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INTEGRATION OF IT TOOLS FOCUSED ON PLANNING AND CONTROL OF OPERATIONS ON THE SHOP FLOOR

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Abstract:
Complex manufacturing systems with mix of semi-repetitive and repetitive products to achieve high level of productivity supported by the standardization of products and processes and the optimization in the use of production resources through, among other factors, the automation of measurement and control of its manufacturing processes. Allowing more visibility of the flow restrictions that can be minimized when properly detected. The automation of the control of complex environment manufacturing processes, however, is heavily dependent of IT tools, applied directly in the operation interface with enterprise systems together with specialist software in some management functions of business as part of an information system that can be designed with a minimum number of interfaces (system with a small number of computer applications) or robust involving greater investment in the acquisition of a significant number of applications licenses, hardware structure and data transmission network, user training and deployment process. In this paper, is presented the historical development of the planning and the control of operations with emphasis on the main IT tools developed in recent decades, in order to identify the main possibilities of the design of an information system capable of integrating the flow of internal information on manufacturing organizations with the flow of internal information on the companies that make up the chain of the business supplies.

Keywords: advanced planning system, operations management, sales and operations planning, shop floor control, supply chain planning

1. INTRODUCTION

It is Important to detach, that the literature review presented in this paper has as central topic of research on the information technology applied to the production management of manufacturers of manufactured goods and not services

Although there are similarities between the use of Information Technology (IT) in environments of production with transformation of raw materials into tangible products and environments of production that aimed at generating services, especially when is approached some peculiarities of the operation, it is not the objective of this paper to study the services segment.

Defined the limits of this paper, involving the literature review on the application of IT in manufacturing companies, it is important to note that the design and implementation of an information technology project in industrial enterprises for this type of organization is currently a huge challenge by different factors, as well as variables inherent in the process of production.

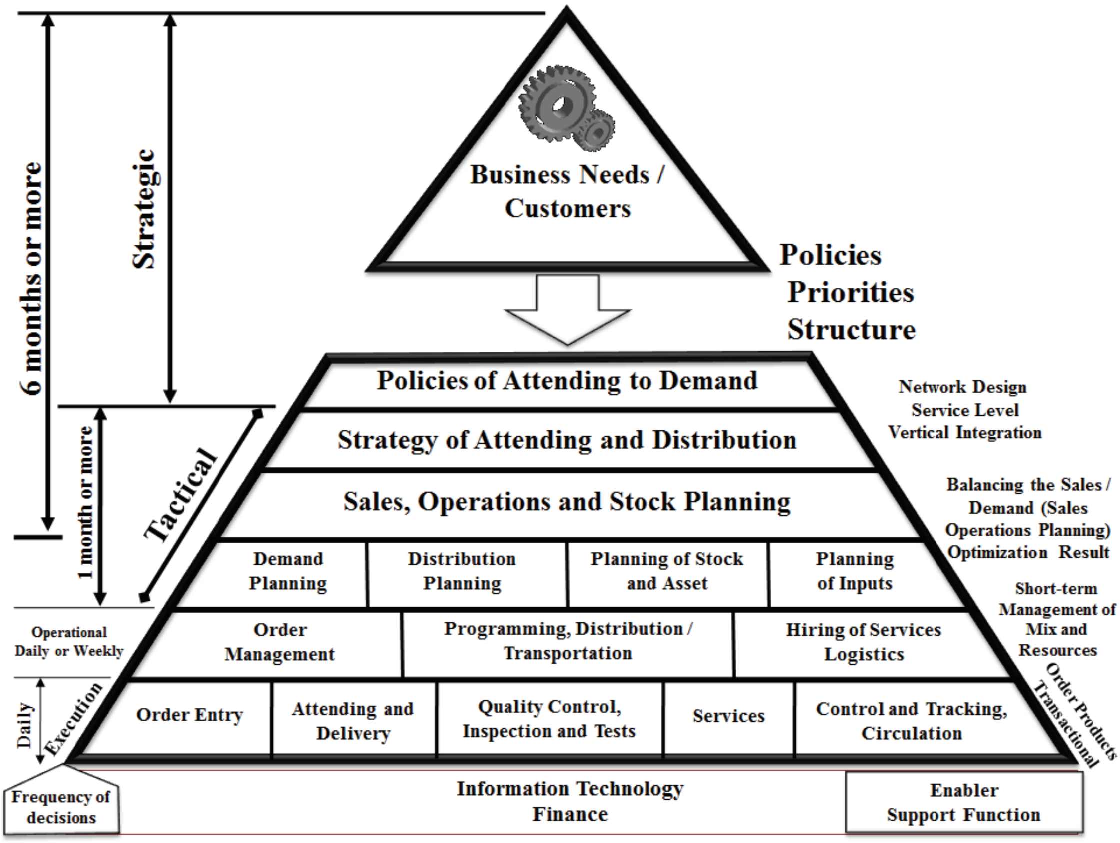
Among the main factors, one noteworthy about the purpose of this paper, according to the literature, is the fact that there is in the market of software development a significant number of computational applications with different functionalities that can be exploited in the scope of IT project and that, once adherent to the corporate management of contemporary industrial companies, can be applied. However, the selection of these software with the purpose of attending to computational applications with the necessary adherence to the operation model of manufacturing enterprises is not a simple task to accomplish.

