Data-navigation through planning, monitoring and diagnosis data via a three-dimensional model of underground mines

	
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Erschienen in:
Mechanizacja i Automatyzacja Gornictwa 4-5/354, 2000
Tagungsband zur Konferenz: 28th Conference on Automation and Telecommunication in Mines and Processing Plants – Coal and Minerals, 14-17 Juni 2000
Zu beziehen über:
PL ISSN 0208-7448, zu beziehen über: EMAG, ul. Leopolda 31, 40-189 Katowice, tel: (-32) 2007700 oder 2007570

Abstract

Over the past two decades, the focus of attention concerning information systems has shifted from a scarcity of digital information to an over-abundance thereof. Mechanisms for filtering, correlating and presenting information in response to the needs of specific users or situations are getting constantly more important.

At the authors' institute, a number of programmes for generating data have been developed and implemented at various underground and open-cast mines. Amongst those products are routines for the design of belt-conveyors, shearers, ventilation systems as well as hard- and software components for online machine diagnosis and process data visualisation. The full range of these tools will be briefly hinted at.

The main focus of the paper lies with a newly developed information system, merging data from the sources mentioned above with office- and HTML-documents. Using a single interface, the user can access any type of data via navigating through a three-dimensional presentation of the mine.

A brief outlook will present a concept for filtering, arranging and processing data in the background with a view to presenting only case-sensitive and personalized information to the user. The mechanisms contemplated for this can best be described as "artificial intelligence" on company-scale.

Data-generating applications

Together with our main customer, the German hard coal industry, and various partners, we have developed over the past decade, a number of autarkic computer applications covering a wide scope of planning, realization and monitoring activities. These applications, however, do only represent a small fraction of the overall information processing and management of a modern mine:

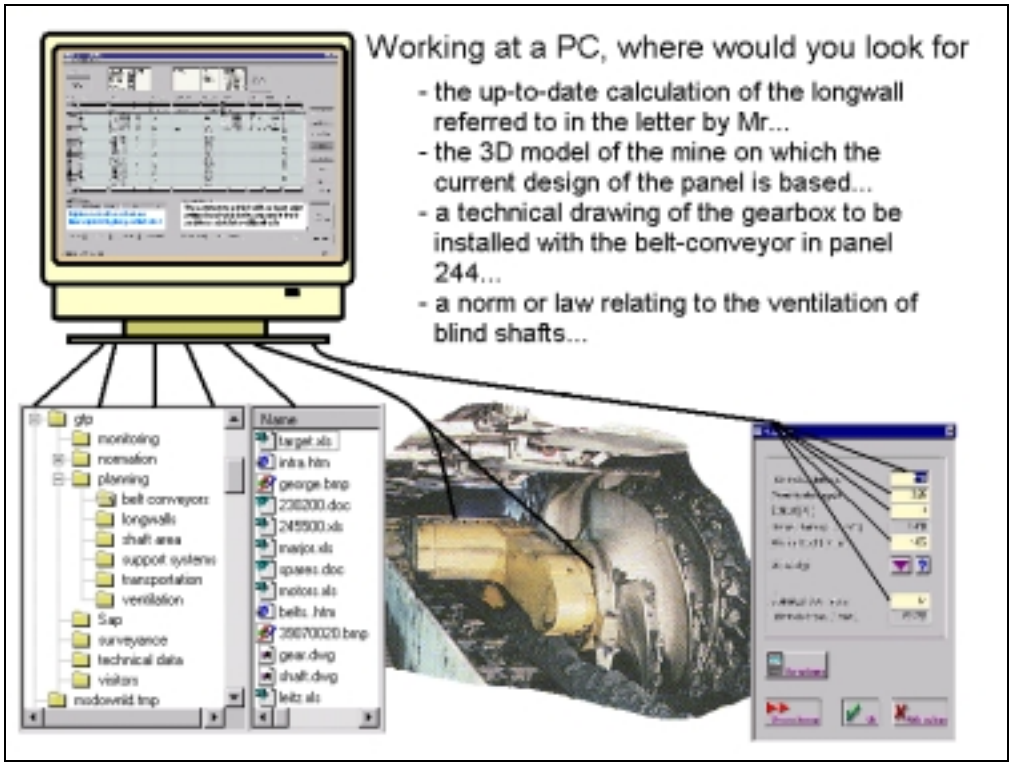

Figure 1: Example of heterogeneity of data-sources

The above picture only hints at the data to be accessed by an ordinary engineer working on a mine. Try to figure the full number of different files, applications, pass-words, data-base source names etc. involved in an engineers daily work.

