IMPLEMENTATION OF INFORMATION SYSTEMS IN MANUFACTURING AREA

P. Peniak [a, b)]

a) IT manager, IT division Continental Matador s. r. o., T. Vansovej 1054/45, Púchov, Slovakia
b) Department of Control & Information Systems, Faculty of Electrical Engineering, University of Žilina, Univerzitná 1, 010 26 Žilina, e-mail: peter.peniak@conti.sk

Summary Paper deals with new trends regarding implementation of Information systems as one of the most important parts of manufacturing infrastructure. The main attention is paid to Manufacturing Execution Systems and Shop Floor integration regarded from the viewpoint of their implementation, manufacturing functions and integration.

1. INTRODUCTION

Industry is more and more technology driven. The following decade has to be the era of IT enabling value creation. Changing from being an internal service provider is one of the major tasks for IT. Information Technologies have been considered as support function which is not directly involved in the core business and value creation process. The success of IT is defined by the success of the business. By that corresponding key performance indicators (KPI) shall be used to define and track functional and project success. There is a need of change in the approach of implementing new IT-solutions based on

- speed of change,
- innovation capability,
- adaptation of new processes, new functions, new tools,
- the intensity of usage of the provided software,
- the ability of value creation.

Core activities and competence to run a comprehensive operating model for IT have to be identified including skills, methods and needed processes. IT takes over more and more responsibility as a partner of its customers in the definition and operation of best in class process chains at reasonable cost. An IT competence centre are to provide proactively all know how, competencies, resources, tools & systems to define and support the processes needed in the corresponding business functions, see Figure 1.

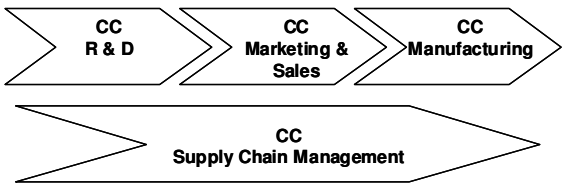

Fig. 1 Example of IT CCs (Competence Centre)

The information systems have to support all the main business processes which are necessary for running of business and to enable company operations in global environment. In addition the manufacturing area is becoming more and more dependent on IT. IT is responsible not only for value creation and support manufacturing processes but must take into consideration high availability and necessity for continual production operations. Any major fail of IT could lead immediately to stopping of production and this aspect is moving position of IT to the one of most important part of manufacturing infrastructure. Therefore an appropriate implementation of Information systems is one of the key factors of business success in manufacturing area.

2. INFORMATION SYSTEMS FOR MANUFACTURING

Manufacturing as a part of overall enterprise or local company must be integrated into general business processes that are supported by **ERP** (Enterprise Resource Planning) Information System. ERP is an industry term for integrated, multi-module application software packages that are designed to provide information system for multiple business functions as order entry, general ledger, purchasing, warehousing, transportation, human resources and manufacturing. With help of ERP companies can standardize business processes and reach easily the best practices. In addition ERP system has to provide basic frame for manufacturing support including

- budget management,
- article calculation,
- product specifications,
- Bill of Materials (BOM),
- basic routings of products via machine chains,
- maintenance methods, and
- quality system definition.

ERP systems are typical transaction oriented systems where one business function consists of several IT operations logically bound to a transaction. ERP systems are focused on transactions whose time scope is defined according to reported period such as months, days, shifts leading up to minutes.