The first step is to identify the levels of planning involved in the management of the operation and strongly influenced on the design of its modus operandi by product design, design and operation of the production system and organizational infrastructure planning system design and control of manufacturing (manufacturing, planning and control system).

Fleury (2000) and Olhager and Rudberg (2002) typify the organizational infrastructure from organizational levels: Strategic, Tactical and Operational represented in Figure 1 and described below:

1) *Strategic Level (long-term)* – emphasis on the needs of the business / customers - Strategic Plan and Business Plan;
2) *Tatical Level (mid-term)* – Aggregate planning from the demand of finished products grouped by product family, Master Production Schedule and calculation of material needs within the scope of sales and operations planning;
3) *Operational Level (short-term)* – scheduling of operations, execution and control (pointing and measurement systems of manufacturing system).

Figure 1: Hierarchical levels.



Source: Fleury (2000).

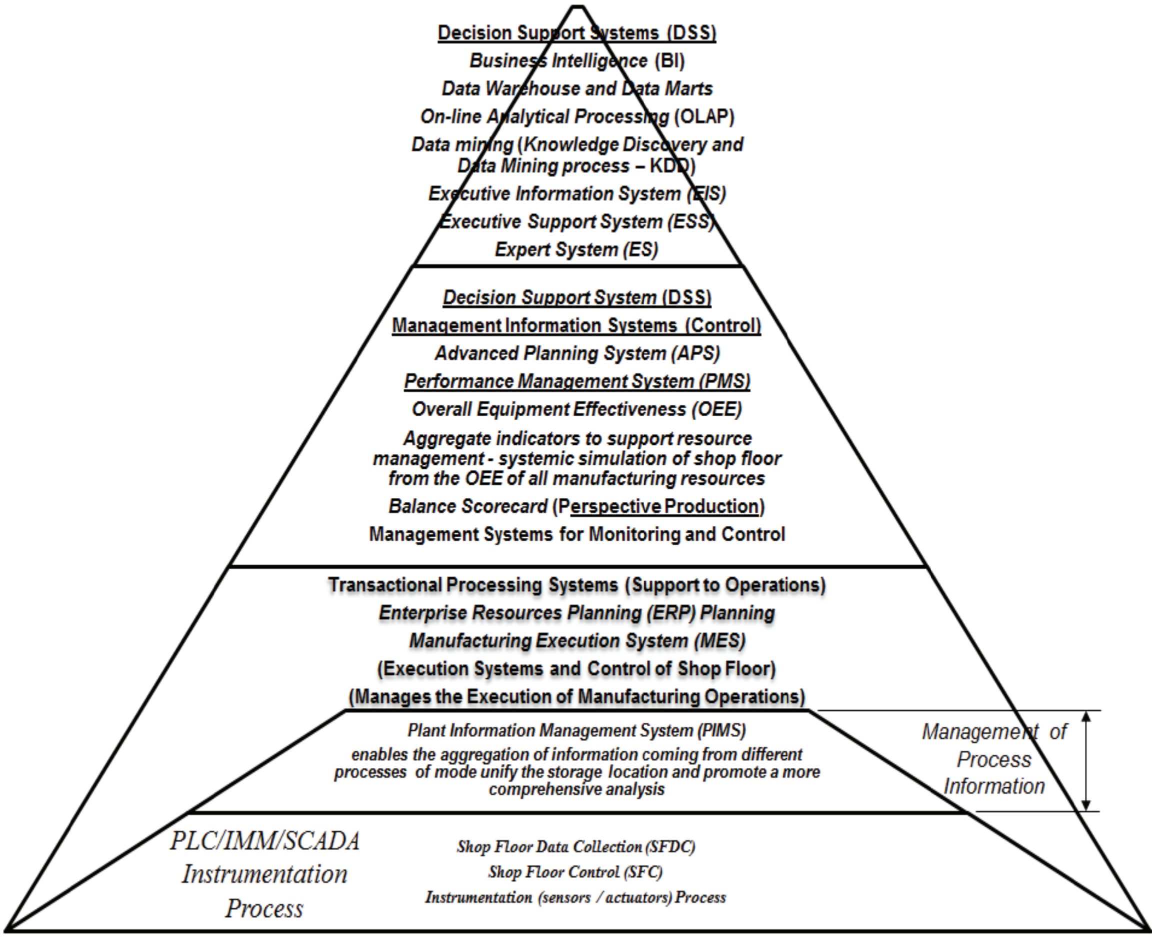
The description is relevant to the purpose of putting in evidence the view that the information system is a set of interrelated components that collect (or retrieve) and process data, transforming them into management information, storing and distributing information to support the decision-making, coordination and control of an organization (Siqueira 2005) and (Laudon & Laudon 2007).