The system presented here has access to a conglomerate of different applications and data sources. Some of them still work within an emulated UNIX environment, others make ample usage of active-X controls running on a company intranet. Data is partially stored in an Oracle data-base and partially as ordinary files. Although C++ tends to become a standard, C, Visual Basic, Visual Basic for Applications, Delphi, Eagle, AutoCAD and VBScript are also found in the source code. The following pictures are to give an idea of the scope covered by these applications:

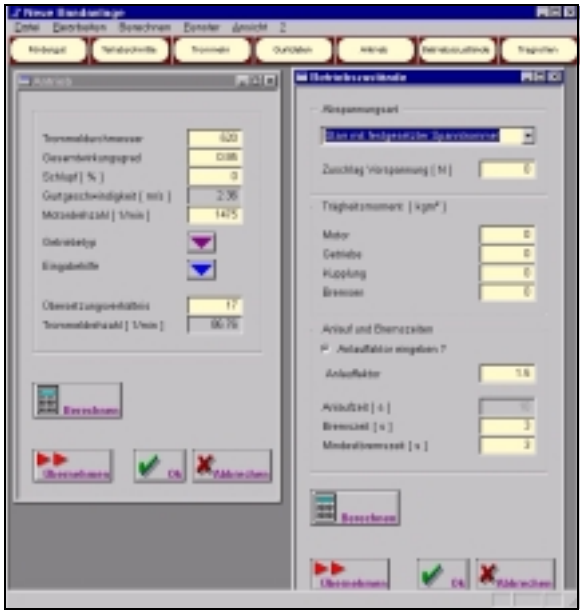

Figure 2: Conveyor-belt calculation, an application recently migrated from UNIX to Windows NT

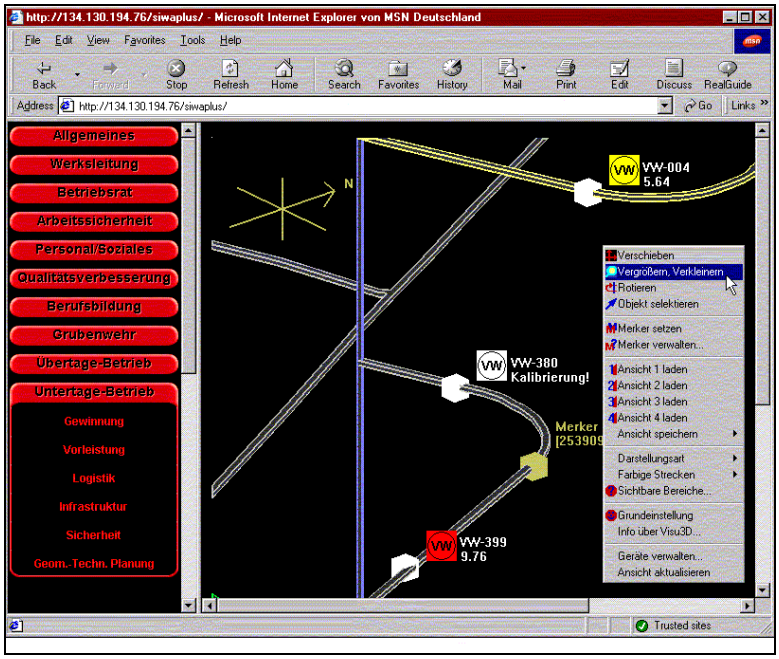

Figure 3 : Visualization of online-ventilation-data within an intranet environment, WEB-based

Figure 4: Online-machine diagnosis (DIAMIS) data of a chain-conveyor drive

However varied these applications may be, most of the data ordinary people are confronted with are dealt with by common office applications. They play a major role in people`s every day working life. An information system for technical data deserving the name "integrated" must take heed of this fact.

An integrated Information System for Technical and other Data

When about ten years ago, IBH started to concern itself with information systems in the mining industry, an integrated system available to all sorts of people was still something of a vision. The strategy then adopted was to first develop a sound theoretical foundation, centring around a 3D-visualization of the mine and its installations. Parallel to this activity, but in strict compliance with the theoretical foundations, a number of data-generating applications were implemented and disseminated within the German hard-coal industry.

The last remaining obstacles in the way of an integrated information system were removed with the following developments of recent years:

- the milestone decision by the German hard-coal industry to exclusively use Windows NT as a platform,
- the rapid growth of computer and network capacities,
- a growing number of people working with computers,
- a strong drive exerted by the hard-coal industry to standardize the planning process itself.

