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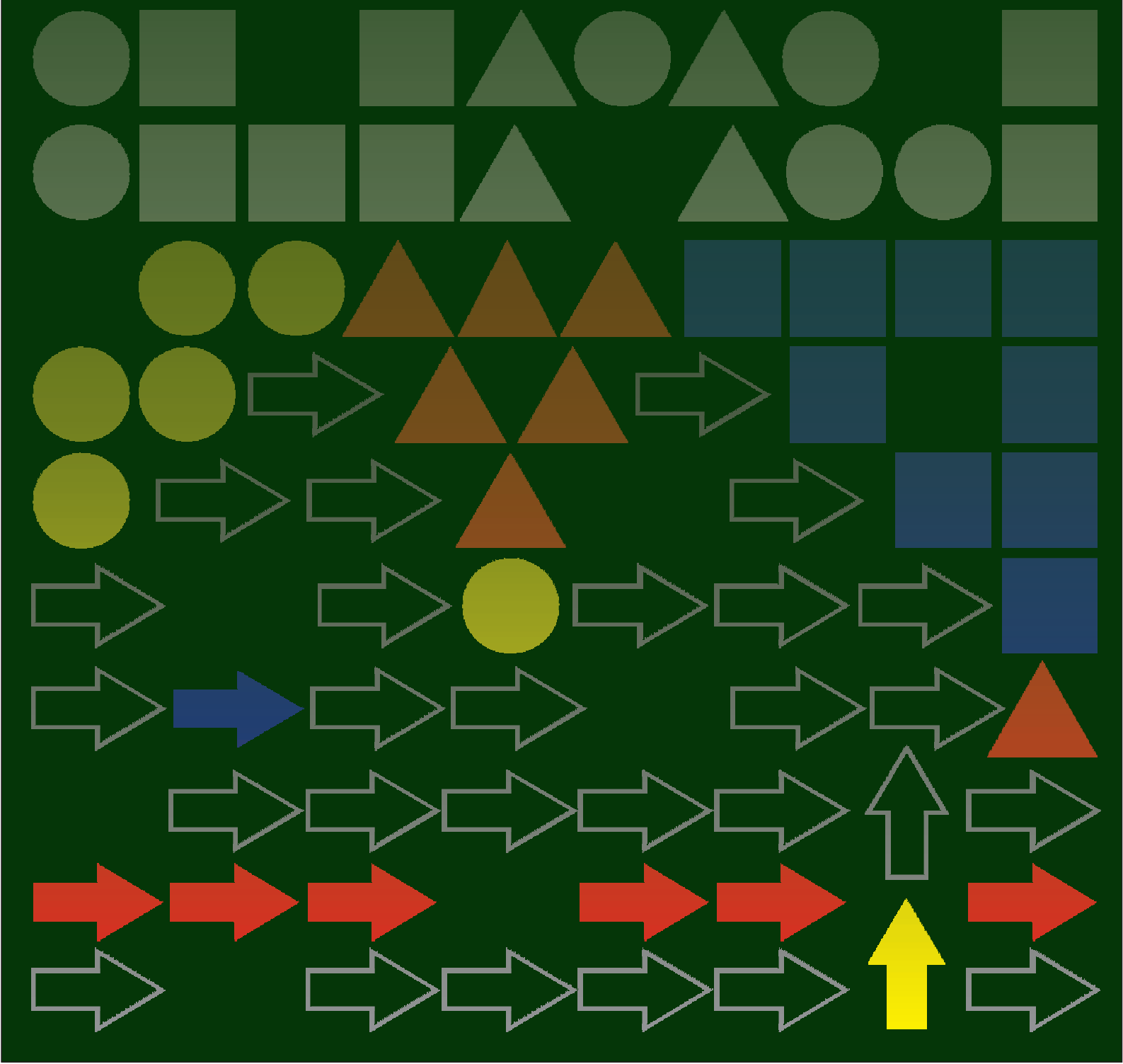

