

In this issue

1. Papers in Distributed Enterprise

Santoro's "The procurement process in the Virtual Vertical Enterprise scenario: the point of view of Large Enterprises"

Within the context of distributed enterprise operations, the question of who will drive future business networks is an essential issue: will it be the large enterprise that often is at the centre of a business network, the small and medium sized enterprises that form the network or will there emerge a new type of entity, i.e., an entity that will solely concern itself with co-ordination of production, transportation and distribution? This is the central topic analysed in the paper of Santoro.

Another fundamental question related to the above concerns the nature of the business relations in these business networks: will networks consist of a few partners that co-operate over a long period of time or will they consist of many partners who occasionally meet for a limited period of time. Important business decisions need to be taken, as, for example, on which core functions to concentrate and which functions to out-source and, in all these, what level of scope or influence is kept, how autonomous will the components be, etc.

Santoro introduces here a new concept of the 'Concurrent Enterprise', which combines the concept of concurrent engineering with the concept of the extended/virtual enterprise. A large enterprise perspective is taken and emphasis is put on the business integrator entity that has the responsibility to co-ordinate the constitution of the virtual enterprise by defining its organisation, processes and information and communication technology.

Mezgár and Kovács' "PLENT: A European Project on SME co-operation"

Contrary to Santoro's view of a dominant position of large enterprises within future business networks, in their contribution, Mezgár and Kovács analyse the perspective of a small company within the context of co-operation with Eastern Europe. The application do-

main is specific and concerns agriculture production. To a certain extent, irrespective of whether the business network is dealing with high technology or commodity goods, the deployment of appropriate ICT is in both equally critical to achieve competitive advantage.

Mezgár and Kovács describe a holonic approach applied to the co-ordination of the production by SMEs in a virtual enterprise. The manufacturing network model applied consists of three modules notably a co-ordination, a local planning and a performance evaluation module. The design and management of a Hungarian network in the field of financing oil seed growing on plantations, seed-oil production and trading are then described in detail. A critical factor is timing, and main advances achieved relate to the agricultural production becoming more reliable.

Hasle's "Transportation management in distributed enterprises"

Electronic commerce is one of the development areas that will and are already revolutionising the business environment in Europe and in the rest of the world. Electronic commerce can be defined as all commercial activity conducted over electronic networks, often the Internet, which lead to the purchase or sale of goods and services. The connection between electronic commerce, benchmarking and transportation networks (the subject of Hasle's paper) is intimate and many-fold. The new business processes that need to be put in place in an electronic commerce environment put great strain on the transportation networks and call for a deeper integration of the production and the transportation network. Similarly, increased consumer involvement leads to a greater variety of products that have to be delivered and supported world-wide. This in turn needs improved decision making that has to consider amongst others the transportation cost.

In this context, Hasle stresses the need for highly optimised transportation management practices at the strategic, tactical and operational control levels. The system developed in the Esprit project GREENTRIP is described. It centres on state-of-the-art decision support tools in transportation logistics. Two examples are presented in detail. The case of PIRELLI concerns

setting up and modifying the distribution network of cables. In the case of TOLLPOST-GLOBAL, the local pickup and delivery of small parcels in the Oslo area are considered. Although the assessment of business improvements has not been finalised, improvement levels of 10% on economy and 25% on environment damage have been indicated in one end user case.

Pham, Dimov and Setchi's "Concurrent Engineering: a tool for collaborative working"

Companies world-wide are introducing Concurrent Engineering (CE) practices as a fundamental part of their product development process. CE is seen as a systematic approach to the integrated concurrent design of products and their related processes, including manufacturing and support. It enables considering all elements of the product life cycle, from product conception to disposal including quality issues, cost and service support.

In the last decade, the rapid advance in CAx technologies enabled the use of solid models, digital mock-up and virtual prototyping as tools to reduce design errors. Furthermore, the explosion of the Internet facilitated EDI use and helped the introduction of electronic exchange of information to business practice and supply chain integration. Today, within the supply chain, CE requires participation from all partners involved in the product in order to achieve maximum benefit.

