A mine planning and information system merging specialized planning data with conventional office-files and process data via a three-dimensional model of underground mines

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ABSTRACT: Although specialized planning, monitoring and diagnosis programmes are vital tools much in use on mines today, they do not usually make up the bulk of most people‘s working day. Most office work such as communication and documentation is dominated by using standard programmes.

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 and ventilation systems.

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.

The information system presented aims at making data produced by specialized programmes accessible to non specialists, who prefer the use of standardized software.

COMMUNICATION: A MATTER OF JARGON?

Placed in the middle of a planning team on any mine in the world, even a highly competent and senior engineer would probably not understand much of what is being discussed:

1. Have the WLGs not supported by SAP been discussed with TB?
2. 334 is 354,4m long.
3. Who is responsible for supplying the „bones“ for 347?
4. Is BH987 on schedule?
5. Could you please retrieve „the coal“ from GRUBE?

Like it or not, such cryptic jargon is a common feature with most specialists and it helps to streamline communication with other specialists to the point. Who would ever dream of talking like this:

„Has the department concerned with technical planning in our headquarters, I mean TB, been informed that not all the equipment we need to order in a few months is sufficiently classified by SAP and that something must be done about immediatetely? And if so, can we be sure, that the solution will be produced in time? Would you please see to it that I need not worry about this topic any more?“

However efficient jargon may be amongst specialists, it has two major drawbacks that can make its use dangerous: Firstly, the exact definition of each symbolic word must be known to all. With example 2 above, the person adressed must know that „334“ is the colliery number of a longwall. And in the case of an inclined longwall, it must be clearly understood whether length is measured through the three-dimensional space or along a horizontal projection of the longwall. Secondly, the context, i. e. some background information, must be known to all. With example 4, the speaker takes for granted that the recipient of his questions knows the time-schedule for the working-panel BH987.

Anyone with some experience of working-life knows, that both assumptions with the use of jargon can lead to much confusion or even serious mistakes.

If used indiscriminately with specialists from different departments, the simple phrase „date of delivery“ in conjunction with a support-shield may mean very different things:

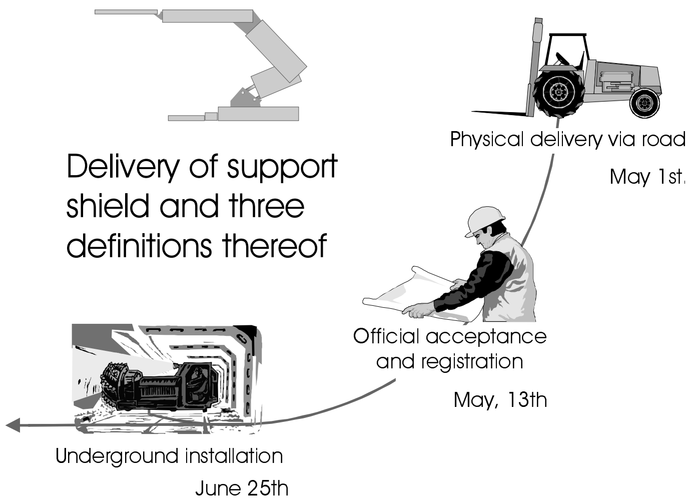

Figure 1: three definitions of „date of delivery“

To avoid misunderstandings, ordinary organisations usually develop a large number of more or less standardized forms, protocols, tables and maps where each word has a clearly defined meaning. Figure 2 is an example taken from a German hard coal mine. These documents are used for both inter-departmental and inter-hierarchical communication.

Such documents are a sort of hybrid between specialists‘ jargon and descriptive illustration. The use of standard-office applications gives the author much freedom in style and content. Constantly changing information demands make it difficult to rigidly formalize these documents. Their „standard“ is rather guarded by a lived convention than by programmable data-base rules.

THE RIGHT POINT OF VIEW

Even when stripped off its jargon, information need not necessarily be meaningful to others. A second prerequistite must be fulfilled: Information must be reduced to the recipients sphere of interest.

