MAPPING DEVELOPMENT OF MES FUNCTIONALITIES

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Abstract: This paper presents a view on MES and ERP functional areas in a hierarchy of enterprise information and control systems. It starts with a background on ERP and MES Evolution. The work is based on the exploration of MES and ERP functionalities development. Consecutively, aspects of ERP and MES integration are treated. In the final section an impact of RFID technology on a validity data stored in MES obtaining from a tracing of material flow in production processes is analyzed.

1 INTRODUCTION

In the present manufacturing paradigm, manufacturing execution systems (MESs) play a significant role. Offered software solutions simultaneously close the gap between Enterprise Resource Planning (ERP) systems and production equipment control or SCADA (Supervisory Control And Data Acquisition) applications. Current ERP systems contain usually modules for material management, accounting, human resource management and all other functions that support business operations. In the past years, the role of ERP has been extended to cross-organizational coordination. Nowadays, as optimization of production activities is increasingly topical, a cooperation of ERP and MES becomes a serious concern of manufacturing managers. The paper is structured as follows. Firstly, a brief view on MES Evolution is presented. Then, MES functionalities are partially analyzed and a general functionality model is described. After that, technical aspects of ERP and MES integration are treated. Finally, decisive factors that influence the further development of manufacturing execution systems are discussed.

2 VIEW ON MES EVOLUTION

As ERP systems by nature are not suitable for controlling day to day shop floor operations, for this purpose a new type of industrial software with acronym MES has emerged during nineties (Choi and Kim, 2002). There is a more interpretation of MES depending on different manufacturing conditions, but the common characteristic to all is that an MES aims to provide an interface between an ERP system and shop floor controllers by supporting various 'execution' activities such as scheduling, order release, quality control, and data acquisition (MESA #6, 1997). In a context of the MES development and deployment it is important to point out that Manufacturing Execution Systems were originally designed to provide first-line supervision management with a visibility tool to manage work orders and workstation assignments. Consecutively, MES expanded into the indispensable link between the full range of enterprise stakeholders and the real-time events occurring in production and logistics processes across the extended value chain (McClellan, 2004).

The phenomena of globalization forces manufacturers to continuously improve their performance. In this context, manufacturing and operational excellence has become the key theme for the manufacturing companies. To improve their

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performance, most manufacturers apply methods and techniques which are focused on the elimination of non-value adding activities. Information systems can by supported in such programs or they can provide a complementary way of improving performance by increasing visibility on plant performance. Accordingly, cooperation of ERP and Manufacturing Execution Systems (MES) becomes a serious concern of manufacturing managers. In that sense, from MES applications is expected to support real-time production control as well as data collection and reporting to facilitate information operability in a company.

3 MES FUNCTIONALITIES

The A concept of Manufacturing Execution Systems is one of several major information systems types aimed at manufacturing companies. MES can be in simple way also defined as a toll for manufacturing management. The functions of an MES range from operation scheduling to production genealogy, to labour and maintenance management, to performance analysis, and to other function in between. There are several general models of typical MES functions that are principally divided into core and support functions (see more in Modrák, 2005). The core functions deal primarily with actual management of the work orders and the manufacturing resources. Other functional capabilities of MES may be required to cover support aspects of the manufacturing operations.

MESA International presents another approach to MES functionalities that is more or less based on the assumption of profitability to begin to deal with wider model of basic elements to ensure incorporating all-important functions into MES (MESA #2,1997).

A point of debate about MES functionalities also is connected with different types of manufacturing.

Understandably, from automation point of view a discrete manufacturing presents much more complicate concept comprising of various technologies that are used to integrate manufacturing system to one another. As the aim of this work is to generalize MES functionalities it is also reasonable to model of hierarchical levels and functions in a common manufacturing company. A hierarchical structure of main companies' functions in this case can be represented by four levels (see figure 1).

