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A Statement Analysis On Electronic Manufacturing Execution Systems

Elektronik Üretim Yönetimi Üzerine Bir Analiz

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Abstract

The primary aim of the Manufacturing Execution System is to execute the production by guiding the users, to prevent limit exceeding, to add deviations, to prepare reports, to control statistics of efficiency-reconciliation and to keep records. E-MES is to enable all these functions by web-based technology. It means that the user is able to log in the system and do some transactions from home, the internet cafe, the mobile. This flexibility is very valuable in today's conditions. A line manager can check all the transactions in the factory while he is on holiday even lying on the beach, a home-office expert can log into the system and solve problems. This flexibility reduces the expenses but all these need investment on hardware and software. All costs and benefits must be compared. Nevertheless in order to be one step in front, this investment should be applied and e-MES should be implemented.

Özetçe

Üretim Yönetim Sisteminin ilk hedefi, kullanıcılara üretim süreçlerinde yol göstererek, limit dışına çıkıldığında uyarmak, raporlar hazırlamak, verimlilik istatistikleri ve kayıtları tutmaktır. Elektronik üretim yönetim sistemi ise bu fonksiyonları web tabanlı olarak teknoloji ile yürütme kabiliyetine sahiptir. Bunun anlamı kullanıcı evden, internet kafe veya mobil telefon vasıtasıyla sisteme girip işlem yapabilir. Bu esneklik günümüz koşullarında çok avantajlıdır. Bir üretim sorumlusu hastalığı süresince evden, hatta plajda uzanırken dahi mevcut platformdan fabrikadaki işlemlerini yürütebilir. Bu esneklik masrafları düşürmede kolaylık sağlar. Fakat buna sahip olmak için bir yazılım ve donanım yatırımına ihtiyaç vardır. Bu makale olası fayda ve maliyetlerin karşılaştırılarak kullanıcılara sağladıkları katkının yanısıra, maliyetleri de gözönüne alarak firmalara karar süreçlerinde bir yöntem önermektedir.

Keywords: MES, electronic MES, Supply Chain Systems, Advantages, Disadvantages, Implementation.

Anahtar Kelimeler: Üretim Yönetim Sistemi, Elektronik Üretim Yönetim Sistemi, Tedarik Zinciri Sistemleri, Avantajlar, Dezavantajlar, Uygulamalar.

1. Introduction

MES and eMES

A shop floor control system which includes either manual or automatic labor and production reporting as well as on-line inquiries and links to tasks that take place on the production floor. MES includes links to work orders, receipt of goods, shipping, quality control, maintenance, scheduling, and other related tasks.

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1.1. MES History

Manufacturing and production activities deal with the planning, development, and maintenance of production facilities; the establishment of production goals; the acquisition, storage, and availability of production materials; and the scheduling of equipment, facilities, materials, and labor required to fashion finished product. Manufacturing and production information system support these activities.

During the 80's great emphasis was placed on the automation of the production floors. A decade later, with the advent of affordable computing, business automation was in the limelight with everything automated from ordering to delivery. One of the areas left behind is the appropriate integration between the two. This is where a MES (Manufacturing Execution System) come into place. A MES closes the loop between the shop floor and ERP. Historically, shop floor information and control systems have been in existence for several decades, whereas ERP systems have come into their own typically within the last 5 to 10 years. This has led to a 'generation gap', in terms of technology, which has been aggravated by different demands of their end users - plant process engineers and management staff. An additional difficulty in complex process plants is that

no matter how good the planning is, execution doesn't always go according to plan, due to forecast inaccuracies, capacity bottlenecks and process inefficiencies.[2]