Only when these prerequisites had all been fulfilled and there was enough digital data to feed on, could the final step of implementing the long hedged information system be taken. The main focus of attention now lies with customizing its functionalities and acquainting as many users as possible with its features.

The picture below gives an impression of the look and feel of the graphical part of the information tool:

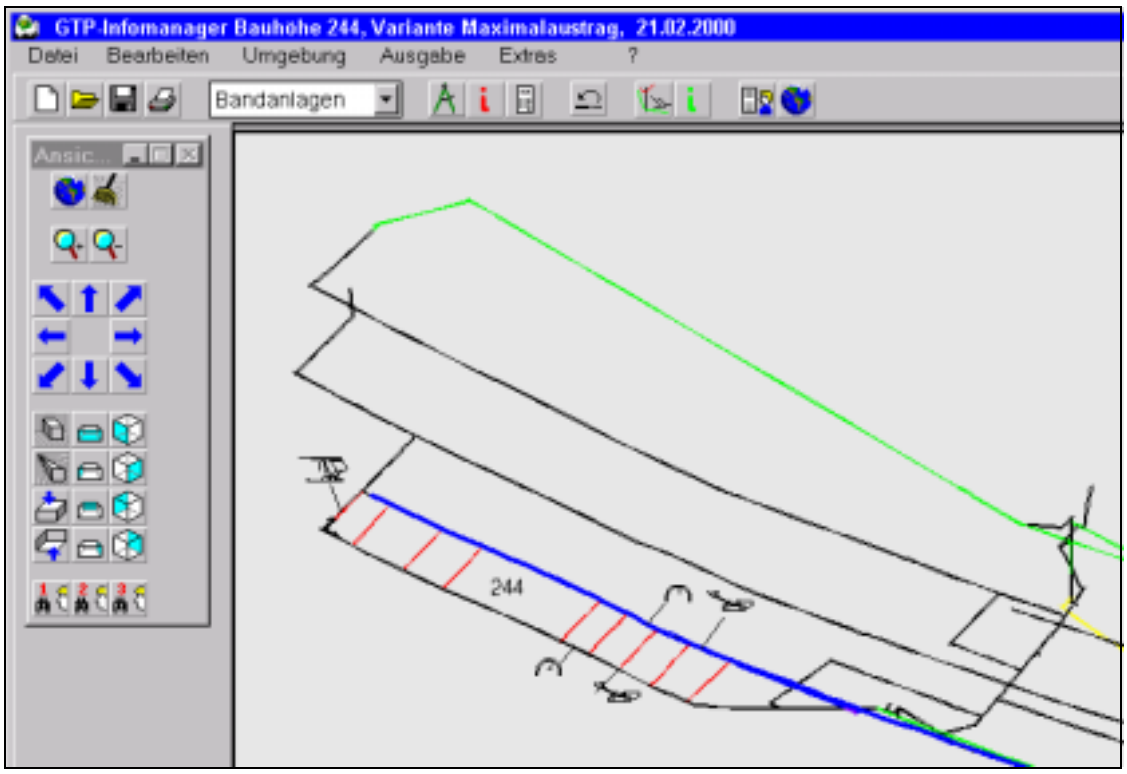

Figure 5: 3D model of a mine showing a typical working panel and shafts. Extension from left to right about 3km.

The main feature of the system are so called "information carriers". To start with, they are empty containers, only consisting of a symbolic representation and a number of telling names for filtering and arranging them.

In the picture above, we see some of these info-carriers for a longwall support-system, roadway support-systems and two dinting-machines. They serve to illustrate a concrete planning version for a working point.

With each symbol can be linked any number of files such as, for example, technical drawings of belt-drives, excel-sheets of the planned personnel, word-documents of legal requirements etc. A mouse-operation on a graphic symbol will open the following dialogue:

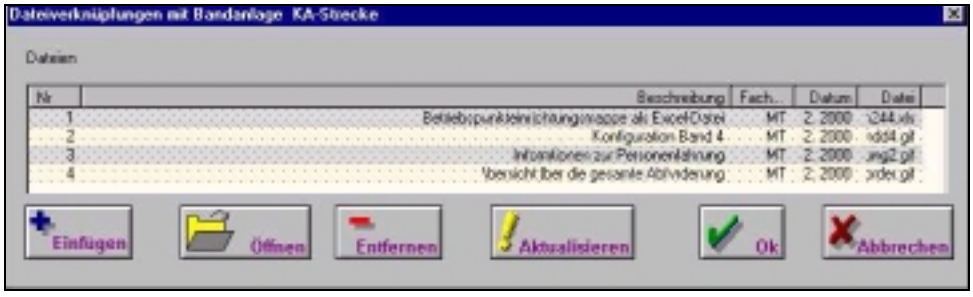

Figure 6: dialogue box showing files linked with an info-carrier

Each row contains a link to a file. Files can be added and opened using standard windows operations.