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DATA PROCESSING FOR CREATING SIMULATION MODELS

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Keywords: Industry 4.0, manufacturing, vertical integration
Abstract: This article is devoted to the main element of the Industry 4.0 concept, which is vertical integration software that connects the necessary parts of manufacturing companies. Software that meets these criteria is required to ensure error-free bi-directional communication and data transfer between IT and OT networks. Better competitiveness technological progress is pushing the possibilities of MES. As a result, MES is becoming an integral element that takes businesses to the next level. If we imagine all activities as operations connected by computer networks and analytical tools, the result is even greater efficiency in the industry and business. Analytical tools provide useful support for customer service.

1 Introduction

New organizational systems have a positive effect on the development of technological and industrial components of companies. The overall process takes place at the level of entire companies. Digitization and automation of production processes are nowadays an integral part. Industry 4.0, on the other hand, requires the adaptation of new ways of managing companies in companies. MES is software whose task is to manage and optimize production and distribute the information needed to perform operations and document operational processes to transform inputs into production into final products and services.

2 Characteristic of Industry 4.0 and Smart Manufacturing according to the main features

We can transform the concept of Industry 4.0 into vertical and horizontal integration. Vertical integration represents a growing need for the exchange of information and the use of cooperation between different sectors within the company. The value chain is classified using so-called continuous engineering, where the main subject is the product, ie monitoring the entire product life cycle, from the initial idea through production and use to its wear and loss and value for the customer to recycling.

Figure 1 shows the principle of Industry 4.0. Within the smart factory, all the physical manufacturing components and elements that are in physical form have their cyber twin (ie, model) in the virtual world. The virtual world, as well as the physical elements and their virtual forms, are simply interconnected to ensure global production optimization, ie that SMART FACTORY can exist. In addition, within the value chain, the target factories are horizontally integrated, i.e., the physical assets and their cyber twins are interconnected, which allows for optimized decision-making within the value chain. The integration itself through the value network leads to the creation of a CPS platform, the principle of which will be that things, services, data, and people are connected via the Internet.

Another important characteristic is the shortening of production times without affecting the quality of the product. Business operations, especially operations involved in the production of products. Many of the technologies used in manufacturing are non-innovative.

The vertical integration of intelligent systems points to the fact that factories are not designed separately, but that there is a need for networking of intelligent factories and production systems. As part of the information exchange, vertical integration includes services exposed for individual parts, service modules that are recognizable to CPS, integration management, and planning for different systems.

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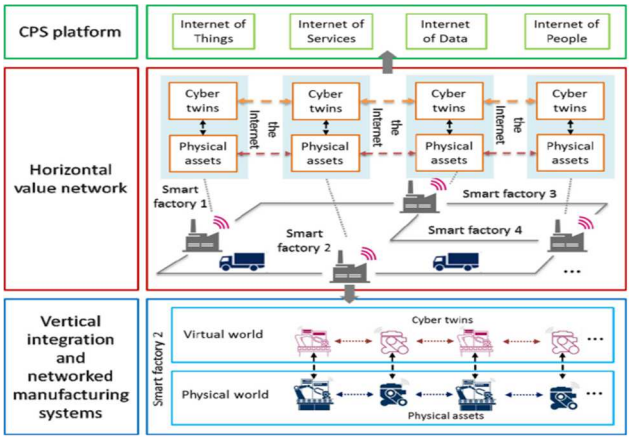

Figure 1 Principe of Industry 4.0

Thanks to the use of a global network of the value chain, horizontal integration facilitates the creation and management of networks that create value or value for the company. Among the basic relationships that we can use as an example of horizontal integration is the relationship between customers and sales representatives (Fig 2).

