GIS-related data, e.g. measuring data, is managed more efficiently, as it is stored in a common database. Another part of the system represents an integrated module for environmental characteristic numbers. This system reads a major part of the required information from the common environmental database. Additional data from external systems for the management of energy and finances flows into this system.
Fig. 2: Concept of an integrated Environmental Information System
Against that, the task of waste management is supported by a separate module, using an own database and a separate frontend. As the business process of waste management in Germany is mainly determined by the strict relation to laws and regulations, there are many standard systems on the market that are very suitable for a use in the case study (López Francas 2005, 496). Therefore, the considered frontend is already determined by the chosen standard system. Connections to central components, e.g. the system for environmental characteristic numbers as well as the data warehouse, are realized by specific interfaces.

In the conception project internal as well as external interfaces are precisely described by the kind of transferred data. The group of product-based environmental information systems further consists of a module for the management of process data as well as safety data sheets as well as a system for the management of measurements at specific workplaces. Both modules process information about materials. A database for pure substances represents a common data source for all, process- as well as product-based, modules, as information about pure substances is required in almost every environmental task of the case study.

The group of product-based environmental information systems consists of a module for the management of material data sheets for parts and a recycling information system. As the major part of the functionalities of these systems is heterogenuous, both modules are strictly separated. The recycling information system however processes information about the structure and material compound of parts. This data is also part of the managed material data sheets. For this reason both product-based environmental information systems use a common database.

The group of product- as well as process-based environmental information systems on the one hand contains a life cycle assessment-tool that obtains an essential part of the required information from the environment-related data warehouse. Apart from product- or process-based environmental information, this central component collects and manages data of the bill of materials, logistics and distribution, information about production as well as vehicle data from external source systems. The flexible reporting functions of a business intelligence component connected to the data warehouse allow the aggregation and output of basis data that is required for the generation of the individual life cycle assessments. The central data warehouse is also a suplir of information for the environmental geographic information system. In this case a standardized data structure for data transfer between both components, data warehouse and GIS, has to be provided. The data warehouse makes a flexible generation of this transfer data possible. In this way additionally information about measuring points, that is managed in the field of industrial safety, among others, can be visualized via GIS in connection with associated concentrations of pollutants.

5. Conclusion and outlook

Target of this project was the generation of a concept for an integrated environmental information system. The basis-requirements for this concept were determined in cooperation with several departments in connection with a case study at Volkswagen AG. Besides a critical view on the existing systems in focus of functional as well as technical aspects, primary system-related and business processes were analysed. Taking this information as a basis and considering the identified potential of optimization, a concept for an integrated environmental information system was derived.

The developed scenario, analogous to the initial state, differentiates product- as well as process-based environmental information systems. On the one hand, the flexibility of the system symbolizes a main criterion: Besides the implementation of individual software, a use of standard systems is possible in the scenario. Providing a single application for a group of or even all environmental tasks would limit the amount of suitable standard systems substantially. Additionally, system support is structured and more efficient using a distributed integrated system. The availability of the individual system modules during
operation is much higher, as they are independent from breakdowns of the other environment-related modules. Furthermore even the organizational structure in connection with the case study contains a separation between product and process in many cases. A fundamental change of data structure would also have a not insignificant effect on the organization structures.

Besides the specific, task-related system modules the concept contains a group of tasks-crossing components: A data warehouse for environmental information allows the generation of specific reports based on environment-related and additional external information. Using the GIS, environmental information and environmental impacts are graphically visualizable. The direct connection of the applications makes a uniform and intuitive information access via plant layout possible.

Moreover, the missing connection of product- and process-based environmental information is realizable using the data warehouse. Finally, the environment-related portal ensures a uniform system access. Functionalties of the system modules can be provided across business tasks using webservices. In further steps of system conception the described elements of the integrated scenario as well as interfaces between the modules have to be described under aspects of technology.

Additional data structures have to be described more detailed to extend the technical concept in form of a data processing concept.
Bibliography


Copyright © Shaker Verlag 2006. ISBN: 978-3-8322-5321-9