Visual representation concept of factory information

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Introduction

The development in industries like the machine tool industry or the automotive industry is to concentrate on the major working fields and buying the best competence in the other working fields from system suppliers (see STRASMANN, SCHÜLER 1996). An information system allowing a fast information flow between customer and suppliers (esp. while constructing a new product) has to be built up. In order to guarantee that every partner gets the actual information, everybody should have access to a shared data base.

One of the tasks of the German Special Research Area 346 (Sonderforschungsbereich) is to develop an information system linking all the divisions of an enterprise together and to design interfaces for partners using the same database from outside. Within this special research area not only the technical problems are solved, there are also ergonomic aspects to be considered. The main ergonomic problem is the visualisation of the data in a user-friendly way. In this context visualisation does not only mean the presentation of the data, it also stands for the possibility to use and work with the data (see ZÜLCH, GRIEßER 1994, pp. 253).

For efficient working with databases, the human-computer-interface is the most critical point. Principally the user friendliness as it is mentioned in ISO 9241 part 10 is to be considered. This means for example that a database interface should be able to be used in a simple and intuitive way. It should be oriented on the commonly used computer graphic tools in order to go confirm with the expectations of the users .

Other functions which should be considered are:

- the possibility to select one or more objects,
- installing new objects,
- opening of objects,
- moving of objects (drag and drop),
- searching and finding of objects,
- editing of texts,
- object menus,
- cutting out, copying, adding,
- navigation in the data base,
- and using with extensive data stock.

Organisation of work inside the factory

Based on the vertical information flow a taxonomy of the users is necessary. As shown in figure 1, the users in a factory can be roughly divided into shop floor, engineering and management. Though there are some other models of work organisation with more levels (see MUSOKO,NAIM,DAVIES 1990), we chose to distinguish between these three elementary forms of work inside a factory (see COSTANTINESCU,SANDOVICI 1990).

The shop floor level

The shop floor level is the main source of information which concerns the processes inside the production flow. All producing processes are part of this level. The workers who are also part of this level need very detailed information for their work. They get most of these information directly

from the machines. Other information like NC-programmes, timetables, maintenance orders or working orders etc. come from the engineering level. The information a worker needs is limited mainly on the issues of his working area and may read up to concerns regarding his working group. The information concerning work progress, production data for the machines, disturbances, personal information about the workers, for example their skills or their presence, are reported to the engineering level.