Figure 3 gives an example. An electrical engineer is not interested in the mechanical intricacies of a belt-conveyor design. He simply needs to know some facts about its power consumption and electrical installations. The logistics department, on the other hand, need not know anything about technical data at all. They need to know the dates of delivery and certain specifications to identify the wanted equipment.

Generating a certain view intelligible to department S out of data produced by department R can rest with either sender or with recipient. Evolutionary principles seem to favour the former.

As a result, many technical planners are concerned with documenting one and the same planning object - like a belt-conveyor - more than once. Each documentation is specifically tailored to the needs of the recipient and gives a different view of the same thing.

To avoid redundant work, many mines of the German hard coal industry have developed standardized folders to which all departments concerned with the planning of a working contribute their results in a generally intelligible form.

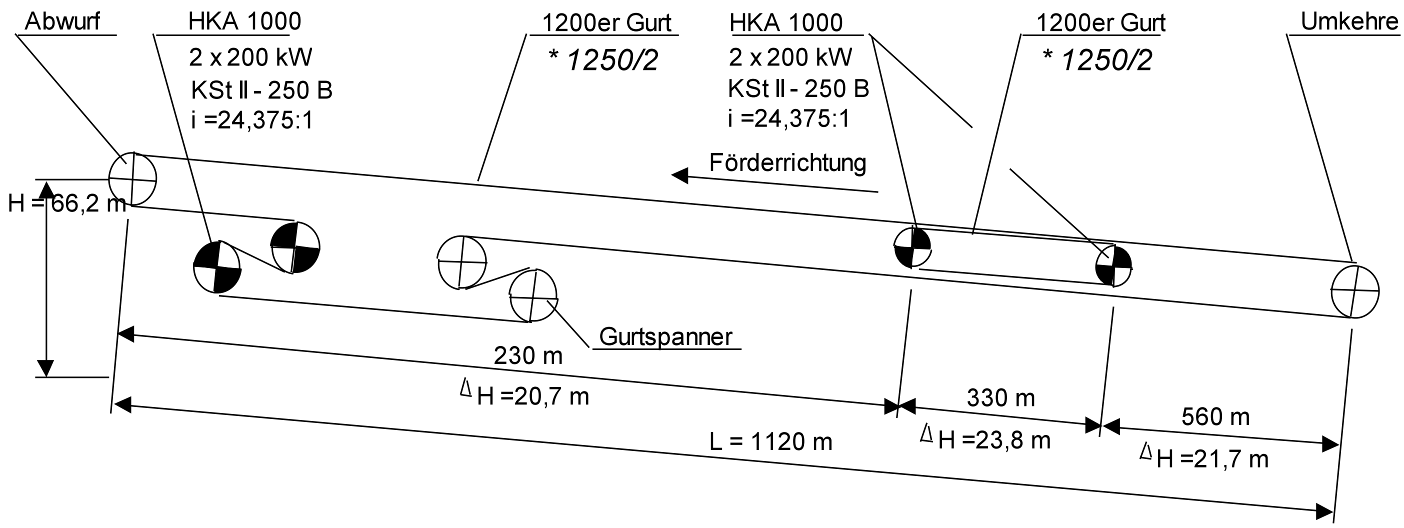

Figure 2: example of standardized document: layout of belt-conveyor on German hard coal mine