Thus, such systems or software in the scope of an IT project became part of all daily activities of an industrial organization, given the importance of these systems have in contemporary organizations (O'Brien & Marakas 2010).

O'Brien and Marakas (2010) state that information systems are made up not only of Computational Systems, but of a number of other elements such as people, hardware, networks, procedures (work instructions) and policies among other elements that contribute to its operation.

This paper aims to present the main computational tools mentioned in the literature according to Figure 2, which from specific features contribute to the process of management of integrated way of manufacturing as the organization's business processes and its network supply.

Figure 2: Main computational tools.



Source: Author.

However, the paper is divided into five sections: Introduction, section, section 2. Decision support systems with a focus on manufacturing management - Manufacturing Execution System (MES), section 3. Plant Information Management System - PIMS, section 4. Organizational Performance Measurement Systems (OPMS) and section 5. Concluding Remarks.

2. DECISION SUPPORT SYSTEMS WITH A FOCUS ON MANUFACTURING MANAGEMENT - MANUFACTURING EXECUTION SYSTEM (MES)

According Mcclellan (1997) the Manufacturing Execution Systems have emerged in the 1990s in order to fill a communication gap between the planning systems of the relevant manufacturing, the evolution of MRP, MRPII and ERP and the control systems used to run the equipment on the factory floor.

The author points out that a Manufacturing Execution System (MES) is a category of software with an integration of functionality to other online applications pointing to data production operation at the factory and whose purpose is the accumulation of the methods and tools used for monitoring of production.

Thus, the Manufacturing Execution System (MES) is initially a consolidation and formalization of the production methods and procedures allowing greater integration of data from all manufacturing processes involved in a more useful and systematic manner.

He also stresses that the Manufacturing Execution System (MES) should be considered as a stage of integration of all activities that are not in the factory planning level or that are not part of the control of the scope of activities as possible components or components of a system that must be proactive and online integrated with all other relevant systems to the management of the production process, and that somehow act in the implementation or management of the production flow.

In this case one Manufacturing Execution System (MES) can be considered a computational tool imbued encompass this entire universe of data and information being able to promote a process of high integration synergy between the pairs, which is much greater than the sum of parts of the production system.