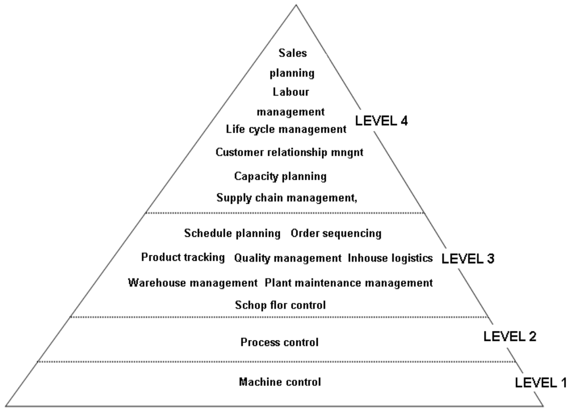

Figure 1: Functional levels in a manufacturing company.

Model of such structured company functions is often divided into three levels that are the company management, the production management, and the production control (Gunther et al, 2008). In this relation, functional areas of MES and ERP might not be considered as closed structure, because it was recognized that functions can run in the classic ERP environment as well as in the MES environment. Accordingly, under specific circumstance they may overlap of both systems. Based on this assumptions the following structure of MES and ERP functions depicted in Figure 2 is mapped.

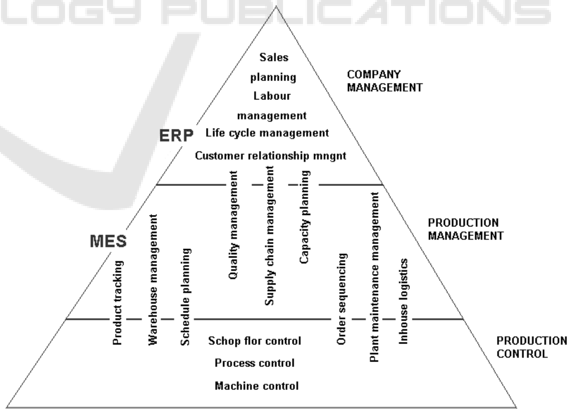

Figure 2: Intersections of MES and ERP functional areas (adapted from Gunther et al, 2008).

Obviously, the scope of operations or functions depends on number of subsystems, but the key functions remain unchanging in their essence. Because, there are no reference MES models that can be used for general manufacturing environments, overcoming of this aspect leads through the presentations of sample solutions by types of environment and other criterions. As example can be used approach to modeling three different management systems for maintenance, quality and production (Brandl, 2002) based on the S95 standard of ISA (ANS/ISA, 2000).

4 CHALLENGES OF ERP AND MES INTEGRATION

Manufacturing execution systems besides their typical functions were developed and used also as the interface between ERP and process control, since it was generally recognized that ERP systems weren't scalable. The seamless connections often required skilled coding to connect to ERP and process control systems (Siemens Energy & Automation, Inc., 2006). Today, the availability of Web-based XML communications successfully bridges the gaps between MES and ERP systems. Built on XML, the B2MML (business-to-manufacturing markup language) standard specifies accepted definitions and data formats for information exchange between systems, and facilitates information flow and updates between ERP and manufacturing execution systems. It also instigated redefinition the role of the MES. The ISA SP-95 model (see Figure 3) breaks down business to plant floor operations into four levels.

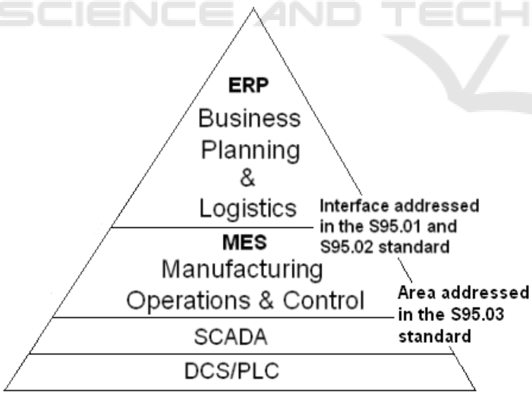

Figure 3: ISA SP 95 control hierarchy.