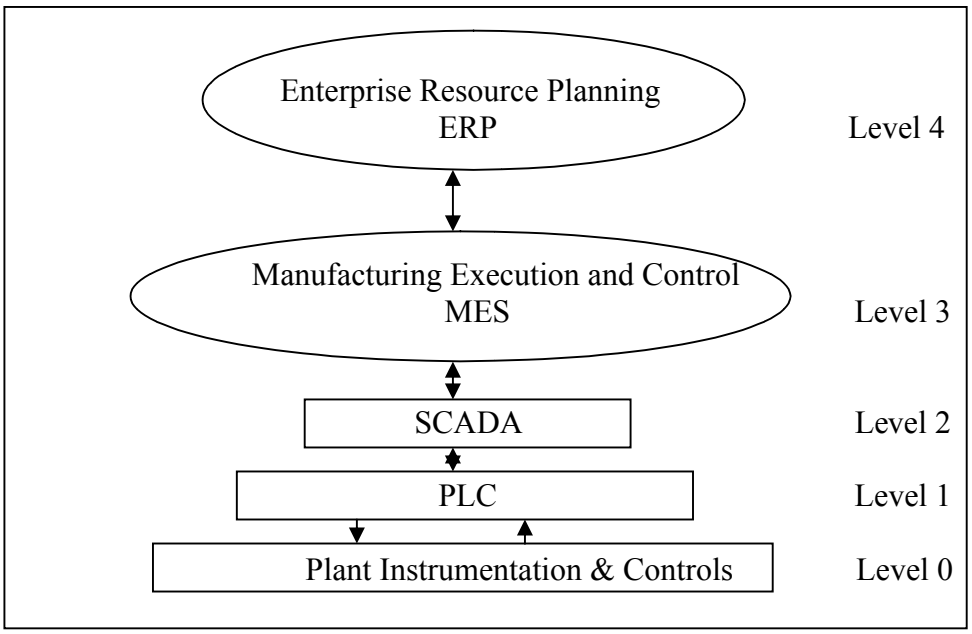

Figure 1. Production hierarchy

The table below summarizes the functions and capabilities of all the information systems that exist across an enterprise.

Information Systems Capabilities:

Level	Major Function	Information Systems	Typical Data Handled	Information Processed	Operation Time Scale
4	ERP: planning, scheduling supply and logistics	Databases, Applications Interfaces	Enterprise level metrics such as sales, finance, manpower	Ability to plan and allocate resources to achieve corporate targets	Days to weeks
3	MES –plant-wide optimization & management	Process historians, Database applications, Middleware	Plant operational metrics such as production, inventory, energy	Ability to optimize and execute operations across the entire plant	Minutes to hours
2	Automation, advanced process control, abnormality management	SCADAs, PC-based systems	Unit operation targets; Metrics of level 1 control performance	Ability to operate a unit at its optimal point	Seconds to minutes
1	Basic control, rectification, statistical analysis	PLCs, DCS, Soft sensors	Variable set points; Process values; Alarms	Ability to maintain process variables at desired conditions; Application logic	Millisec-onds to seconds
0	Measurement and sensing, on-line monitoring	Sensors, actuators, field devices	Measured values of actual process variables, e.g., temperature, pressure, etc	Current state of process streams and equipment	Continuous

MES provides an additional level of detail and real-time control impossible with ERP. Thus, tactical scheduling in small increments is possible by units, shifts, hours, or within minutes.

As a result, there exists a wide information gap, which is untenable in today's competitive world, where customers expect instant fulfillment of orders at globally competitive prices and the highest quality. There is a clear need for a set of systems that seamlessly bridge this gap. MES enables management & execution of day-to-day production activities and its associated information to be shared across the organization in real time for analysis and decision purposes.

MES accentuates on the application of Information Systems Technology in assisting & optimizing the management & execution of production activities from order release to finished goods, resulting in an improved bottom – line.. The plant automation service practice offers solutions and services for MES in the areas such as:

Opportunity assessment: Manufacturing operational assessment, industrial automation assessment, and information integration assessment.

Opportunity realization: Solution requirement analysis, solution / technology evaluation, solutions design & development, solution deployment and support .

2. General Analysis of MES and eMES

To understand the MES and eMES, we have to investigate the facts why they are needed. There are some presumptions on that.

2.1 Keeping Update

Discrete manufacturers are faced with constant change in technology, materials, and customer needs as well as aggressive competitors. As a result, products have ever shorter lifecycles and go through many engineering changes. Product line proliferation is a fact of

life. All of this is great for sales and marketing, but a major challenge for manufacturing operations.

Manufacturing Execution Systems provide support for the high-mix, high variability in assembly environments. While product proliferation strains human ability to remember specific issues for each configuration, MES solutions have no such constraints. Further, MES can provide a complete genealogy for every product, with multi-level serial number tracking as well as other relevant production information such as any reworked subassemblies or test irregularities. This fills in the critical as-built piece of a Product Lifecycle Management (PLM) strategy. It can also feed design for manufacturability information back to engineering. [3]

2.2 Customer Satisfaction

New business has become an integral component, linking technology and business strategy in new ways. These dynamics require companies to be more integrated and externally focused than ever before [3]. That means being able to interact, connect, and execute with trading partners quickly, seamlessly, and continually. Technology is accelerating the rate of this business change. Customers are demanding more personalized products, and competitors with new business models are emerging from unexpected sources. Business organizations are seeking to improve their supply chain's performance in terms of faster, more reliable, and cheaper operations with less inventory solutions [7, 5, 6].