It is a fact, based on the literature in production management, the Manufacturing Execution System (MES) is not able to provide significant changes in production methods applied on the shop floor and the Production Control Systems - SPC also should not change existing manufacturing processes in a production system, which certainly does not prevent the MES software to be used as a part or component of IT applied to manufacturing so that your information to support the decision-making process.

Once the manager has management tools that enable it to precisely identify which production resources are available, it may at first not be able to increase production, but the information can help you improve priority setting. Similarly, the time variable and the ability to meet the production orders running in the factory, even if they cannot contribute monitored as a change in the volume of production released by the factory, knowledge of specific skills identified as available can allow to carry out a plan more realistic or feasible.

MESA International defines as activities supported by the Manufacturing Execution System (MES), related to the different areas involved in production management.

- Status and allocation of resources;
- Details of the operation to support production planning;
- List of production tasks;
- Control of documents;
- Data acquisition and receipt of materials or inputs;
- Labor management - provides the workforce status in a given period of time;
- Quality management;
- Process Management;
- Maintenance management;
- Traceability of products;
- Performance Analysis.

Although the author cited in the text of this topic to that paragraph had their respective paper published in the early 1990s, as well as the publication of Manufacturing Execution Systems Association (MESA International), scientific publications emphasizing applications involving integrated computer systems in the process of production management today, do not explore very different issues on the importance and difficulties related to the use of these tools as shown in the published work (Bikfalvi et al. 2014).

3. PLANT INFORMATION MANAGEMENT SYSTEM - PIMS

According to Feijó (2007) in the 1990s the industry faced the problem of the structure of computer control systems consisting of a concept that gave rise to the formation of islands of automation without the information integration between existing manufacturing processes in its industrial park, thereby inhibiting the availability of receipt shop floor production data of raw materials and components to the last process of manufacture or shipment of finished products. Thus, the biggest problem faced by industries in that period in general, was the consolidation of data from different manufacturing processes on the shop floor.

In order to assist in tackling the problem of pointing and recording such data was developed initially in continuous process industries, specifically in the petrochemical sector, a new concept of specific database to control the flow of industrial information, the Plant information Management System - PIMS, which Feijó (2007) stands out as an advance of the availability of production data.

Dante (2009) points out that the Plant Information Management System - PIMS is also defined in the literature as Process Information Management System - PIMS and Production Information Management System - PIMS and represent a solution designed to fight the problem of lack of accessibility to information and to the actual knowledge of the manufacturing process which allowed to move up a level in the pyramid of automation according to the scope of the systems Enterprise

Production Systems - EPS, which are included, according to the author the Plant Information Management systems - PIMS and Manufacturing Execution Systems - MES.

According to Dante (2009) it is a computer system with the ability of the software to take the logging functionality of the industrial operation data in a consolidated manner involving all the different plant processing units to be kept in a single database and stored for a period of time not limited, that is, for several years, these data may be kept available for the different levels already at the planning application-specific format that can add high value for the monitoring and analysis of the production process.

From the functionalities attributed by the authors to Plant Information Management System - PIMS they claim that the project should allow the application to provide the user of the following gains:

- Consolidation of data in a single database: from the exclusion of single points of information concentrated, which should allow the consolidation of data from different areas and business systems maintained integrated into the same analysis;
- Decentralization of access to information: access to data from different levels of users shall be done in real time;
- Collecting and pointing data and information: availability of different types of data and information of the manufacturing process as productivity losses, consumption, process status, unexpected events alerts, performance analysis, process behavior, variability, downtime;
- Consolidated data allows adding value to information made available for analysis: the system has features capable of performing advanced analysis of the manufacturing process which can be deployed in the process of statistical controls, interrelationship data from the used performance indicators, analysis batches and consequent search for knowledge about the process in order to upgrade the industry know-how regarding your industrial process.

4. ORGANIZATIONAL PERFORMANCE MEASUREMENT SYSTEMS (OPMS) AND PERFORMANCE MANAGEMENT SYSTEM – PMS)

Currently the design of Organizational Performance Measurement Systems (OPMS) and Performance Management System (PMS) have become one of the central issues related to the alignment of business strategies and manufacturing, noting that a system is a consequence of the other and that most methods Retrieved from the literature have been developed to meet the measurement and management features and that both systems belong to a single system able to measure and manage the organization's performance.