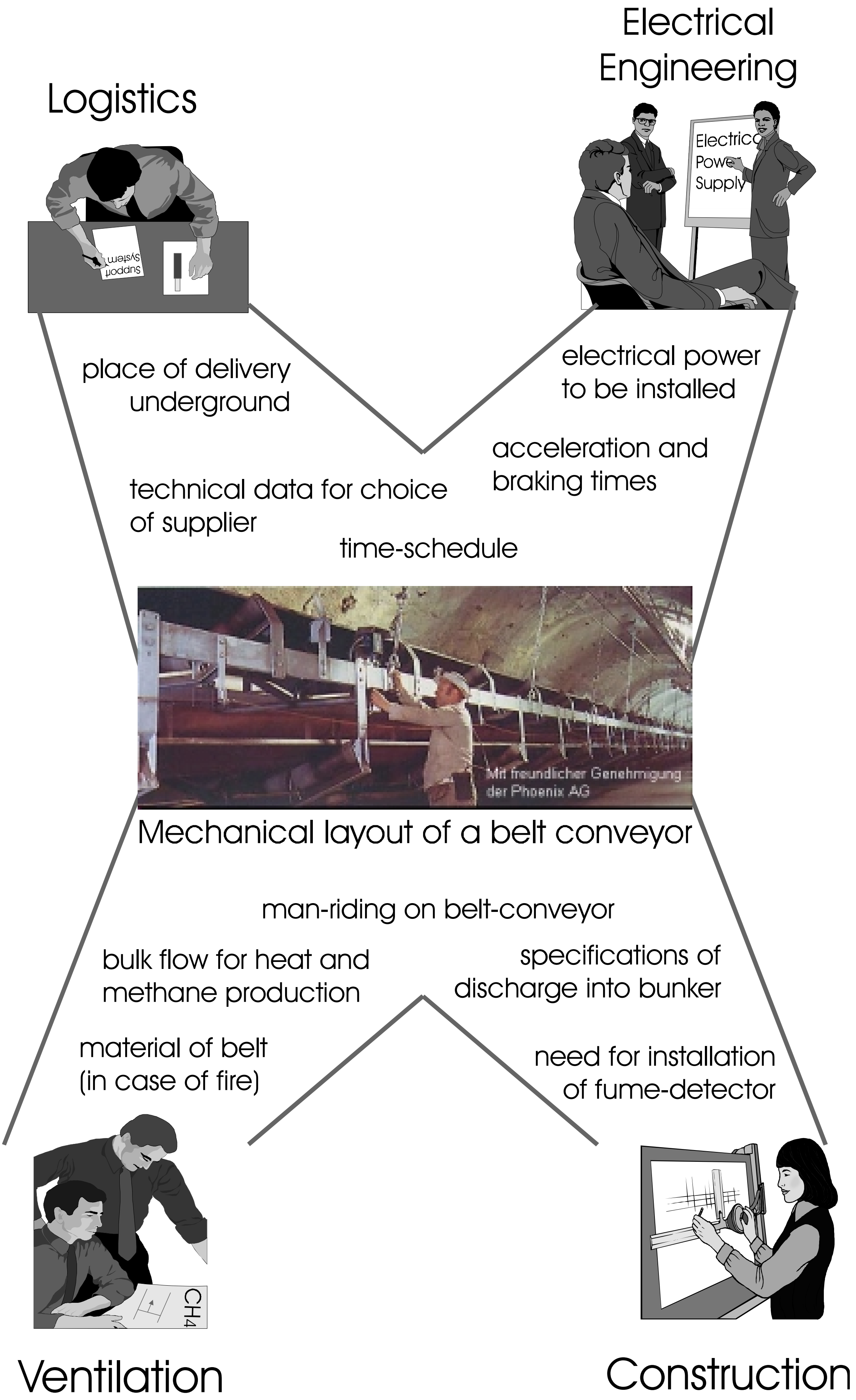

Figure 3: different views of a belt-conveyor system reflect different information needs

MERGING DATA-BASES AND FILE-SYSTEMS

A number of computer systems have tried - and mostly failed - to successfully support the kind of information flow described above. The leading idea was to store information in a database and then create different views on the data, according to the users‘ needs. The main problem is the discrepancy between the highly standardized and regulated modes of storing information in a structured database on the one hand and the need for descriptive, informal and flexible data-presentation on the other hand.

In addition, the widespread use of office applications that do not support the retrieval of logical data out of their documents must be taken as a fact that cannot be altered without a dramatic loss of user-acceptance.

Over the past 12 years, the authors‘ institute has been involved in the development of both specialized calculating routines as well as global information systems. The philosophy that evolved during that time was to give each piece of information its due form of storage and then see to it that these pieces of information can complement each other in the best possible way.

This led to the creation of „virtual planning objects“ as illustrated in figure 4. To start with, they are empty containers, or information-carriers, only consisting of a symbolic representation and a few compulsory annotations. Shearers, shield support, dinting machines, ventilators and belt-conveyors are some examples. A „planning object“ should be an identifiable object of reality on which standard planning activities are focussed. With a virtual planning object, any number of any file-type can be attached as well as pre-defined data-base contents.