Levels 1 and 2 include process control zone. MES layer consists of managerial and control functions depending on different types of manufacturing. Level 4 corresponds to the business planning and logistics.
The goal of ISA-95 standard was to reduce the risk, cost and errors associated with implementing interface between ERP and MES. The ISA-95 "Enterprise - Control System Integration" is a multi-part series of ANSI/ISA standards that define the activity models and interfaces between manufacturing functions and other enterprise functions. Parts 1 (Models and Terminology), parts 2 (Objects Attributes) and part 5 (Business to Manufacturing Transactions) define the exchange of production data between business and plant systems. B2MM provides a schema implementation of the ANSI/ISA-95 and represents an independent technology implementation of this standard. B2MML has been developed by The World Batch Forum (WBF) and adopted by players such as SAP and Wonderware. Coupled together, B2MML and ISA-95 permit designers to bridge ERP and MES systems by using B2MML XML vocabulary.
Mentioned and other ISA standards significantly facilitate the implementation of integrated manufacturing systems. It is aimed to integrate ERP systems with control systems like DCS and SCADA. To support batch control level optimization, the standard S88.01 (ANSI/ISA, 1995) has been developed. It provides standard models and terminology for the design and operation of batch control systems. At the control level the key attribute is integration of all process information into one place. For this purpose are ordinarily used both a programmable logic controllers and SCADA software.

5 CHALLENGES OF ERP AND MES INTEGRATION

An effectiveness of exploitation of new manufacturing technologies depends on the way how successfully will be synchronized newly obtained data from a production control layer into MES/ERP systems. This challenge escalates as the RFID applications are increasing to a large number of products and facilities and as they include integration in broader Supply Chain Management systems. According to Williams (2005), the opportunities enabled by RFID are expected apart from other effects in simplification of business processes. Many manufacturing organizations have processes where a product, asset, document or even a person is "touched" by many different people at different times. It causes limited view of information that can introduce inefficiencies in the overall process when information about other steps is needed to execute the current step. Accordingly, common MES/ERP systems can not have an access to detailed information and they have no idea of what is really happening to material flow on the shop floor. Mentioned drawback leads to insufficient coordination between material and accompanying information flows and so-called bull-whip-effect. When all data that information systems operate with are "fed" to them by intermediary subject, information on material flow is time dependent so it is already outdated when inserted into the information system by human operator. Until the next synchronization information become more and more outdated. Reducing the bull whip effect by means of RFID system improves the efficiency of execution/information systems not only within the site but also across the supply chain. The results of our experiments presented earlier (Modrák and Moskvič, 2007) showed that application of RFID technology for tracking and traceability of material flow will impact the whole performance of information systems in terms of information validity and practically eliminate time dependence of amount and quality of information available for ERP/MES systems.

6 CONCLUSIONS

As it is conceded that production planning activities have become more complex and therefore need to be in principle optimized. Manufacturing Execution Systems, which are positioned between the Enterprise Resource Planning and control systems levels, have significant potential to be effectively used to optimize business processes on the shop floor. Besides that fact, MES are being viewed as critical in getting the most value out of existing investments in automation. A frequent interest of manufacturers concerns a balanced scale of MES functionalities. As mentioned earlier, it depends on more factors. For instance, when an existing ERP system contains factory floor control functionality, then functionality model of MES has only supplement character. Thus, a scope of MES functionality is evidently influenced by changes in using automated identification (AID) technologies, because they have positive impact on the plant floor optimization. Therefore, mass use of RFID technology can bring significant rationalizations in the manufacturing automation in the near future. This tendency was indirectly confirmed by such IT players as Oracle, SAP, Microsoft and IBM, as they all have accelerated efforts to meet the RFID challenge (Rockwell Automation, 2004). In this sense, rules concerning manufacturing execution such as control, scheduling, routing, tracking, and monitoring might all be modified responding to RFID challenges.

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