An info-carrier can not only be linked to files, but some info-carrier types are automatically identified with, for example, a calculation of a conveyor-belt or a shearer. Other types stand for

certain sensors used for monitoring underground ventilation. Activating a certain info-carrier gives automatic access to these specific informations.

The process of customizing includes a careful selection of different types of info-carriers: there should be enough to allow a differentiated documentation of the planning process, but there should be not too many to cause confusion and irritation to non-specialists. The following picture presents some of the main types of info-carriers in use today. They should be more or less self-explanatory:

Figure 7: Exemplary info-carriers for use with 3D-model of a mine

Info-carriers can not only be handled via the 3D model of the mine but also by using a text-based dialogue box. This enables any user to search for and filter different info-carriers and take a quick glance at the information attached to them:

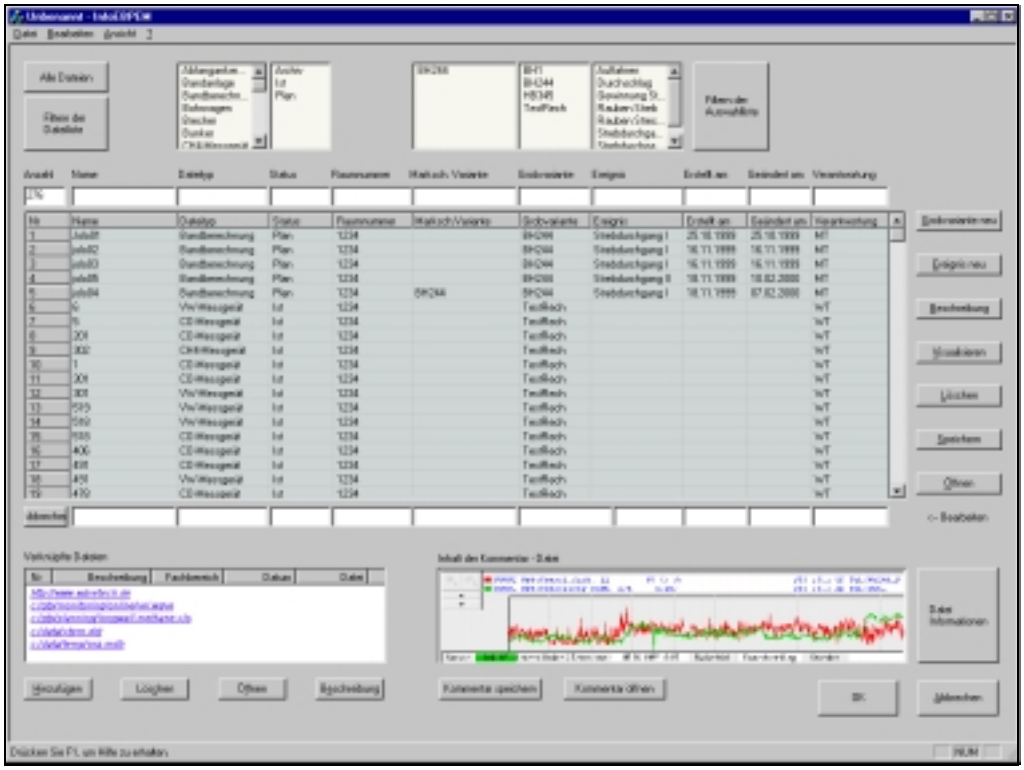

Figure 8: Dialogue box for viewing and managing information-carriers

With easy-to-use mouse-operations, the list of info-carriers in the middle of the box can be filtered, readily showing all documents

- that where changed yesterday
- that relate to a certain working panel, such as 2440
- that relate to a planning version assuming a minimum longwall output
- that relate to a planning version assuming a maximum longwall output etc.

Activating a certain info-carrier reveals further information about it. At the bottom left are shown linked files, that can be opened by a mouse-click. The bottom right shows a documentation file permanently attached to the info-carriers. This file can be edited by anybody and serves to communicate comments.