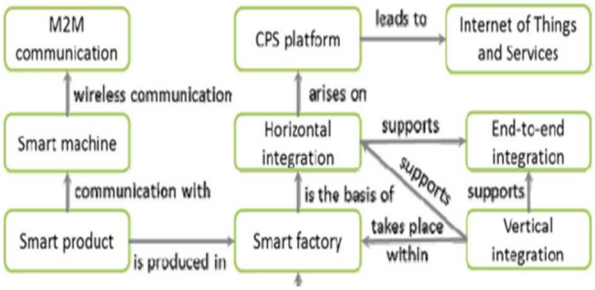

Figure 2 Horizontal and vertical integration

In intelligent manufacturing, MES is understood as a functional and certified monolith between ERP and automation in manufacturing. The problem was the mismatch between distribution intelligence and IIoT. On the other hand, this era of systems is slowly coming to an end. Their replacement is MES connected to IIoT. The result of this interconnection is a shift from intelligent manufacturing to a higher level. IIoT provides data aggregation, visualization, and analysis. The problem is that it does not present a broader perspective. It is the addition of the MES solution, which works in cooperation with IIoT, that brings the necessary complex solution and a stable process connection. The result is better standardization, monitoring, and refinement of quality processes and clarity of events in the supply chain.

The ERP system works on the interconnection with the MES system. ERP controls the level of production by monitoring orders generated by retail and supermarket chains and sends instructions to MES to start production in the quantity needed to meet order requirements. MES receives the incentive for production and fulfillment of orders and provides feedback on the state of production to the ERP system.

3 Vertical integration

The escalating requirements of modern production require an upgrade, especially the main goal of connecting all logical layers within the company, starting with the field layer, also called the production floor. Integration has the advantage of making it easier to make challenging strategic and tactical decisions at any level, due to the freedom of information that is not fixed but flows freely transparently, and freely. However, the primary advantage of this type of integration is a significant reduction in response time, which increases the company's competitiveness in the market.

Figure 3 represents vertical and horizontal integration from a different perspective. The figure shows the two ends of the vertical axis, which represent the trade side (top) and the production side (bottom). Customers (right side) and suppliers (left side) represent the two ends of the horizontal axis. To clarify, ERP is more closely linked to the business side, on the other hand, PLC and manufacturing technology are more closely linked to the production side. Supplier relationship management, in short SRM, as the name implies represents support for suppliers. Customer relationship management (CRM) maintains customer relations. Last but not least, the figure shows PLM systems that help manage product lifecycle processes. Modern manufacturing is so demanding for companies that to meet all production requirements, information in digital form must flow as easily as possible between all integrated systems, even in the event of degraded conditions. All important user groups in the company, from marketing to purchasing and from production staff to top management, should have access to relevant data. such access to information is provided by collaborative production management (CPM). MES is at the core of CPM, which suggests that it can help interconnect other systems.

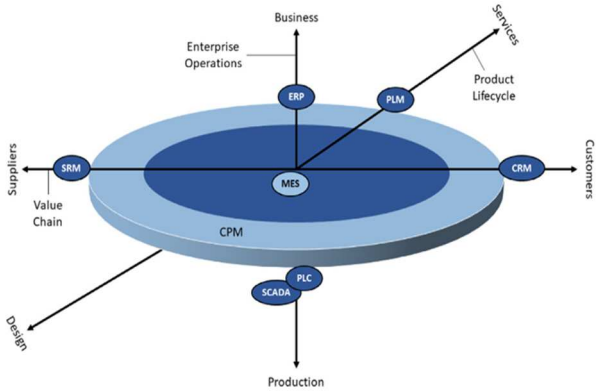

Figure 3 Shows Vertical/Horizontal integration across the organization

Growth in industry and technology is supported by modern organizational systems, as modern manufacturing requires the adaptation of new solutions and ways of managing destruction in companies. From an organizational and business point of view, all activities can

be designed as a set of operations that are linked to computer systems and information networks, thus achieving greater flow efficiency and a new perception of the business sector includes a variety of analytical tools that are useful to support service efficiency. intended for customers.