Fernandes (2004) states that the Organizational Performance Measurement Systems (OPMS) emerged in the 1950s from the use of the Board of Tableau in France due to the increased dynamism of the world market and the resulting complexity of production systems. However, several studies in the literature dealing with the computational organizational performance measurement system design address the need of software measurement for this purpose and list all variables and constraints of systemically manufacturing from the manufacturing process data related to manufacturing roadmaps, used manufacturing resource and process parameters as productive and unproductive times, losses and more.

For this purpose the central challenge of these works is the development of construction methods of these systems able to consolidate performance indicators previously defined in general indices in order to facilitate analysis of the decision maker from the aggregation of such indicators.

Based on the criteria for consolidation or aggregation of core indicators literature emphasizes three main methods of measurement and control through performance indicators:

- BSC - Balance Scorecard - emphasis on resource planning and budget linked to the strategy, that is, the method provides that business strategies must have been defined and should be rated the alignment of manufacturing strategies with business strategies from measurement and management of organizational performance, based on the measurement system being built;
- TPP - The Performance Prism - emphasis on the linked strategy for resource planning and budget, i.e., the method provides that strategies are not set, but must be built from the identification of needs, expectations and contributions of stakeholders in the construction of measurement system and should be observed that what this method provides is an initial step

in the design of performance measurement system the definition of stakeholders to identify the needs, expectations and contributions of the same in order to draw the measurement system design to identify how the organization is able to support business strategies that you want to set, or rather, the method should be able to answer: the alignment between the strategies presents deviations that the company will be able to meet or is able to minimize or eliminate restrictions making business strategies feasible within the set time period to implement them or will not be able to reverse any adverse likely scenario?

- SCOR - Supply Chain Operations Reference - the method is applied through a diagnosis tool developed from prospects, strategies, and best practices to apply the management technologies in the standard supply chain management by the specialized literature. For this purpose the 11.0 SCOR tool describes activities carried out under the Supply Chain Management based on macro processes inherent in the planning, supply, production, delivery and return.

Each macro process is divided into sub processes for which performance and statements of best practice attributes are defined, allowing comparison and knowledge transfer between supply chains (SSC 2014).

Conduit, the director of the definition of which measurement indicators should be considered during the design process of Organizational Performance Measurement Systems (OPMS) should consider how central premise the key performance indicators - KPI of each internal and external process, based on standards clearly known and control necessary to manage the processes.

Also regarding the definition of the main Key Performance Indicators - KPI that should make the measurement system, the authors Michel and Michel (2007) propose acceptance criteria of the key performance indicators, since the choice of these indicators was based on response given by management regarding the following issues:

a) It is clear to the management the cause and effect relationship between indicators and action plans?
b) The action plans are considered as a process improvement or a control system in the eyes of decision makers within the hierarchical structure?
c) The key performance indicators - internal KPI are aligned with the key performance indicators - KPI of internal and external stakeholders?
d) Key performance indicators - KPIs are used in a fair way in the performance evaluation of employees?
e) The alignment of business and manufacturing strategies ensures that the changes generated from the strategy adopted in the short, medium and long term are consistent related to the monitoring and prospects for correction of key performance indicators - KPI?

The authors emphasize that only after the answers to these questions, you can get the key criteria that must lead to the key performance indicators - KPI to support the use of the measurement system as a management tool that can take the company from the process decision-making to become much more precise so that the decisions to be taken by the manager within the scope of a continuous improvement system and perspective satisfices the stakeholders.

According to the authors the key criteria that should be considered are:

a) The design of a management system with visibility;
b) The identification of a transparent communication system of the strategies adopted;
c) The implementation of management monitoring and control systems, such as BSC - Balanced Scorecard;
d) The definition of key performance indicators - KPI based on the particularities of the company's organizational structure with emphasis on manufacturing;
e) The decentralization of management of improvement projects;
f) The definition of promotion criteria of the people consistent with the key performance indicators - KPI;
g) The management control from the use of the operation information system and integrated performance management;
h) The definition of fair and consistent criteria in hand resources management work, materials and manufacturing (equipment).