2.3 Cost Factor

The customers request the best product with the cheapest price. To handle that the costs must be reduced. A computer system is always better and faster than the manual system. This is the first plus for that system. Whether companies keep their manufacturing or outsource it, MES and eMES can help to manage for increased ROA. For company-owned production facilities, MES and eMES can radically reduce operating costs. In The MES Performance Advantage research, companies using MES

reduced their product costs per unit, energy consumption, and cycle times more than others. They also increased yield and their ability to build-to-order for just-in-time (JIT) shipments to customers. For those who outsource, an eMES at the supplier's plant means visibility into the operation that is otherwise beyond the OEM's control.

2.4 Product Quality

Quality of products and services is critical to satisfying customers and maintaining a competitive edge. Companies must constantly improve quality, and document the improvement. This requires documenting the quality of products as well as the processes and tests through which they ran in the plant. Warranty and liability risk also depend on excellent quality.

MES systems not only measure and record product and process quality, they help ensure employees follow best business practices that ensure higher quality. The best MES for discrete assembly industries support best practices in not only production and assembly but also test, repair, non-conformance handling, corrective and preventative action (CAPA) and returns processing. Through real-time visibility into the plant, MES can identify quality problems faster, thus reducing the cost of quality significantly. Their tracking capabilities also lower liability risk. [2]

2.5 Compliance to Production Rules

The complexity of increased regulation demands calls for sound genealogy throughout the general process. MES implements all relevant data provided by the one-source system and provides for a wide basis to prepare the required gapless documentation and case-specific evidence and thus facilitates compliance

Nearly every discrete industry has to comply with government regulations. Aerospace and defense and medical products have always been heavily regulated. Now, new regulations require trace ability of products and documentation of issues from other segments, as well.

MES includes genealogy and performance management functions that help ensure compliance is streamlined, and the extensive data collection mandated is relatively automated. The cost of compliance with MES is radically lower than with paper systems. Better yet, MES can help manufacturers benefit from the need to comply. For example, the data coming back from customer complaints and end-of-life products can shed light on ways to improve product quality and lifespan. Being able to track back all components to final assemblies by serial number greatly reduces the scope of warranty and recall costs, by pinpointing precise units that may be affected by a problem rather than recalling or quarantining all units of a product. [2]

3. Results, analysis and discussions of MES and eMES

3.1 Key Benefits of MES

The potential gain by implementing MES addresses the need for immediate current, on-line information that allows users of the MES system to make the best informed decisions regarding the application of inventory, plant resources and people

Reduction of Activities and Personnel Costs

MES has an impact on the number of tasks of the employees and as an effect of it, it reduces the personnel costs. The employees will not print a lot papers to control the documentation, this will help to eliminate two issues. One is the paperless production other one is the time consumption to review these papers.

- Scheduling and planning: All the plans will be updated automatically.
- Paperless production: Information about the production will be on the screen instead of paper.
- Progress control, work allocation, and other routine tasks: The lines could be controlled and tracked by the system.

- Minimum manual data entry: Data entry will be done automatically by the system. (Getting weight from the scale automatically etc.)

Increased Productivity and Efficiency

By optimizing the machines with the best set up and production times, it increases the productivity. The trainings of the employees will be organized more reliable and this helps to the produce more secured products.

- Minimum machine stoppage times: Manual entries will be reduced; stoppages will be tracked and be reduced.
- Best possible machine utilization: With the stoppage statistics machine will be used more effectively.
- Goal-oriented weak point analysis: The transactions will be in the database. Improvements will be done by data mining.
- Qualification profiles of personnel: The system will not let the user to execute a task without the needed training and qualification.
- Container management: The carriers will be tracked all over the plant.

Improved Quality & Safety

The protocols will be followed on the system, this will help to produce the same product every time. System will guide the operators to use the required materials.

- In Process Control (IPC): The results of IPC will be entered in the system and available for everybody.
- Current information: The product will be tracked and the status of it will be known by everybody.
- Identified materials to be used: System will prepare of a list which materials must be identified for the product to be used.