The Human-Computer Interface designed for the German hard-coal industry provides two modes for accessing virtual planning objects: graphically via a 3D model of the mine and via a text-based dialogue box.

Figure 6, overleaf, shows the typical lay-out of a working of a German hard-coal mine as presented in the 3D information navigator. About 2km in diameter, the view shows a blind-shaft at the right end and some parallalel roadways. Symbolic representations of real objects such as dinting-machines, support-shields or roadway cross-sections indicate the presence of further information.

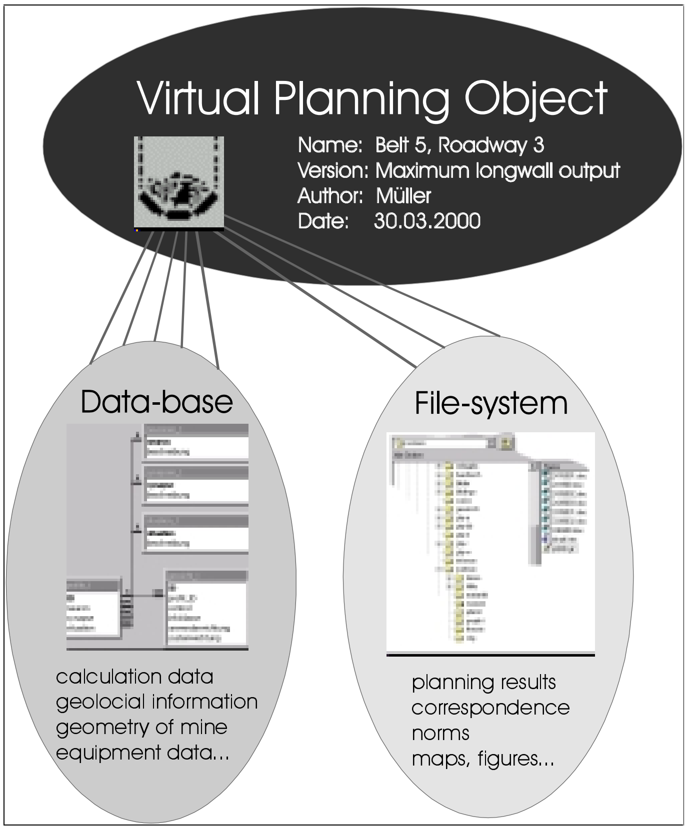

Figure 4: concept of virtual planning objects

The symbols have been placed by planners who wish to draw public attention to their planning results. The view can be opened by anyone on the mine involved in technical planning. Some easy-to-use mouse operations can expand the view of the mine to other workings or areas. The angle of view can be changed interactively, revealing three-dimensional structures of the roadway system.

Double-clicking on a graphic symbol opens a browser-like window as shown in figure 5. Each line is identical with a virtual planning object i. e. with a symbol in the graphic 3D model of the mine. Laying the focus (dark line) on a planning object in the table above immediately reveals office-files (bottom left) attached to the object by different users as well as a textual annotation-file used for communication between users (bottom right). The annotation file can be edited by anyone. Anyone who wishes to make comments on a certain calculation can therefore write his comment into this box. Clicking on a planning object below the one marked at the moment shown above, will show different attached files and a different annotation.