In their paper, Pham et al. describe three different systems they developed when applying CE methodology within the framework of a number of BRITE-EURAM and INCO-COPERNICUS research projects where they participated.

The first application deals with the use of 3D product CAD modellers and the efficient structuring of information regarding a product in order to provide a *design decision support system*. The described system is a combination of a feature based 3D object modeller with an expert system capturing knowledge relating to the underlying characteristics of manufacturing processes, equipment and process planning. According to the authors, such system allows decision making on product "manufacturability" and estimation of production cost and permits a better integration between product and process design.

The second application is relating to a system for the *extraction of assembly models and assembly related data* from 3D CAD models of products. Such system permits the analysis of possible assembly strategies

of a given product and their automatic generation by matching the technological requirements that the product has to fulfil with the capabilities of the manufacturing processes and manufacturing equipment to be used.

The third application is a system for providing *intelligent product support*. The system integrates three different technologies, namely CE practices, knowledge-based technology and hypermedia tools. CE technology is necessary for providing collaborative authoring of product manuals and for achieving integration of product data. Knowledge data base systems are indispensable for storing and retrieving experts' knowledge on the product and for supporting product operational and maintenance procedures. Finally, virtual reality technology is introduced for improving the presentation of design and for creating virtual reality scenes and 3D animations using the 3D CAD product data.

Białek, Gruszka, Karolczak and Koch's "Distributed Enterprise from the supplier point of view on the example of WSM Krotoszyn"

The opening of national economies to world markets has been a major catalyst for restructuring, for the introduction of new technology and for increased international co-operation, especially between main manufacturers and suppliers. This led to a rapid transfer of technology and helped Eastern economies to catch up relatively quickly. The establishment of a modern ICT infrastructure, the development of appropriate skills and the necessary changes in the regulatory and legislative environment helped to create a very promising market.

The example described in the paper of Białek et al. concerns a manufacturer and supplier of cylinder sleeves and elements of tuning gears for combustion engines situated in Poland. The company co-operates with several main manufacturers in a distributed enterprise. As a result of the opening of the Polish economy, it had to upgrade its operations considerably in order to be able to compete with other suppliers. The main areas for improvement sought included the increase of quality, the reduction of inefficient time and becoming more customer oriented.

In going through this process of upgrading, emphasis was put on training and the use of by now well known technologies. Especially, in order to improve co-operation with the main manufacturers, EDI was successfully introduced and this led to significant re-

duction of transaction costs. According to the authors, probably a major reason for success was the setting of clear business goals driving the change together with a good understanding of technology and the possibilities that ICT can offer when properly implemented.

2. Papers in Intelligent Automation

Valckenaers, Van Brussel, Wyls, Peeters and Bongaerts' "Multi-agent manufacturing control in holonic manufacturing systems"

Rapidly evolving customer requirements and lower-cost, low volume customised products require from tomorrow's manufacturing and production systems to become more agile, more flexible, more networked and being based on *distributed* and *autonomous* entities, production units, subsystems and machines equipped with appropriate communication capabilities. In the international literature, there is an abundance of new theories and implementations relating to future *intelligent manufacturing systems*. They mostly involve the use of intelligent multi-agent systems technology with self-adapting, self-learning capabilities and increased co-operation and communication skills for scheduling, realising and co-ordinating production and for optimising *local reaction* while operating within a *global information framework*.

Work on *Holonic manufacturing systems* is one of the most important recent research efforts as a response to the challenge of designing and implementing 21st century manufacturing systems. In their paper, Valckenaers et al. present the latest ideas and implementation results achieved at Katholieke Universiteit Leuven when applying the notions of holons and holonic systems in manufacturing control. After a short introduction on the basic holonic concepts they use, Valckenaers et al. describe the reference system architecture and the basic system behaviours that are achieved. The reference architecture consists of a number of basic autonomous and co-operative entities (called *holons*) and of their appropriate hierarchical structuring.