4 IT/OT coverage

The gap between IT and OT systems is starting to close. Companies require enterprise-wide visibility and intelligence from production to make informed, actionable decisions. This means MES must be connected to and integrated into the overall information system and the supply chain enterprise-wide. MES functionality and capabilities are increasing. There are fewer siloed applications and point and line solutions. While some suppliers embed their database into their solution, most can integrate and operate among many different types of data sources. In the future, everything will work together seamlessly: people, technology, and things.

The rising interest in the Internet of Things (IoT) and digital business transformation means that new opportunities will emerge and associated risks will need to be mitigated. Doing so will involve high levels of cooperation between IT and the groups managing the operational technology (OT) monitoring or controlling the physical devices and processes in the enterprise. Therefore, IT leaders (CIOs) need to prepare for the transition of their organizations to the converging, aligning, and integrating of IT and OT environments. This is the cornerstone of using Industry 4.0, the industrial Internet, (I) IoT, and cyber-physical systems with maximized benefit (Fig.4).

This IT/OT convergence is often a challenge. It is not just a challenge because of new and exciting technologies but also because of new ways of thinking. This tends to be an even bigger challenge when two different worlds, that have worked separately and with completely different systems, technologies and vendors, must integrate into the context of IIoT and the Industrial Internet.

Competition in the next millennium increased emphasis upon time as expressed by speed, quality, service, and global focus. Agility is the watchword. Manufacturers are measured by their ability to react quickly to sudden, often unpredictable changes in customer demand for their products and services. To compete successfully the manufacturing applications have to be time and activity-based and above all should be focused on customers. Today companies must be able to deliver customer-specific products with the lead-time of standard, off-the-shelf products. Make-to-stock and make-to-order types of modes at times have to be selected by the company.

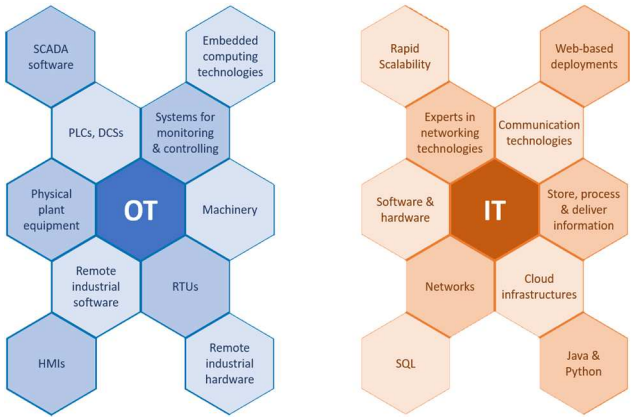

Figure 4 IT/OT coverage

Initially, cultural, organizational, operational, and technological constraints slowed the convergence of OT and IT for plant- and field-level automation. But over time, many of these constraints have either faded away or largely been overcome and IT/OT convergence is proceeding at a rapid pace. Examples in place today include:

- Wireless field devices and plant networks
- Ethernet-at-all-levels
- Virtualized hardware and applications
- Cloud computing, software-as-a-service (SaaS), and product-as-a-service (PaaS)
- Advanced simulation and digital twins
- 3D scanning and additive manufacturing
- Advanced robotics
- IIoT-enabled remote asset monitoring
- Predictive/prescriptive maintenance, and
- Advanced operational analytics

The above are just some of today's advanced technologies and solutions being deployed in industrial environments. None would be possible without the convergence of operational and information technologies. In addition, IT/OT convergence is a key enabler for important industry initiatives such as Industry 4.0.

5 MES or MOM

The MES software is designed to meet the requirements of even the largest companies by connecting through front office accounting with systems and products taking into account the factory. In addition to connecting parts of the company, MES connects the outputs of three layers of information systems, which form part of the planning functions, such as MRP, performing supervisory or quality control functions and software, and control systems that provide the data used so that the enterprise has unrestricted access to separate data databases that exist within the organization. MES functions such as process and quality management, planning, and operational analysis, all of which need real-time access to information. Mainly data that affect process control. It is further linked to other complementary processes, such as labor, warehousing,

production monitoring and product tracking, and support systems.