- Constant product quality: By following the same tasks at every step of the system, system will supply constant product.
- Realistic planned values: with the passed information in the database and data mitem will let to have realistic values.
- Keeping of events: All the transactions will be kept in the database.
- Improved safety: By following the validated system the production safety will be supplied.

3.2 Key Benefits of e-MES

In addition to the MES benefits, eMES provides more benefits. They have also some same benefits but by using different approaches. eMES provides personnel cost not by reducing the employee number but by eliminating the transportation and office costs.

- Improved communication (online information): The managers will log in the system by an internet explorer and track the system online.
- Constant operational flow: The production will never stop; the responsible person will log in the system, check the system and give a decision.
- Efficiency and transparency: The production will never stop because of a lack of person in the plant.
- Flexibility: The system expert or the managers are not needed to be in the plant during the production.
- Personnel Cost: The expert of the system will not be in the plant, transportation, desk, cleaning etc costs will be reduced.
- Short reaction times: Against an error, the solution will be provided in a short time. The responsible persons are not needed to come to the plant.
- Fully graphical user interface: The interface is the standard internet explorer and easy to track.

- Integration of common intra-, extra- and Internet standards: The log in will be done by an any internet explorer which has a standard.
- (E-mail, Web etc.): System will send e-mail or sms to the responsible persons incase of any problem.

If we look from another perspective, the first experts on eMES will lead the sector and get profit from that. They will be the most wanted employees for a plant.

3.3 Potential Problems of e-MES

- Exhaustive knowledge of all manufacturing automation levels: holistic approach to problem solving:

  To be able to solve the problem there must be a link to the all automation levels. Scada to MES; MES to ERP etc.
- Domain and IT expertise from a single source:

  The IT must allow the users to log in the system without any problem. There must not be any kind of Network problems etc.
- The unavailability of the expert:

  The expert could be unavailable for a time and the urgent problem could not be solved. He could be out and has no connection to the net.
- Privacy and Security:

  The connection from outside of the plant network must be secured properly. The most important thing for a firm is the privacy of the firm information. This must be kept with a very high security.
- Cost of the infrastructure:

  To build a system like that needs a lot of investment. The servers, equipments, cabling as hardware, software licenses, consulting costs, training costs as software.
- Platform based software:

To adapt the used eMES software to the platform of the operating system could cause some problems. Nes updates could be a problem.

- Online Support:

The minority of the educated experts on eMES support could be a problem. Trainings must be organized to eliminate that problem.

- The difficulty of the process :

To adapt the users to the new system could be painful. The users will try to use the new system with the old processes. This could cause a lot of problems.

- The implementation phase:

Being unaware of the eMES and this technology, this will cause problem on implementing the software on the system. Trainings are required. This means time and money.

- eMES is not widespread:

The first owners of eMES will spend more time and money on the application developments and implementations. To develop a new functionality will be only relevant to the requested plant. The solutions will not be general.

3.4 MES and eMES Implementation

How does a plant design, build and implement a cost-effective, integrated MES appropriate to their unique needs? The key steps are to assess the present state of integration and the availability of infrastructure (hardware and software), and then to map the information needs of all the operational layers. Based on this, the framework of the MES and eMES have to be designed for the plant-specific conditions. The key parameters and issues to be considered are:

3.4.1 The information between different systems

As there is a wide disparity in the frequency of information polled by various systems, ranging from milliseconds to days, an intermediate data storage and transmission layer (process historian) is required. The

quantity of information to be stored determines the sizing of this buffer, which is critical to the economic success of the MES. Too small a database will make the system less effective but faster; too large a database will make it slower and more expensive but more comprehensive.

Properly designed and maintained, the Integrated System provides a kind of "Distributed Database" that provides data in a secure and timely fashion to all major functional areas such as process control, production management, commercial and technical applications.[3]

3.4.2 Project Plan and Project Groups

Communications and timing should be determined so as to minimize systems dependencies and maintenance of the integration. There are cost implications associated with each option, which need to be carefully evaluated. Being under the pressure of the management, the project must be started as it is shown on the plan. The communication between the project groups for the implementation is very important. Each team must finish their tasks on time not to stop the others. For example, the IT department must have installed the servers, softwares and network connections to the internet, Validation team must finish the validation, business team must finish the business process etc. All teams must also consider the other teams tasks if they work parallel.