Basic system behaviours and specific system dynamics are achieved through an adequate control system design according to which, the overall system behaviour *emerges* as the result of the behaviour of smaller entities in the system. Such entities are implemented as agents that are loosely coupled to the overall system. According to Valckenaers et al., the introduction in this system architecture of an ant-like agent

communication and co-ordination technique permits distribution of local agent knowledge and information at global system level without exposing the agents to the global characteristics and complexity of the whole manufacturing system. This is seen as the key issue that enables implementation of flexible systems that exhibit self-organisation properties and can cope with global changes through local adaptations.

While current laboratory and small-scale first practical implementations of the holonic manufacturing systems paradigm already confirm foreseen potential advantages, their full-scale implementation and testing in manufacturing industries constitute the major R&D challenge for the next coming years. In such effort, certainly future holonic manufacturing systems will increasingly gain from advances in software agents, agent communication technology and object-oriented programming languages.

Chrobot, Klukowski, Koch, Rakowski, Smalec and Weiner's "An example of a shop-floor control system application in a Polish manufacturing company"

Until 1989, CEEC industry was lacking internationalisation and its production patterns were decided by planning authorities rather than the market. Ever since, trade liberalisation and opening of frontiers to the free market economy were the driving motors towards an organisational and technical restructuring of CEEC manufacturing companies. In fact, changes in CEECs' industry that are under way are closely following concepts already validated or under validation in their Western European counterparts, namely restructuring and re-organisation of activities following new principles of *work organisation* and *personnel management* and better use of available information and communication technologies.

In their contribution, Chrobot et al. report on such efforts with some particular emphasis on the role that information systems and especially shop floor control systems play in this restructuring process. Restructuring the company organisation into small, decentralised and self-organised units facilitates decision-making. This in turn reduces the requirements of the company's information and communication system, since this should focus only on few well-defined processes and their specific tasks.

With the advent of decentralised organisations comes also the need to adapt shop-floor control systems to

the new decentralised structure of production departments. Existing central management and planning systems are replaced by new distributed information processing and shop-floor control techniques that allow efficient production planning and enable optimisation of the underlying manufacturing processes by controlling the timely realisation of shop-floor tasks. Their effective integration with the existing company information flow makes possible their communication and co-ordination with other existing shop-floor control systems.

In the last part of their contribution, Chrobot et al. describe a shop-floor control system that has been implemented in a Polish manufacturing company within the framework of the INCO-COPERNICUS project 94337 "Adaptable low-cost shop-floor control system" and the results that have been achieved. According to the authors, such system is in fact "one of the rare examples in Central and Eastern Europe dealing with information and communication technologies in an engineering way".

Koch, Smalec, Reiner and Skura's "Communication systems in manufacturing and their role in automation"

The existence of reliable, cost-effective and secure information and communication infrastructures is increasingly driving all the business operations of production companies. In particular, within a company, ICT technology plays an essential role in transferring high volume information flow between the various company units. It also plays a catalytic role in the design and implementation of distributed manufacturing systems at the shop-floor level.

In the first part of their contribution, Koch et al. review the communication networks that are actually employed by manufacturing industries to cover their communications requirements. Three different types of communication networks are identified and relating standards listed: Wide Area Networks (WANs), Local Area Networks (LANs) and fieldbusses. WANs and LANs are mainly used by companies for communication of voice, video, fax and computer data with the exterior world and other company sites; LANs are used rather locally, for inter-office communication of information between different company units; and fieldbus technology is mainly reserved for communication purposes at the shop-floor level.