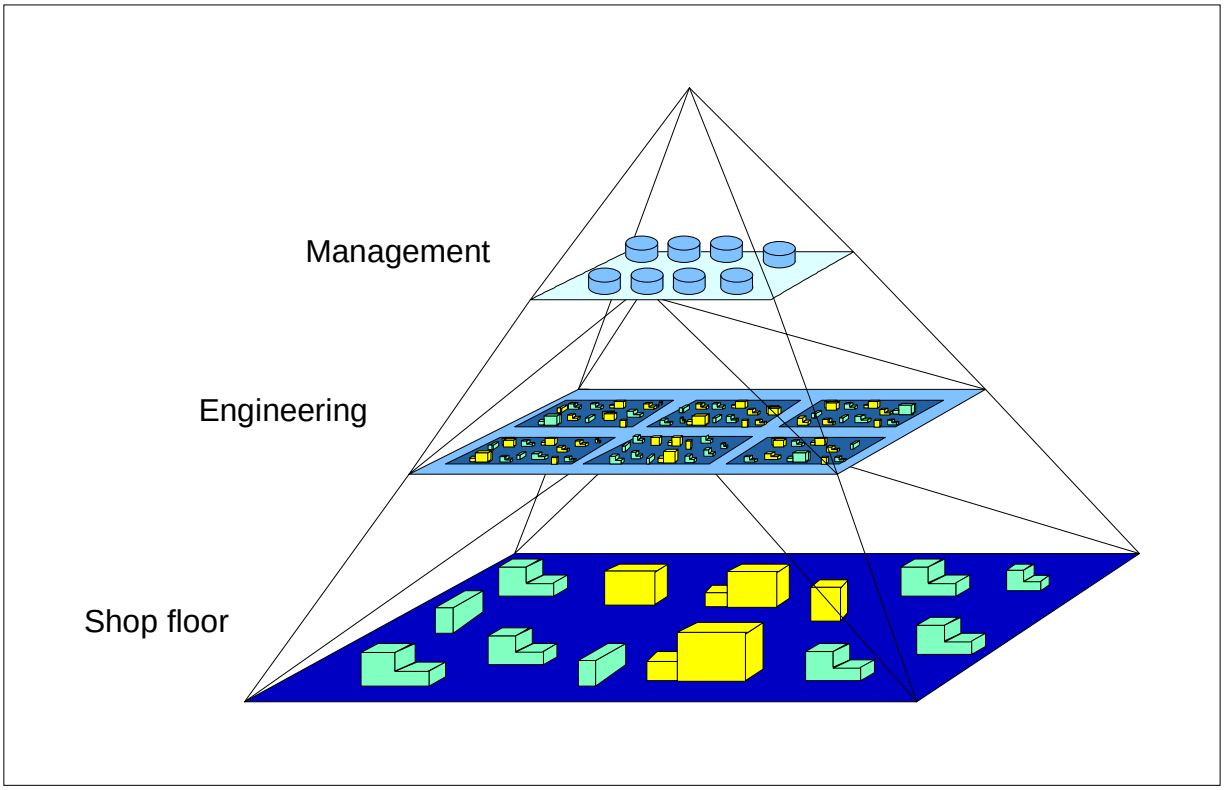

figure 1: hierarchical taxonomy of information users in a factory

The engineering level

The engineering level includes all the designing, planning and control tasks concerning the technical aspects of the factory and the automatic order processing. As one input the engineering level gets processing information from the shop floor level. Additional information comes from other departments by horizontal information flow (e.g. acquired orders), and guide lines from the management. Inside the engineering level there are a lot of very complex and detailed planning problems. Therefore, the planers need a wide range of detailed information. This is not only technical information from the shop floor, there is also e.g. personal information from the personal department, information about suppliers from the ordering department and cost information from the controlling to be considered. So the range of information needed by the planers reaches beyond the border of the planning department or the working area, which the planer is responsible for. Because of a lack of authorisation some of the other departments give only characteristic numbers as an output to the planers. The output of the engineering level are characteristic numbers for the management and also the information which is necessary for the workers at the shop floor level. Nevertheless, the most voluminous information flow is inside this level, because of the different responsibilities for the working areas at the shop floor level.

The management level

The management level includes the decision making area which includes the strategic planning. The information which is needed in this level is less detailed than it is in other levels. Mostly the information is highly compressed in characteristic numbers. The input of this level comes mostly from the engineering level and hardly ever from the shop floor directly. The guide lines from the management are directed to the engineering and arrive only indirectly at the shop floor.

Organisation of data flow

Engineering data bases are usually very large. Because of this it is important to give the individual objects a high extension volume (see KILGER 1995). According to this high extension volume of information in the database it is not advisable to create one interface for all users. Only such information should be presented to the individual user which is essentially needed in order to do his work. This goal can be achieved by dividing the data structure into certain information areas. This process does not follow only the horizontal information flow between the different departments, it follows also the vertical information flow between the management as its top to the shop floor at the bottom. When all relevant information is stored in a relational database information may be stored twice because of its usage for different points of view. These are for example technical or business management points of view. To avoid this multiple storage it is advised to use an object-oriented database. The information will be stored only once and can be combined with other information which will be necessary for these special points of view.

Presentation of information

According to the taxonomy of users there are three different kinds of information concerning each level to be presented: a virtual reality presentation, a modelling presentation and an abstract presentation. This division is necessary to support the powers of comprehension of the users. The skills of the workers depend on their education. Users with academic education, who are mostly represented in the management level are trained to think abstractly; so they will prefer an abstract presentation. For skilled workers a real life scenario will be the best presentation.

