Multimedia Technologies Provide Test Scenarios in a National Research Project

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Abstract – **This paper discusses some of the advantages of using a multimedia system to deliver the diverse range of information within the manufacturing environment. The multimedia technologies allow a user to have controlled access to the required information within a a range of applications, in an easily accessible and structured manner, by using on a system delivering maintenance and process information on the factory floor, within a fully automated manufacturing plant. The close monitoring of the operational performance of various plants, manufacturing shops-floor/cells/machines, as well as their associated instrumentation and control is seen to be of increasing strategic importance. Failures can lead to increased costs, reduced product quality, consistency and production, plant shutdown, an increased environmental impact. There is a real need for the advanced monitoring/supervising technologies to be applied, and their potential demonstrated, on complex industrial plants. With the integration of multimedia technologies and knowledge-based systems with network technology giving access to external databases, we may analyze a concept of industrial multimedia that can be realized.**

I. INTRODUCTION

The Hungarian Government had launched a research and development program to support high-tech national projects in several fields. The concept of Digital Enterprises and Production Networks was evaluated as a convincing topic for research, development and initial implementation. The project plan identified 3 separate fields of focused interest, and selected the tasks within 3 parallel running program streams, referred to as project clusters.

This paper gives an explanation on the structure of the project within the second cluster that was devoted to interactive multimedia and tele-presence. Comprehensive descriptions can be found at [1].

Information technology developments have given faith to system designers to plan for a new generation of manufacturing environment. Some experts tend to call this new era as DIGITAL revolution in manufacturing, and foresee a time in the near future, when the "paper-less office" will be replacing the present workplaces. In a similar process as the design and planning, also the execution and control of the manufacturing processes in a factory will (or could) run in a paper-less style, and this vision has led to the birth of a new topic: "running a digital factory". Our consortium, consisting of a large and a small industrial enterprise, 2 departments from 2 separate Hungarian universities - and an academic research institute has selected certain subtopics to get prepared for the new age of running "digital factories".

The project has reached its end-term, and the implementation and test phase has enabled the verification of our preliminary research results. Further important aspects of the research project, e.g. topics on Constraint - based scheduling for production planning and artificial neural networks' training and application are detailed in other papers of this workshop, and in [2], [3].

II. THE DRIVING FORCE: EFFICIENT INFORMATION MANAGEMENT

Information Management plays a critical role in almost all areas where computers are used. This area includes the acquisition, digitization, representation, organization, transformation, and presentation of information; algorithms for efficient and effective access and updating of stored information, data modeling and abstraction, and physical file storage techniques. It also encompasses information security, privacy, integrity, and protection in a shared environment.

The integration of complex system data is a principal key to efficiently ensuring in same time the objective and the performance of complex systems. The way to provide the right solution involves some essential elements:
-the systematization of the system data through an integrated data schema for representing system product and process information, which is critical in developing and controlling a sophisticated integrated environment.
-an integrated environment that employs formal methods and automation to support the full range of data manipulation and communication required by complex system life cycle activities; provides a continuous down to business means of identifying and successfully addressing the main challenges for a complex system over time;
-an open philosophy, where the governing rule of the enterprise is the collaborative teamwork and personal contributions are encouraged and efficiently administered.

Multimedia documents provide a means of communicating and storing information. Since such documents are used in electronic format only, many variations in viewing result as each user controls the order and manner of interacting with each element in the document. In addition, multimedia documents can also be designed to receive information from the reader and process it to provide individualized responses. This interactivity adds a new dimension to the reading/writing process and the capabilities of reading and writing.

The biggest obstacle to the successful implementation of the multimedia based applications is the authoring labor required. This requires significant effort in several areas, including the assembling and formatting of the data, construction and validation of the scenario, and subsequent maintenance of the system. Collection and formatting the documentation is the prevalent element and can vary relative to the available material. The documentation may only be available in a paper form, and therefore need to be converted into electronic format before loaded into the system.

There is no any unitary existing classification we can use for multimedia development. The approach is better a holistic one to the content or a smaller content units cataloging, or even data entities? The parallel between MM designers and painters given in Reiser and Reiser [1995] could be the answer. Painters look at each detail separately and also step back to look at the composition as a whole. Designers, just like painters, may find it difficult to not focus on details, and hence to forget the purpose of those details in conveying the message as a whole. Thus, the description must identify general categories of data objects as well as relationships among them that may affect the decision-making process.