In the second part of their contribution, Koch et al. focus on the use of fieldbus communication systems. They support that the design of distributed manufacturing systems is strongly dependent on the technology of the underlying system communication networks where shop-floor equipment and machinery together with I/O devices, sensors, actuators and control units are connected. For decades, communication systems for shop-floor automation have been the exclusive realm of proprietary devices and architectures. However, solutions for intelligent automation demand communication systems that are open and standardised for guaranteeing easy connection and full interoperability of off-the-shelf devices ("plug and play"). Recent developments in computing electronics and their peripherals and the strong user requirement for standard solutions have permitted the development of cheaper communication systems with comparable reliability, short response times and high-volume data throughput. Reduced installation costs, simple expandability, system's speed and distribution of the intelligence are now the primary motivation for migrating from conventional wiring to serial bus systems. At present, there exist a multitude of industrial fieldbus communication systems, which compete with each other in the market. They differ in the complexity of the communication protocol they use and the electric characteristics of their interfaces. They all battle for the crown of a world standard. Despite recent standardisation efforts in the area and the recent establishment of a couple of CENELEC standards, the debate and efforts for open systems and standardisation solutions that provide to the user seamless integration of automation devices irrespective of the underlying physical application are still ongoing.

Koch et al. conclude their contribution by presenting the communication network – a combination of LAN and fieldbus technology – that has been implemented at their Institute of Production Engineering and Automation in Wrocław (Poland). The development of such network has been co-supported by the INCO-COPERNICUS project 960161 TRAFICC.

Garibotto's "Computer Vision and robotics in postal automation"

The recent liberalisation of postal services in Europe, the continuing transformation of national post services into private companies operating under open market competition conditions and the appearance of new players in the area introducing new services and

employing the latest available telematic technologies have dramatically increased competition in the postal sector. Key success factors are high efficiency and increased service quality.

Within this highly competitive environment, several modern automation solutions in conjunction with recent advances in information technology and telecommunications have opened new perspectives of development in postal automation that could provide the sought efficiency and quality. Typical examples include the use of intelligent sensors and the application of recent advances in Image Processing and Computer Vision for sorting and classification of mail, the use of planning and control systems for dealing with postal logistics and mail transportation and distribution issues, the introduction of robotics technologies for material handling, loading and unloading operations, etc.

Garibotto extensively reports on all those postal operation processes that can benefit from automation solutions and provides some concrete application examples. Among the solutions, one can report the following:

- automatic mail sorting and especially flat sorting systems and machines with automatic address reading capabilities. Typewritten and hand-written address reading is based on optical character recognition systems guaranteeing a good success recognition rate (actually at the level of 70% for hand-written and approaching 98% for typewritten mail);
- 3D parcel sorting and parcel classification systems according to parcel size and shape. They use 3D vision classification techniques based on stereo vision or projected light patterns, which make recourse to 3D model-based object recognition techniques. From the bulk of daily mail, flats represent one of the most challenging objectives for postal sorting machines because of their volume figures and growing circulation rates;
- mechanised and highly specialised sorting machines for loading, handling, sorting and sequencing mail;
- transportation systems of mail items (loading/unloading of letters and mail) to/from mail sorting machines – these include rail transport systems, electric tracks and more recently, autonomous guided vehicles and mobile robots equipped with sensory and autonomous navigation capabilities.

The availability of new high-resolution imaging sensors, fast pre-processing tools and new real time hard-

ware and software solutions – especially the implementation of new robust object recognition algorithms and 3D Computer Vision techniques, the ever increasing processing power and the possibility of off-line distributed reading systems are enabling the development of new systems for postal automation. In the future, the networking of postal plants together with transportation and distribution services will increase the need for new logistics solutions and in term, the possibility to offer enhanced quality services to the customer.

Batlle and Ridao's "Mobile robots in industrial environments"

The last few years, the pace of introduction of intelligent mobile robots in industrial and other indoor or outdoor environments that are capable of performing various tasks in a completely autonomous mode is rapidly increasing. According to the International Federation of Robotics, some 1000 service robots are already in every day use in various environments basically dealing with transportation and cleaning but also with a multitude of other operations (such as maintenance, forestry, surveillance, decontamination, etc.). Forecasts reveal a huge potential market of future autonomous mobile systems.

In the first part of their contribution, Batlle and Ridao proceed to an extensive overview of recent R&D efforts in the area of mobile robotics in different application areas world-wide with some particular emphasis on European initiatives. From this overview, they infer a classification of the main architectures mostly employed in today's mobile robotic systems. In the second part of their paper, Batlle and Ridao describe implementation efforts and results they achieved at their Institute relating to the use of mobile robots in two application areas, namely for outdoor navigation and for underwater exploration. Two operational modes are detailed, tele-operated and autonomous navigation.