The virtual reality presentation

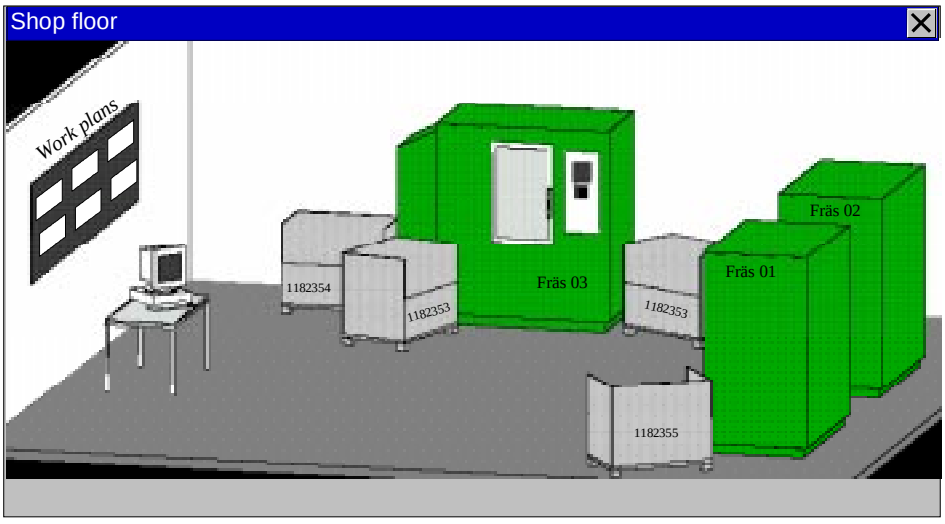

figure 2: Virtual reality presentation for the shop floor level

This presentation will be used in the shop floor level. The workers know exactly where the information is created. Because of this knowledge and their good tree-dimensional imagination, the information is presented best to the workers by a virtual reality which is an image of their own work area inside the factory. There will be images comparable to the existing machine tools in real life. These machine tool images will also have displays where information is presented. They can be recalled by mouse or touch screen actions. So every information will be placed on the screen at the same place where it is situated in real life. The information the workers need and which are not obviously created inside their work area will be presented as notices on special boards. For the information input there will be the image of a computer on the display. If somebody clicks on this computer, an input mask will be generated concerning the desired data.

The modelling presentation

The modelling presentation will be the main used presentation for the engineering level. As already mentioned there is a huge amount of information necessary for daily work in this level. This amount makes it impossible to use virtual reality for the presentation without getting unacceptable response time, and unclear, overloaded views. As figure 3 shows, the most important programmes which will be used for daily work are represented by command buttons on the tool bar.

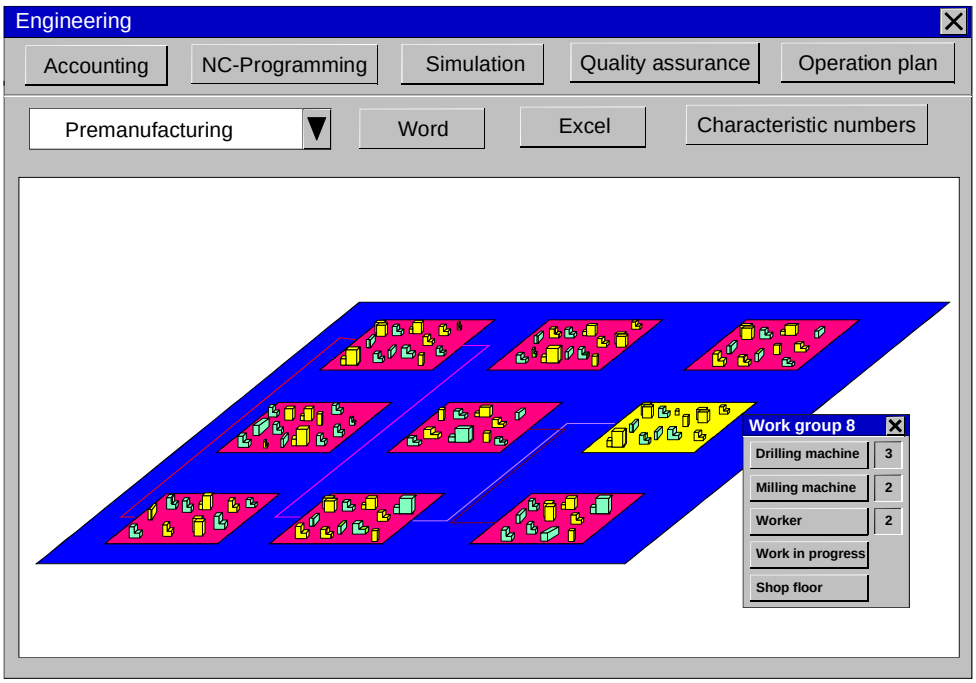

figure 3: Modelling presentation for the engineering level

The button "accounting" connects the computer with the controlling department to get important information for user's work. Simulation will be used to optimise the utilisation constraints of the machine tools and customer due dates. The operation plan which is necessary for manufacturing at the shop floor has to be created and stored in the engineering level. So there is a special link to a programme for creating and storing the operation plan in the engineering view. Another important point is compressing the information to characteristic numbers for the management. For each work group there are condensed information presented which can be started by a mouse click. More detailed information are available by pressing the command buttons in this window. There is the option to change into the shop floor view of the regarded group.