Michel and Michel (2007) emphasize that all systems and principles should be simple and well maintained to improve the performance measure achieved.

Kumar et al (2013) point out that the use of performance indicators in recent years has become the scope of the measurement systems and performance management, from the above systems in support tool for decision-making management process assets or manufacturing resources, especially in the maintenance area, because of the foregoing that significant deviations from business strategies regarding the actual performance of the operation and organization of investment capacity in the given period of time to implement these strategies may occur, and the fact that the possibility of being without being defined can make them feasible, which may cause problems for economic and financial viability of the enterprise.

Indicators should therefore focus on the interrelationship of systemically individual indicators as to the shop floor environment, rather than just the asset management itself.

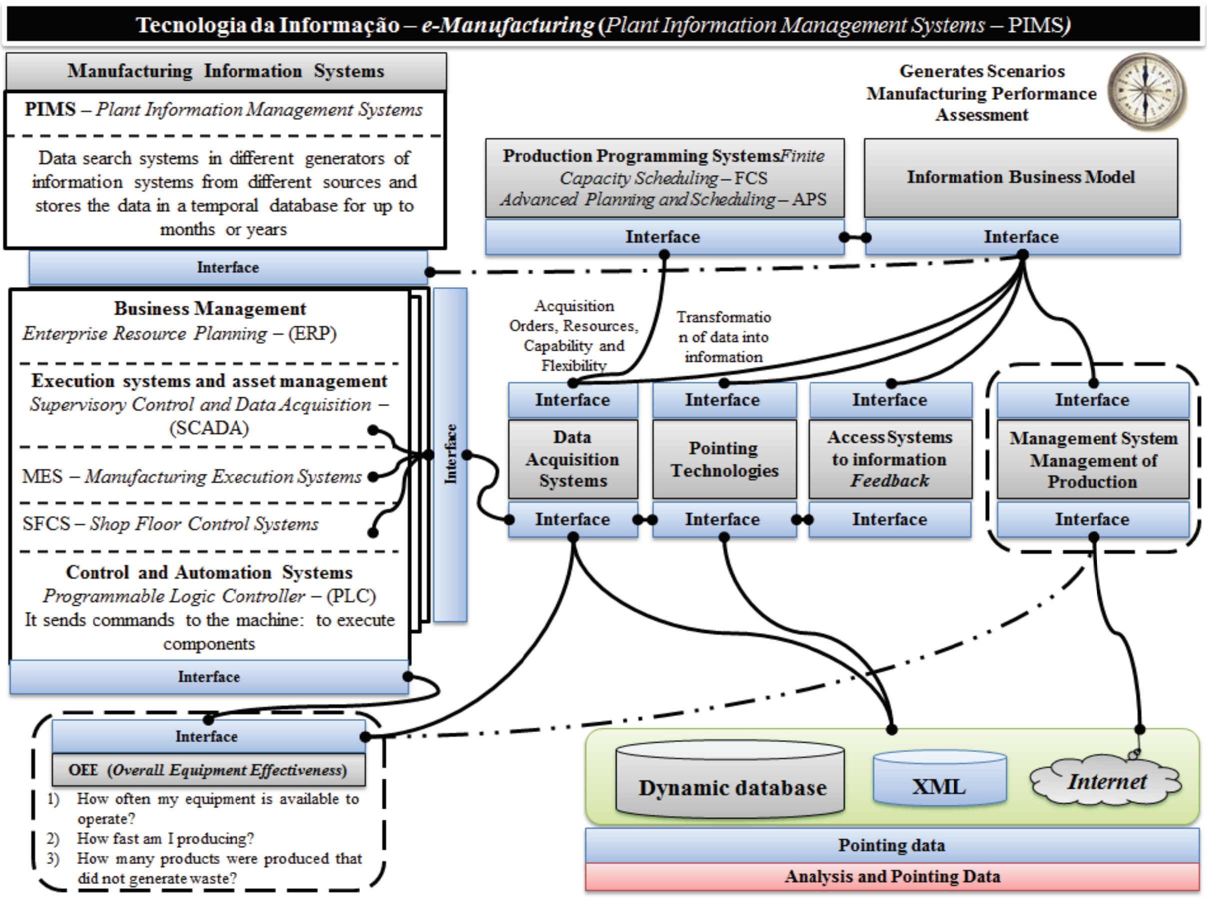
Thus, the use of OEE (Overall Equipment Effectiveness) can be useful both for the use of BSC - Balanced Scorecard as to the TPP - The Performance Prism about the prospect of internal business processes related to manufacturing.