MES systems help create faultless production processes and help create a consistent view of production data. Other benefits of a successfully implemented MES system are:

- traceability of production,
- ensuring accurate production data,
- reduction of downtime, nonconforming production, shortening of setting times,
- increase overall equipment efficiency (OEE),
- reduction of inventory,
- introduction of paperless production,
- possibility of accurate economic evaluation of production and others.

Manufacturing Operations Management is the principle of setting the necessary rules that are essential to maintain high standards of production value and to ensure that the entire process begins, runs, and ends exactly according to the established rules. This management includes the constant need for improvement, such as improving inventory, production, quality and quality control, maintenance, all according to strategic objectives. Among the most well-known strategic goals are cost reduction, product innovation, sustainability, quality, and compliance.

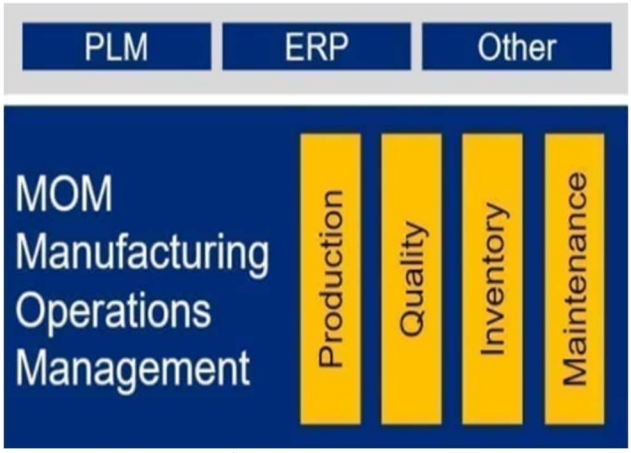

Figure 5 Manufacturing operations management

6 Real production implementing system, acquired knowledge and experience with the use

The portfolio of industrial solutions, which is quite extensive, and the portfolio of components of companies includes components such as motors, hydraulic equipment, compressors, control units and controllers, meters. All of these components are designed to positively impact global advances in sustainability, energy efficiency, renewables, the food distribution system, and more. Such a company can be defined as a company with a large production volume, a high degree of configuration to production, with minimized interventions in production (basically complete elimination of manual interventions and providing full traceability of product history.

Business challenges:

- Demand for more complex and personalized products in the condensed period.
- Adapt new product introduction to shop floor processes.
- Adjust manufacturing lines and processes to efficiently handle the influx of new products.
- Meet market demand to quickly bring more complex products to market.

The MES grid fulfills several key functions, from

ERP through automation integration to error logging, NPI product configuration, reporting, order list, clarity, information collection, employee order management, and automation and fault stopping. MES has a positive impact on increasing production flexibility and management efficiency in production solutions in the form of product combinations. Since the introduction of MES, the company has experienced an increase in the number of needed resources to complete the project. Thanks to this solution, the company has significantly improved and is equipped to handle more product variations than in the past. It is necessary to note the result of the implementation, which results in increased accuracy of the production process, speed of obtaining information, identification of the main causes of any problems, and many other benefits.

Results:

- Enhanced flexibility of manufacturing processes.
- Increased speed of innovation of new products.
- Leveraged Siemens technology to accelerate the digitalization process.
- Elevated product quality and transparency.
- Reduced administrative efforts and costs.

7 Conclusions

We can define a modern execution system as the main part of the production workshops, not only in terms of business operations but also in general facilities, suppliers, and divisions. The main advantage is the consistency of data, which serves people or the whole team to collaborate and share data. MES provides the appropriate advantage of traceability of components at a specified level without fear of data misuse, without data distortion. MES provides true data in the right place at the right time. The information that is received from the workshop is further used as an indicator to increase the competitiveness of the company. A large number of companies have already addressed this implementation, or have already implemented it, due to the many benefits for the company, many of which are described in this article.

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