The successful introduction of any new equipment or system is largely governed by the acceptance of the new item by the users. There is therefore a need to evaluate the effectiveness of the Human-Computer-Interaction within the factory environment, along with the design of the user interface and navigational aids.

The industrial environment brings together users with different and varying computer skills, all of whom need to be supported. It is well know that effective screen management is a key to efficient human-computer interaction. Modern Graphical User Interfaces such as Microsoft Windows allow users to have a number of pieces of information displayed concurrently on the screen with each piece of information being displayed in a separate window that can be moved and sized independently of the others. For some users, the conventional Windows interface will be far too unstructured, it is very easy to hide inadvertently a piece of information with another window. To manage the screen resource within Windows it is necessary for the user to be reasonably comfortable with skills such as moving and sizing windows. Not all users want this ability as the focus should be on accessing the desired information. Because of this, interfaces are often developed, using fixed windows that cannot be moved or sized. The system takes responsibility for stopping information from being obscured by fixing the windows and restricting the flexibility of the interface. For a novice user this might be quite suitable. For an expert user however the restrictions might affect their ability to access the information they desire. Multimedia tools can be applied to overcome the bottlenecks, and to maximise the efficient bandwidth mand minimise the required time needed for the job.

Within any manufacturing organizations, engineering personnel are highly skilled, and hence highly priced, therefore the percentage of their time spent on performing useful maintenance tasks must be maximized, in particular the time spent locating the correct information must be minimized. Estimates have shown that over half an engineer's time is spent in searching for and retrieving information to undertake an activity [Hogbin, 94]. It is the ability to integrate many forms of information, from a number of sources, and allowing the engineer to access them with ease, at a single point, that has led to the requirement for computer based information retrieval system.

In the development of an industrial multimedia application, a number of questions need to be addressed, in particular those relating to the capture and subsequent authoring of the information resources for the application. Within manufacturing industry, operational and maintenance information is normally held on either paper or microfiche. The size of a set of documents ranging from a few hundred pages for a medium sized industrial machine-tool, to thousands of individual manuals, with supporting engineering drawings, for a complete manufacturing plant. If the information provision not only includes production and maintenance information, but also incorporates design, quality, and standards, the stored documentation can become significant. With an industrial application it should be noted that the information capture, digitizing and authoring is a continual process as modifications are incorporated, all of which must be correctly linked into the existing multimedia system.

Many people benefit from the advantages offered by artificial intelligence and some modern techniques, which include fuzzy concepts, and a lot of friendly tools is intended to help them to understand one of the powerful techniques behind them. It is obvious that a 3D simulation, a movie film and a spoken material can say more than letters can do. The development of the modern society is based on the technical progress, which in change implies a growing complexity of our world. These needs to be overcame by the society and the best way to do it is using the new facilities offered by modern devices that generated the issue. Multimedia can help us to achieve faster the knowledge and the understanding of even abstract or complex problems. Internet facilitates access to an enormous informational database, and more than that, offers the possibility of distance interacting between those who are searching in the same area of interests. We tried in our projects to mix all the multimedia facilities in order to make easier the interactive learning process. The Internet integrated facilities offer the possibility of long distance testing and to interact via news groups and WWW.

III. INITIAL AIMS

There are several fields within a factory environment, where it is essential to involve human experts to observe, to test, to control and to feel the details of the production processes, both in the design and the planning stages, and during the manufacturing, testing and verification processes. As soon as digital technology reaches a complexity within the environment, appropriate digital communication and information processing subsystems

can meet the above listed user requirements. These new features raise the quality level, the efficiency, the observability and controllability of the production, but also allow the customer and end-user to actively take part in the processes of manufacturing. Implementing interactive multimedia services for tele-presence, advances the technology of the given manufacturing facility into a new, higher level. Dreams were envisaged to introduce such tele-presence oriented multimedia services within specific productions scenarios at several industrial factory sites. The foreseen applications and dreams were giving us an inspiration, and helped us to achieve the basic goals.