With its technically realized integration of different data-sources and applications, the information-manager is now being established as a major tool in the everyday working life of people involved with technical processes on German hard-coal mines.

The Future: CSCW and Company Intelligence

Once a system for supporting a group activity such as the cooperative planning and realization of underground operations has been implemented, new questions will soon be put forward. How does, for example, the system support

- notifications about changed documents,
- coherent data-structures,
- a personalization of man-machine communication,
- case-sensitive presentation of data,
- preservation and dissemination of personal knowledge?

Looking for an answer, one will soon meet with some of the following key-words:

- Work Flow,
- Groupware,
- Group and Project Awareness,
- Computer Supported Cooperative Work etc.

Merging these new ideas with the current state-of-the-art of the information-manager presented above, we arrived at the concept of a "synaptic browser" as one possible course of development for the future. The basic idea is to model a company as a neural network, with single people at a PC working place as neurons. One form of company knowledge is then stored in the "links" between neurons: who should communicate with whom in which situation to produce an optimum result?

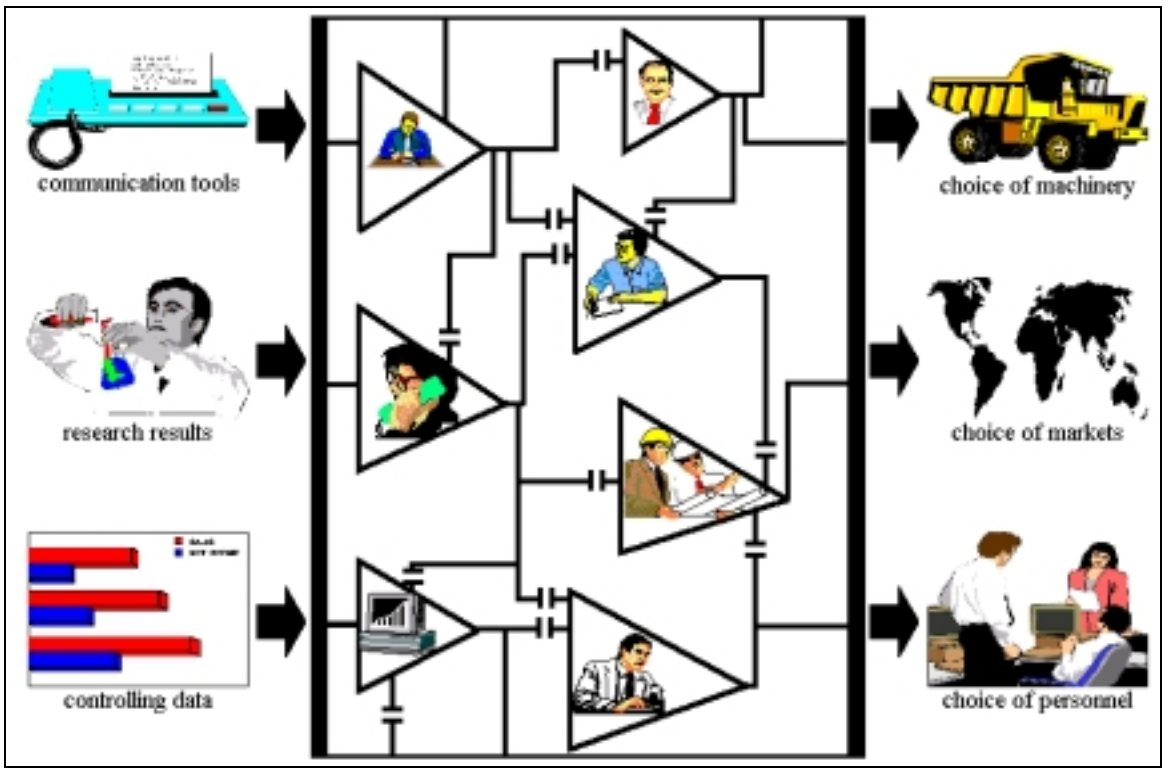

Figure 9: The vision of a company as a neural network with people at a PC as neurons

Taking the present information-manager as a starting point and adding typical CSCW features to it would lead to a browser-like application that could "weigh" information flow between people according to a specific situation, just in the way synapses in brains influence the probability of a signal transmission between specific neurons.

Connecting a certain configuration of weighted communication channels with financial or technical controlling-data could eventually lead to a company showing learning abilities comparable to neural networks.

There will be plenty of scope for research and development in this field as the awareness grows that group-processes can be actively supported by computer software and semi-intelligent agents acting in the background.