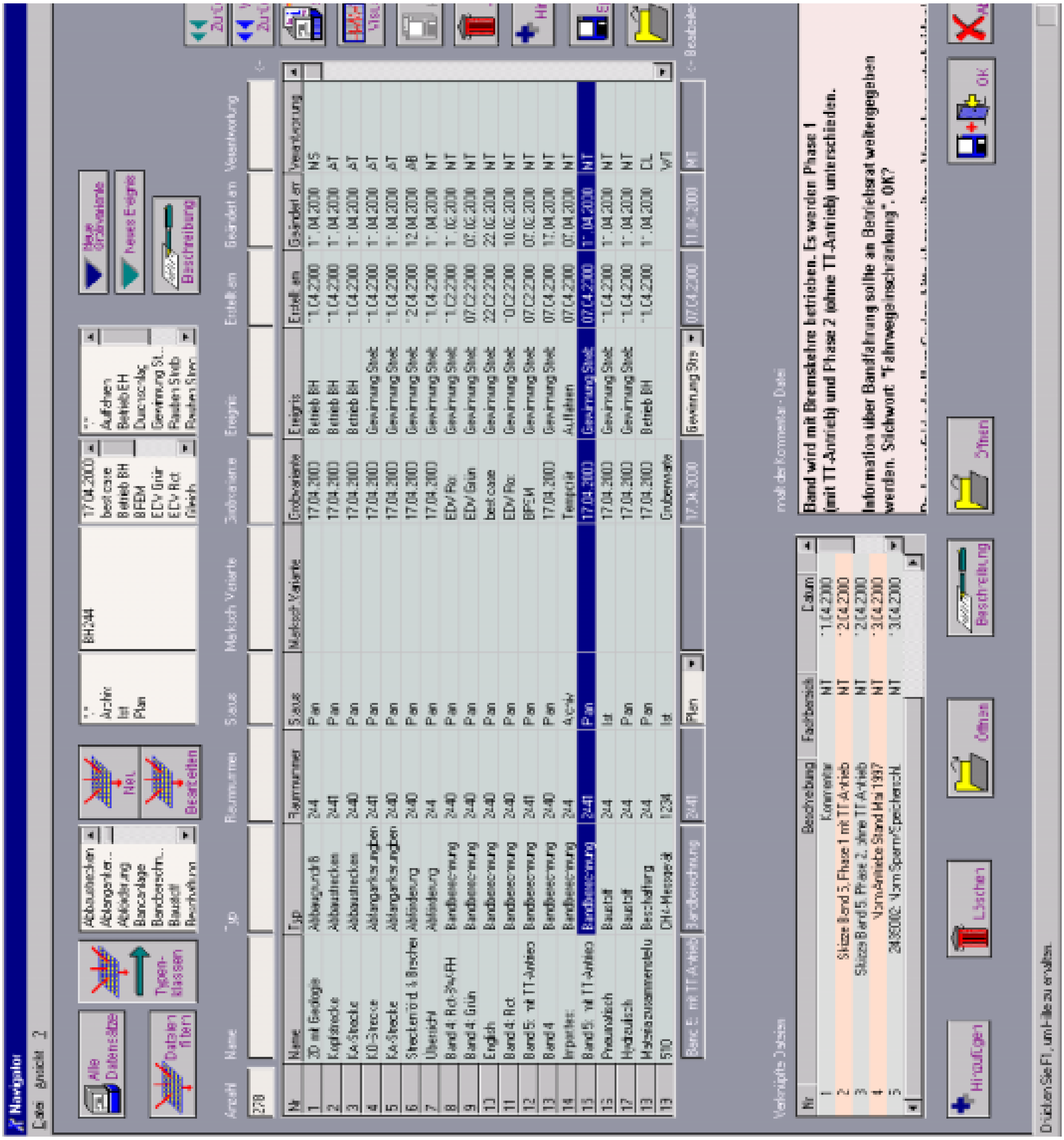

Figure 5: text based information-navigator showing info-carriers, attached files and comments