3.4.3 Change management

The definition and final architecture of an MES and eMES are often a difficult negotiation, rich with issues of ownership and privacy. It is necessary to separate the needs of the political environment from those of the business. In all cases, the appropriate level of detail for decision support must be provided to the users without creating a nervous planning system or an uncontrollable shop floor control environment. [3]

3.4.4 System Architecture

Enabling a system like eMES is not simple. It is easy to use via an internet explorer but there is a huge system behind. The system is kept alive by different servers, connections, softwares and hardwares.

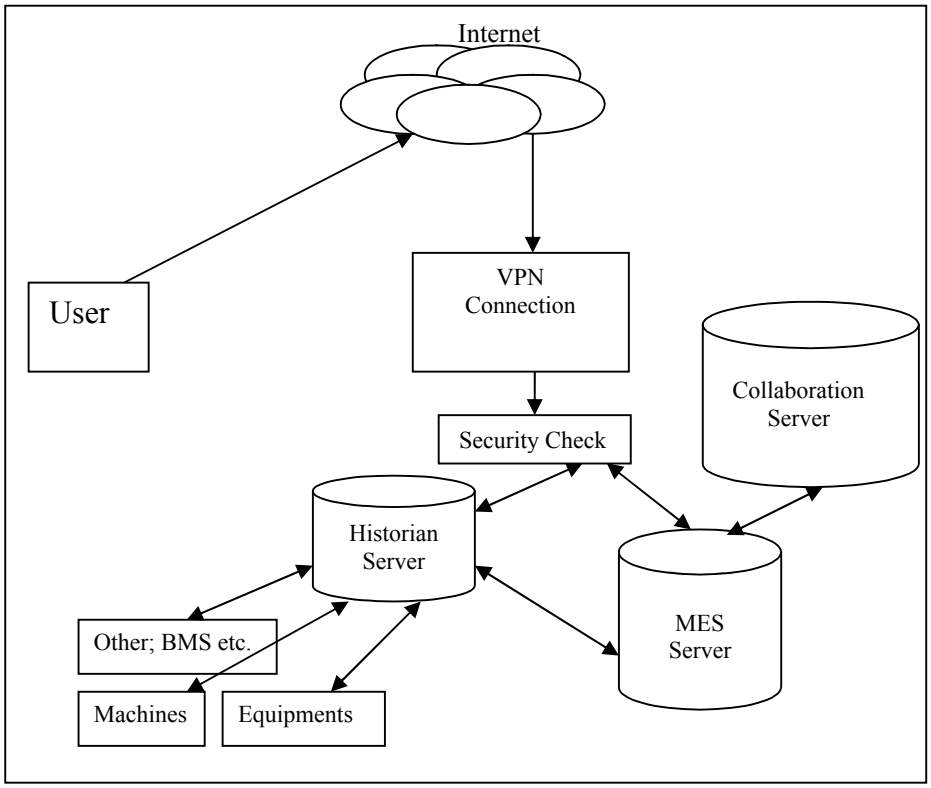

Figure 2. Production Hierarchy

To build this architecture;
Historian Server: To collect all the transactions of the machines, equipments and other systems. Building Management System is an example.
MES Server: The production transactions will be executed and kept.

Collaboration Server: This server gathers all the information from different servers and has an ability to work with internet explorer.

Security Gate: The system must control the users who are logged in the system and keep their transactions.

VPN Connection: The user must have its authentication before he logs in.

4. Conclusions and future directives

Today there have been an implemented eMES yet in neither our country nor the worldwide. However, the studies about MES and eMES are continuously developing. In fact we believe that manufacturing processes and reports are becoming more efficient and productive in further period and here MES solutions will bring incredible benefits and valuable contributions. But today it is no enough application and experience unfortunately. For that reason, we are only expecting and believing that "eMES is useful". Here in this paper, it is included the key benefits and potential problems and costs relating to these new concepts. They are only the consequences of the live observations and current applications.

However if consider the benefits of MES right now we can say that eMES is also useful and valuable. After some implementations and experiences there could be a better aspect in future. The production sector leads always the initial innovation and developments so it is expected that this eMES solution will be a part of high tech production in next technology.

Still there are some tasks that could not be done rather than assisting the human resources. The new directives must be on that. Then it must be a part of eMES. In the future there will not be a lot of human resources in the factory only for the emergency cases; personnel will be kept around the factory. By the help of a PC anywhere in the world the production will be executed, tracked, controlled and released. Maybe it seams to be further or

even a dream now but MES has been also considered as a dream of 20 years ago. MES/Enterprise integration is not something companies can avoid any longer. It's just a matter of how to do it that remains in the way for most. [8]

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