The different approach has to be taken in manufacturing area. IS systems do not only provide information for control of production according to established rules, they have to be also designed to capture real-time data as it is created, and help manufacturers take action in the moment, based on that information. The plant floor (so called **ShopFloor**) needs are unique and require an "active" system that provides immediate detection and notification of any non-conformance event with alarming. Production managers require a system that will manage variances, problem inspection and resolution, and continuous improvement processes while enforcing production rules, operator certifications, and corrective actions. The time factor must be adjusted accordingly and should be close to real-time response [in seconds]. The direct application of transactional ERP systems for mentioned services in manufacturing area is not easily managed and brings a lot of concerns. There was a need for specific functions and IT services that could not be covered only by ERP.
Therefore there was a need to introduce middle-layer so called **MES** (***M**anufacturing **E**xecution **S**ystems*) to provide a bridge among Enterprise systems (e.g. ERP systems such as SAP, PeopleSoft), and the automation systems controlling manufacturing on the plant floor (**Machine Control**). This system shall also solve the time factor issue transforming time of operations between transactions of ERP systems and real-time communication that is required by machine control systems. The proposed pyramid architecture of information systems including time factor is shown in Figure 2. The detailed block diagram of functions that are provided by ERP, MES and integration layer for manufacturing is described in Figure 3.

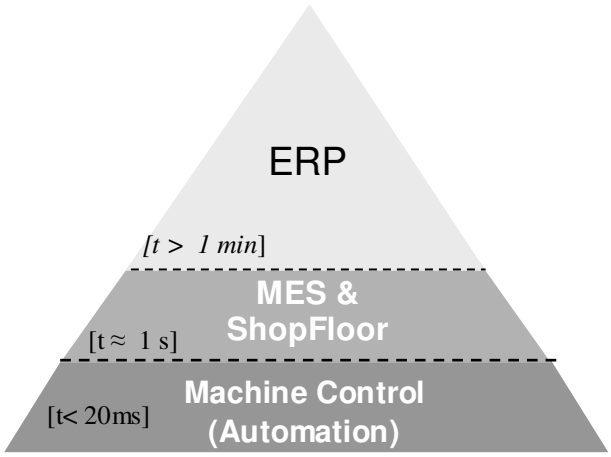

Fig. 2 Pyramid architecture of manufacturing IS

MES systems shall provide the following functions for manufacturing:

- Dispatching of manufacturing processes in ShopFloor and operator instructions.
- Comprehensive, accurate and timely production and inventory data.
- Eliminated manual record keeping, improving the accuracy and organization of the data on the shop floor.
- Provided full product traceability and genealogy correlating work orders (BoM, Recipes) with process data.
- Integrated quality, process data collection and quality analysis (quality processes).
- Reporting functions like summaries, utilization, downtime, product yields, scrap, inventory and production control (on-line reporting).

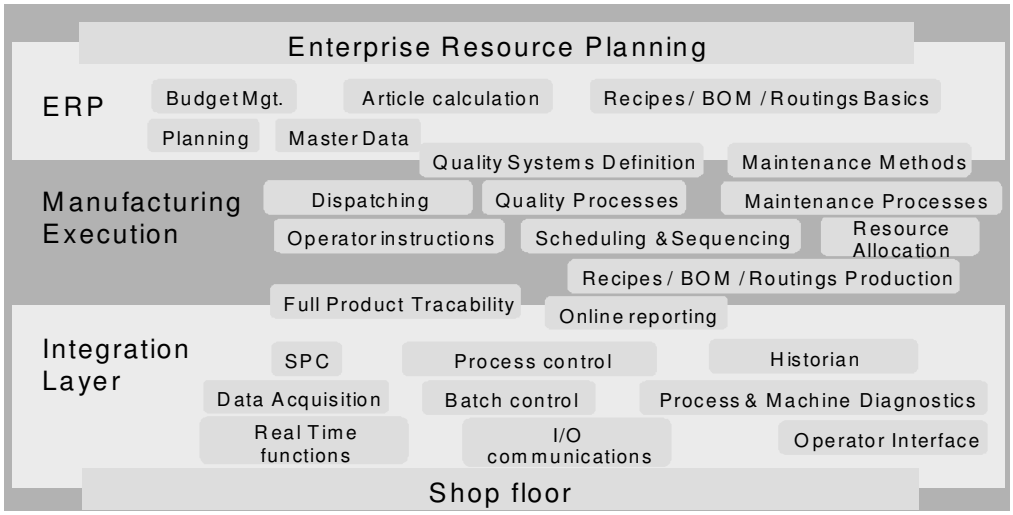

Fig.3 Block diagram of Manufacturing IS functions

There is also an **Integration layer** that creates logical link among MES and the control systems in ShopFloor. This layer must integrate various systems into one common subsystem which provides information necessary for manufacturing processes such as