Till present, computing environments have been dominated by a standard desktop/laptop configuration. A single user sits in front of a screen with a keyboard and pointing device, interacting with a collection of software applications. As many researchers have pointed out, computing today is moving away from this model in a number of areas:

- Information appliances, such as palmtops, computers integrated with mobile phones and small specialised information devices;
- Information environment, which occupy room-sized spaces, making use of large display areas, sound, environmental control, etc. ;
- Immersive environments, both head mounted and shared;
- Multi-user work environments, with large shared displays and multiple devices operating in an integrated information environment;
- Deviceless interaction, in which people's normal movements, gestures, vocalisations, and even physiological parameters are observed and interpreted by the computer system.

During the 80's, the accent within manufacturing industry was on the integration of a number of systems within the confines of a single manufacturing plant. This was illustrated by the introduction of CAD/CAM, and its integration with the production and planning systems. The result was that each manufacturing facility became an island of automation. Currently the highlight on integration is moved towards the concept of the virtual factory through the use of supply chain management techniques, such as electronic data interchange or just in time. Successful collaboration within and between organisations is in principle achievable by sharing the wide range of engineering and commercial information produced, and used during all phases of the business process.

To the manufacturing engineer, integrated manufacturing means the integration of CAD/CAM/CAE, while to the factory deck it implies a communication and system consolidation exercise. In the fields of manufacturing, intelligence will generally be given to individual manufacturing cells, to aid with production, quality, and maintenance. Database and information systems technology therefore have a crucial role to play in modern manufacturing management. Rigorous and consistent structuring of data that describes a product from design to final shipment will potentially allow anyone within the organisation to access the information for their decision making process.

IV. THE MULTIMEDIA ROLE WITHIN MANUFACTURING

Computer-based systems for the presentation and distribution of text together with a limited range of graphical information, in a linear sequence fashion is no longer considered sufficient, for the complexities of modern production equipment. If the information available is expanded to include high quality graphics sound and video, and is provided with a retrieval system that permits the user to move easily between the different items of information in a structured fashion, then the management of the engineering data resource can be optimised.

Each of extensions to today's standard computer interaction modes raises its own technical difficulties and specialised areas of research. The conventional model of interaction architecture and device communication that has served until now will have to evolve towards a "human-centred" architecture. Rather than conceiving of systems as a network of processors and devices, we will build them around an architecture of user-centred models, which cut across conventional device boundaries.

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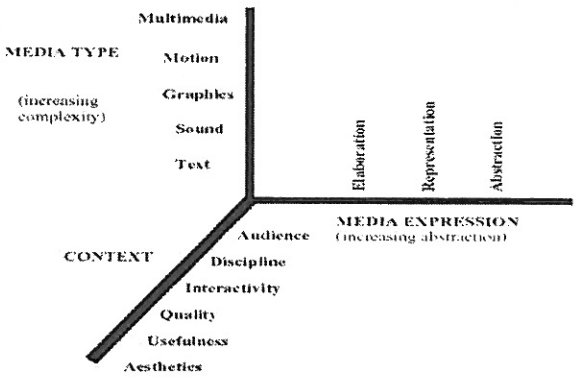

Fig.1. Multimedia aspects

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the time spent locating the correct information must be minimised. Estimates have shown that over half an engineer's time is spent in searching for and retrieving information to undertake an activity [Hogbin, 94]. It is the ability to integrate many forms of information, from a number of sources, and allowing the engineer to access them with ease, at a single point, that has led to the requirement for computer based information retrieval system.

The biggest issue of a successful implementation of a multimedia application is the authoring effort. This requires significant effort in several areas, including the collection and formatting of the data, digitization process, construction and validation of the navigational structure, and subsequent maintenance of the system. Collection and formatting the documentation is the biggest element and can vary depending on the available source material. At one end of the spectrum the documentation to be used may only be available in a classic form, and therefore need to be digitized into electronic format before loaded into the system. On the other end of the scale, all the materials will be available in electronic form, therefore inputting the information will be a relatively easy task. One of the main differences between traditional documentation and multimedia, is the ability to use temporal data such as sound and video. This will have a considerable impact on the presentation of dynamic information to engineers.

Extensive use of 3D models is an important part of the authoring process. Within the factory floor environment the use of computer generated graphics are more acceptable than a photograph. The application uses graphics not only to provide information, but also to act as a menu as part of the user interface

V. ACCESSING INFORMATION

The introduction of multimedia into manufacturing industry is governed by acceptance by factory floor personnel, this in particular, requires the user interface to be carefully designed. Most of the constraints are centred on finding an acceptable system, which will allow the maintenance engineers to use the multimedia enabled system with ease on the factory floor, and require storage and display capabilities. At present, the standard interface for Windows based system (such as the mouse used as a pointing device), has been shown to inappropriate to the factory floor environment due to special conditions and the lack of convenient flat surfaces. There are a number of options, including tracker balls and touch screens, but the pen computer currently provides the most acceptable approach.