The abstract presentation

This presentation is designed for the management level. On this level there is an authorised access to all existing information concerning the enterprise. Because of this huge amount, the information should be compressed to characteristic numbers. For this purpose it is wise to use an abstract presentation instead of a virtual reality presentation because managers on this level often do not know where the information is created. So it is not possible to use the three-dimensional imagination in order to ease the finding of information. The abstract presentation, as it is shown in figure 4, is in this case the most meaningful type, because it guarantees a fast access to the information with a clear presentation.

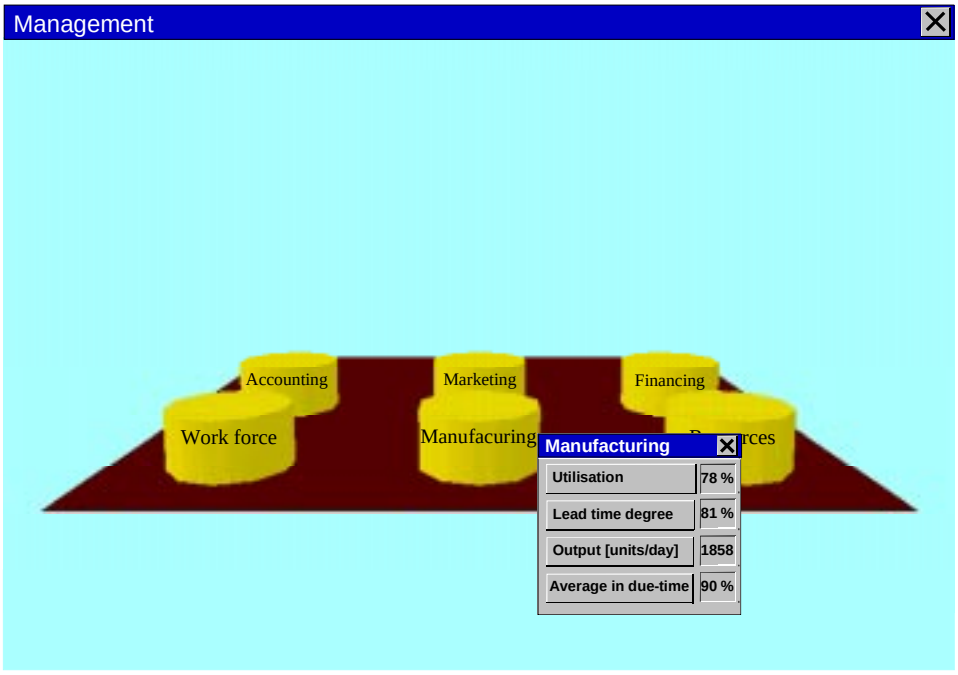

figure 4: Data view for the management level

The presentation of information is structured like a hypertext. The first display which is shown for the management level is the presentation of every department in a three-dimensional room. This presentation form uses the three-dimensional imagination of the users. With the click on the right mouse button all characteristic numbers of the whole department will be shown in a window. To get detailed information about this characteristic numbers, the button inside the window is to be clicked. By pushing the left mouse button the sub-departments will be shown. Another possibility is to see links between the departments and their characteristic numbers which depend from each other. The whole presentation is adaptive, which means that the user may change the places of the presentation of each object.

Further Investigations

This visual representation model of factory information exists at the moment only as a concept. To get more information about the usability of such a concept several investigations are planned for the future. For these investigations it is foreseen to use several methods to evaluate the ergonomic aspects of the human-computer-interface. Besides a practical test in co-operation with industrial partners the model will be evaluated with PROKUS. PROKUS is a computer supported evaluation-tool which is a development of the ifab-Institute at the University of Karlsruhe (GRIEßER,

FISCHER, JONSSON 1996, pp. 93). Other methods to be used in an experimental test are eye mark registration and keystroke-recording. These tools help to investigate the behaviour of test-persons by solving typical tasks (see also GRIEßER 1995). In addition to these methods every test-person will be interviewed.

The new concept which is described here is based on several experimental investigations. The first investigation considered the representation possibilities for characteristic numbers and the general representation of data. For achieving the results in the usability laboratory at the ifab-Institute at the University of Karlsruhe the methods of eye-mark registration and structured interviews were used. Based on the results of this investigation a second one was started, considering the representation of comparisons between different planning processes. The aim of this experiment was to find out a relationship between different kinds of information representation, personal preferences and the correct interpretation of data (see GRIEßER, FISCHER, JONSSON 1996, pp. 93). One result of this experiment was that there is no relationship between the correct interpretation of data and the choice of a two-dimensional or a three dimensional representation of information. Another aspect which was not considered in this investigation is the information retrieval which is part of this concept and further investigations.

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