With their contribution, Batlle and Ridao convey the following messages: new autonomous robotic systems constitute an excellent platform for basic research, development and integration of a broad range of advanced ICT technologies. Despite current successes, major R&D efforts and significant advances will be needed in human/machine communication and man machine interfaces, systems safety and reliability but also in international standards and legislation before guaranteeing a "smooth" introduction of future robotic machines harmoniously collaborating with and serving human beings in tasks of every day life.

3. Papers in Industrial Benchmarking

Andersen's "Industrial benchmarking for competitive advantage"

As indicated in the Editorial, benchmarking can be considered at three levels, notably benchmarking of a single enterprise, benchmarking of sectors and benchmarking of framework conditions. Not surprisingly, most of the literature on benchmarking deals with benchmarking in the enterprise. In the nineties, a variety of authors having different backgrounds and coming from different disciplines have extensively reported on benchmarking in various technical conferences and in business magazines and books. Benchmarking was often presented as a panacea for all business problems, the gains that could be obtained were often overestimated and the efforts needed to carry out a sound benchmarking exercise often underestimated or not mentioned at all. Since then, a better understanding of benchmarking has been achieved and recently, more emphasis is given on one hand on the benchmarking process itself – a way of analysis and learning – and on the other hand on the benchmarking of business processes rather than on a limited set of indicators. Recently also governments showed interest in benchmarking as, e.g., exemplified in an initiative launched by the European Commission on "Benchmarking the competitiveness of European industry".

In the paper, Andersen considers enterprise benchmarking and gives a comprehensive overview of what benchmarking is – stressing the learning element and the types of benchmarking that can be distinguished. The author essentially distinguishes between internal, competitive, functional and generic benchmarking, depending on who is benchmarked, and between performance, process and strategic benchmarking, depending on what is benchmarked. The various combinations that result are briefly described and put in a broader legal and ethical context. A step-by-step description of a benchmarking process is further described, which provides for each step concrete advice/hints to consider for the successful implementation of a benchmarking study. Evidence is given for the need for proper preparation and follow-up.

Finally, in his contribution, Andersen highlights major findings of his recent PhD study on results achievable through benchmarking. The author comes to the conclusion that medium strength indications for correlation can be found as follows:

- Positive connection between the existence of a formal benchmarking programme and financial savings from the benchmarking studies;
- Positive connection between benchmarking support, both from management and employees, and increased process understanding in the organisation;
- Positive connection between both benchmarking support from management/employees and financial/staff resources for benchmarking, and increased improvement motivation;
- Positive connection between benchmarking support from management/employees and overall benefits from benchmarking.

Peppard's "Benchmarking, process re-engineering and strategy: some focusing frameworks"

The primary responsibility for ensuring that enterprises remain competitive obviously lies within the firms themselves. Benchmarking goes beyond competitive analysis by providing an understanding of the processes and by identifying the factors and conditions that determine superior performance. Within this strategic context, Business Process Re-engineering (BPR) should be undertaken. BPR is not a goal in its own right and should not be undertaken in isolation. The goal of BPR should always be related to strategic business objectives and aims at improving customer satisfaction or, e.g., shareholder value.

In his paper, Peppard stresses the opportunity that BPR offers for the introduction of new and innovative ways of organising work. As in the paper of Andersen, the business process is put at the centre and here an enterprise level approach is advocated. It is strongly argued that BPR is substantially different from restructuring, delayering, TQM and other management techniques. The essence of BPR is to eliminate non-value-adding processes and this calls for a strategic approach. Equally, Peppard points to the substantial role that IT has as an enabler of BPR.

In order to illustrate the findings of the paper, a practical example in Assembly TEC is described. The main point made is that BPR is not so much about automating existing work practices but is mainly about taking a thorough look at the value adding of the processes themselves. The paper concludes with concrete guidelines for success and pitfalls in BPR.