The major disadvantage of any form of portable computer is that it is a one or (more probably) two handed operation, as with paper documentation it is not a 'hand free' operation. As a solution to this we are currently investigating the use of the true wearable computer. These systems, such as Virtual Reality based simulation of Flexible Manufacturing Systems, [Kopacsi, 2000], have a head mounted display, with a computer and battery pack worn on the belt, with GPS features could be included. The combination of a voice operated system and head mounted display provides considerable advantages for the user when operating within the confines of a machine.

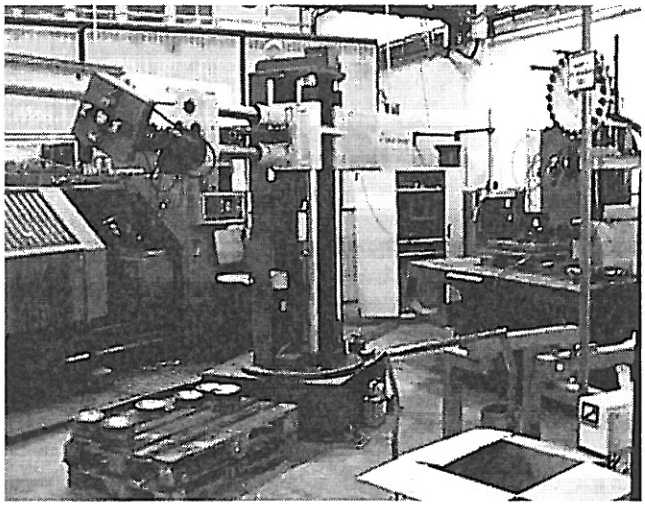

Fig.2. Flexible manufacturing cell

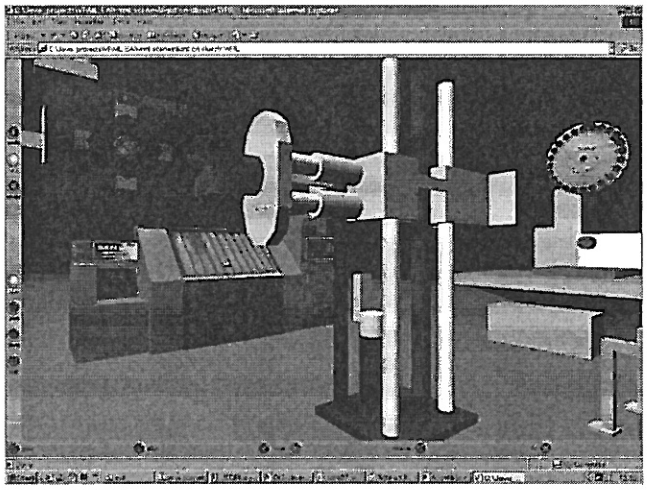

Fig 3. Virtual Reality model of the cell

The successful introduction of any new equipment or system is largely governed by the acceptance of the new item by the users. There is therefore a need to evaluate the effectiveness of the Human-Computer-Interaction (HCI) within the factory environment, along with the design of the user interface and navigational aids.

The industrial environment brings together users with different and varying computer skills, all of whom need to be supported. It is well know that effective display management is a key to efficient human-computer interaction.

There are important features that need to be considered with any proposed solution to display management:

* The display management should be able to be tailored to meet the needs of individual users.

* The display management should be centralised to allow the interaction between interface components to be controlled as well as the individual appearance of interface components.

We have therefore been developing processes that provide a number of different screen management functions. The openness of the system allows the display management functionality to be determined by the users' requirements. Furthermore, as new display management tools are developed they can be plugged-in directly into the

system without the need to alter all the modules that contain interface components.

VI. ACKNOWLEDGEMENT

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VII. CONCLUSIONS

The application of Multimedia Technologies in manufacturing is still not yet a fully evolved capability and accepted practice and it requires more investment in adequate education and development of available hardware/software tools. As manufacturing systems tend to evolve into networks of co-operative nodes forming e.g. virtual enterprises, these new technologies will be even more beneficial. Our present projects are focusing on these aims.

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