- I/O communications,
- real-time functions,
- data acquisition,
- process control and batch control,
- operator interface (HMI), and
- machine diagnostics.

The ShopFloor control systems (PLCs, machine PCs, Industrial PCs, control applications) are connected to native industrial networks for instance fieldbus technologies like Profibus, DeviceNet, CAN or Industrial Ethernet. For integration with MES there are special gateways used instead of a direct communication. There are many ways how to integrate MES through the gateways with control systems in ShopFloor instead of direct communication. The former solution was based mainly on the international standard MAP/ISO and the protocol MMS (Manufacturing Message Specification) that used virtual device model for each manufacturing device and introduced mapping of physical elements of any industrial device to logical variables (Var 1..Var 3) that are accessible via network see Figure 4. By using different networks a gateway has to support several drivers for each applied industrial network protocol (Fig. 4a) or there has to be used any open solution supported by all devices for example DDE (Fig. 4b).

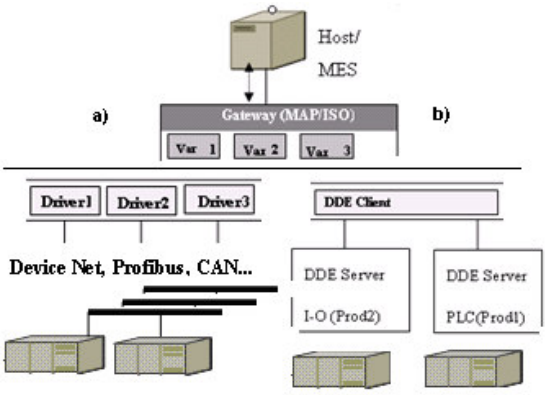

Fig.4 Gateway as Integration layer for MES

Nowadays standard OPC is widely acceptable in the area of industrial integration, which is used for integration purposes and as open model for communication. We can find the following methods for implementation of gateways

- **OPC** (**O**bject **L**ink **E**mbeging for Process Control)
- **DDE** (**D**ynamic **D**ata **E**xchange)
- **DCOM** (Distributed COM)

OPC is being used instead of MMS as de facto standard for industrial integration of control and fieldbus systems with any kind of host system or complex information system like MES for instance product with OPC Server for machines directly supporting OPC and OPC proxy for devices without OPC support, see Figure 5.

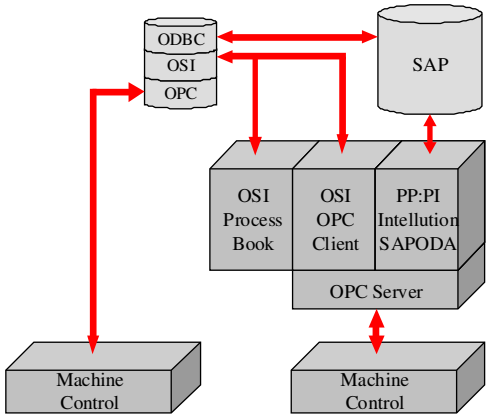

Fig.5 MES OSI with OPC integration layer

3. IMPLEMENTATIONS OF IS IN MANUFACTURING AREA

The implementation of information systems in manufacturing area and Shop Floor requires the specific conditions and building blocks (see Figure 6) in order to support real-time processes and machine control. MES systems must be available in real time so that machine control level could get necessary information for production control, recipe management etc. Therefore MES systems are to be implemented in local DPCs in contrast to ERP systems which can be hosted in central DPCs and accessed via WAN. The last decade was significantly influenced by introduction of the new technologies, protocols and standards that causes a major change in IT industry. We can summarize them as follows:

- Consolidation of hardware infrastructure (Clusters, SAN, Grids,...) with focus on availability, reliability and overall support of operations,
- Application of database technologies (**SQL**) with real-time support and fail-safe techniques,
- Using of open standards for interfacing of different products and solutions (**OPC, XML**,...),
- Introduction of effective IT operations and processes (rightsourcing, **ITIL/ITSM**),
- Consolidation of **DPC**s (Data Processing Centre) in order to reduce complexity and to provide reliable infrastructure for **ERP** systems and **MES,**
- Using of communication technologies with support of **SLA** (Service Level Agreement),
- Tracking of material flow with using barcodes and **RFID** (Radio Frequency Identification).

MACHINE CONTROL	Automation	Profibus, Device/Control Net, EthernetIP(CIP), MMS…..
	Integration level	MES, MMS/OPC/DDE gateways
MES/ERP	Middleware Components	OPC, WebSphere, BStar,…..
	Data-management	SQL DB, XML, DataWarehouses, OLAPs
	Security	Firewalls, Antivirus protection, VPN/VLAN with IPSec
	Servers IT Platforms	HW RISC/Wintel (Clusters, Blades, SANs), SW OS (UNIX, WINTEL)
	Desktops	Thin clients with Windows WP, Linux,….
	Comm Services	GroupWare, Email , LDAP, ADS…
	Comm.. Protocols & infr.	TCP-IP, Secure DHCP, DNS
	Network Infrastructure	Ethernet (10/100 Mbit and Gigabit, 10G), WLANs(802.11x)|, WANs (MPLS)

Fig. 6 Building block of ERP and MES for manufacturing

The example of IS implementation in manufacturing is shown in Figure 7. ERP system (SAP) is implemented in central DPC with using of the cluster technologies and **SNA** (Storage Area Network). ERP is connected with several plants via WAN. Local DPCs of plants host local MES that are connected via OPC/ industrial Ethernet or via specific gateways with machine control layer and fieldbus.

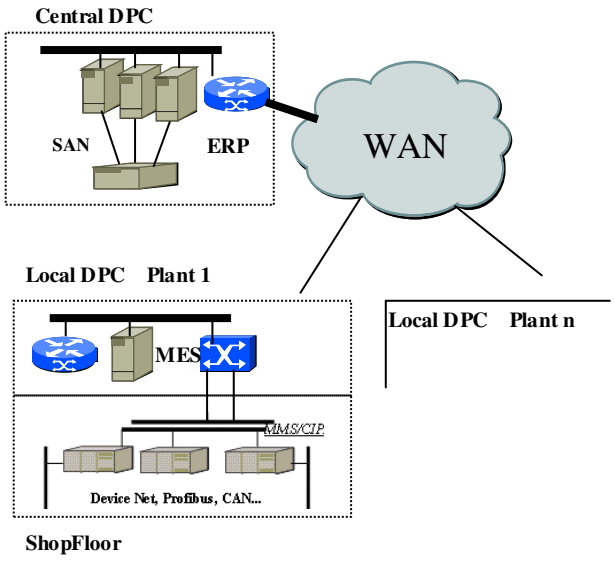

Fig. 7 Example of IS implementation for manufacturing

4. CONCLUSION

Information systems are one of the most important parts of manufacturing infrastructure. They must be implemented in an appropriate way to secure and enable necessary processes and allow value creation. They will have to cooperate more and more with control systems in ShopFloor and missing functions and services in standard ERP systems will have to be completed by using MES. MES will be a key element in integration with machine control and will be implemented in local DPC in contrast to ERP system. As well fieldbus and control level will be driven to open communication and services with IS via open and accepted standards such as OPC.

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