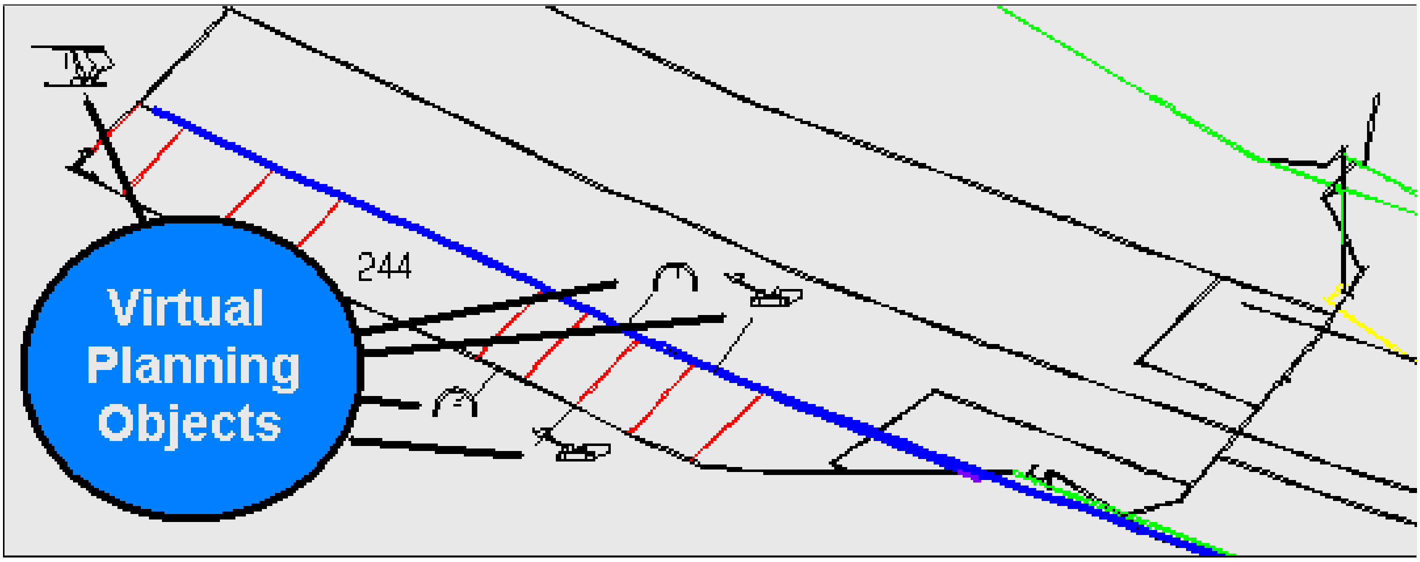

Figure 6: graphical information navigator, 3D-presentation of virtual planning objects (information carriers)

If a data-based calculation is connected with the planning object it can be opened with the „Öffnen“ button. This action then starts the application adressed just the way the office-explorer opens a word-document with MS-word. Without even having to know about it, the user browses through and manipulates both file-documents and data-base information.

Experience has shown that a mine implementing the above system will soon have to manage hundreds or even thousands of different planning objects. A number of filtering mechanisms can quickly reduce these to a manageable number of about 5 to 20 objects. The white boxes above the table in figure 5 serve to define filtering criteria. The user can decide to only see „belt-conveyors“. If these should be too many, he can further limit the results to those belonging to „working 2441“, created „on April 4th, 2000“, by „MT“ etc.

It is up to the customer, i. e. the mining company, to decide which information should best be stored in which way. At present, it is decided that geometrical and geological data about the mine, SAP-style equipment information and calculations of belt-conveyors and longwall-equipment are stored in a professional Oracle data-base. All other information is handled via file-systems. Accessing the information via the system described above, the front-end user, however, cannot tell the difference.

STATE-OF-THE-ART IN THE PRODUCTION ENVIRONMENT

Operating 15 large scale mines, the German hard-coal industry put about 30 longwalls into operation during the last year. The planning of longwalls is a continuous process on all mines.

Computers are in widespread use for communication, documentation and calculation purposes. Although there has been a strong urge for standardization during the last decade, calculation and documentation applications still represent a variety of different technologies and producers. XGraphic, an IT-company based at Aachen, Germany is one of them. In close cooperation with Aachen Technical University, a couple of applications have so far been implemented and are in active use today, such as:

- Belt-conveyor calculation
- Ventilation planning
- Longwall calculation
- Generation of 3D-underground plans
- Material management
- Calculation of roof-support systems
- Pipe-system planning
- Information management

CONCLUSION

The focus of future developments will be mainly with customizing the products in use today. An aspect constantly gaining in importance is the preservation of knowledge. With high fluctuation of employees and much organisational restructuring knowledge about where knowledge can be found can become vital. The system presented here will both help to retrieve and store this sort of meta-information and to streamline communication without making it too cryptic for non-specialists.