As emphasis on manufacturing, the focus of the paper and, according to the considerations of Galar et al (2014) the biggest problem to be faced in designing a performance measurement system is consolidating in order to meet the three main indicators demands raised by the authors, the authors of this paper proposes a preliminary model of the design to be followed for the design of a more robust information system for application in more robust manufacturing systems, according to Figure 3.
Galar et al (2012) points out that in the presented context the greatest challenge to be faced is the transformation of existing data in a production system in consolidated or aggregate indicators, so that the information for decision makers deem greater performance visibility of accurate and current mode of operation.

According to Figure 3 the proposal of the papers authors concerns initially the Business Management which is configured in terms of information systems in three interrelated levels:

1) Enterprise Resource Planning.
2) Execution Systems and Asset Management, which includes:
    a) Supervisory Control and Data Acquisition - (SCADA);
    b) MES - Manufacturing Execution Systems;
    c) SFCS - Shop Floor Control Systems.
3) Control and Automation Systems.

Figure 3: Application of information technology from the functionalities of each category of computational tools



Source: Author.

Since the pointing of manufacturing processes must be carried out by Control and Automation Systems, whose data should be processed by the Asset Management Execution Systems and consolidated in data acquisition systems to be filtered and distributed by Pointing Technologies according to the structure desired data. The Access Systems to release Feedback information from this stage to the data transformed into information for the Information Business Model which together with the Management System Management of Production and Production Systems Programming Finite Capacity Scheduling - FCS / Advanced Planning and Scheduling - APS do adjustment implementing guidelines or strategies, both the business and manufacturing.

Galar et al (2012) suggests the use of an array of indicators that should be consolidated or aggregated in order to support the decision making process of both the tactical level and the strategic level, in one or more indexes that represent (s) the real manufacturing performance, and among them, the use of OEE (Overall Equipment Effectiveness) as shown in Figure 3.

The difference according to Galar et al (2014), is that the use of the OEE (Overall Equipment Effectiveness) refers to calculation from an inner product characterized by a binary function, whereas the BSC (Balanced Scorecard) use a matrix calculation of the matrix whose size depends on the dimensions related which can make the calculation of the inter-relationship between the dimensions as to the degree of influence between individual dimensions.

5. CONCLUDING REMARKS

There is a strong trend of large corporations to invest in the use of specialist software for production planning and the use of computer simulation software on manufacturing processes in order to have greater visibility of the real capacity of the plant and perform more appropriate production plans and the demand to minimize any loss in production flow-sensitive stock level reductions in the process.

In this context, studies in the literature focusing on the development of specialist software in production scheduling with ability to program the supply chain from the first-tier suppliers to the last level of the customers to ensure greater visibility and responsiveness in real-time participants in the chain or network cooperation, respecting the particularities of each element in a given moment in time, which it is for the chain links to map its restrictions and minimize them or eliminate them in time for the partners are not replaced .

However, it is up to this new conception of expert systems in production scheduling being able to manipulate a significant number of manufacturing process data respecting all kinds of interrelationships and interdependencies as the use of tooling, machines and various manufacturing resources in manufacturing of a significant number of finished products by product mix, with their manufacturing routes and Bill of Materials.

This entire process should converge on the need to update the data and information involving product engineering, process engineering, plant management and demand management, and this framework that the primary model of Figure 3 proposed in this work seeks to consolidate as a test preliminary drawing not a definite, but initial, to define the relationship of the computer systems that a possible proposal for the Technology applied to manufacturing design information shall appear depending on system complexity.

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