

Industrial Production Management: Tendencies and Reflections

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Abstract: - Modern Management can be thought of as a synergy between humans and machines in order to produce value. Management determines the relationships of the company with its environment by taking into account the production process, the type of products produced, the purchasing power, the geographical dispersion and the effect of the society on the company. This means that managers need to have a deep understanding of theories, methodologies and systems of industrial production Management in order to take appropriate decisions. This paper analyzes such theories, methodologies and systems from various perspectives and presents a critical review of the information required to take decisions in the various production systems. The paper closes with research findings describing the tendencies and necessary requirements for an efficient industrial production process.

Key-Words: - Industrial production management, manufacturing systems, operations management, production control.

1 Introduction

In its broadest possible usage the idea of Management is as old as human society. Certainly, governance or rule of people in ancient tribes, kingdoms, and empires involves the notion of managing.

In ancient Egypt, the rise of the state and its bureaucracy to create pyramids and canals rested on a state monopoly of wealth and power administered through delegated authorities. State planning that included predictions related to the rise of the Nile waters, forecasts of crops, and forecasts of state income tax revenues are examples of management techniques. Similarly, in China the emergence of the state governed by a large civil service administering uniform and formal policies over remote territories established managerial practices that resemble those of today's global companies.

The rise of the Roman Empire and the rule of Roman order and law backed by a state hierarchy established principles for the management of modern constitutional governments. Nicolo Machiavelli's *The Prince*, written at the 16th century as a treatise on governance of Italian principalities by the Medici family, is today a recommended reading for every student of Management, as it vividly portrays a managerial style in which the "ends justifies the means."

Moreover, warfare and the role of the General Commander in the management and strategies of troops and armies convey many of the concepts adapted to modern use in the management of a corporation. At present, Management students often study the *Art of War* by Sun Tsu, the 13th century Chinese military genius, or *On War* by Carl Von Clausewitz, the Prussian general and military strategist of the 19th century.

Although the pre-industrial history and literature is quite insightful about Management, we do not trace the founding of modern Management to these sources. Modern Management is business management, and pre-industrial state craft and war strategy simply provide a narrow view of the management function as something worthy of kings, princes, and emperors or, in the case of war, generals. This viewpoint is in part due to the low value that pre-industrial societies placed on commerce and business. There were, of course, trading establishments, merchants, and even bankers before the Industrial Revolution, but they were not significant aspects of societies to merit much attention and mostly represented distrusted elements of society. Perhaps this distrust was rooted in the notion that even early businesses competed with the wealth and power of the state; more likely, early civilizations simply valued aristocratic wealth based on land and inheritance.

The early Greeks disdained trade and commerce. Manual workers and merchants were excluded from citizenship and were often foreigners or slaves. This attitude towards commerce was adopted by the Romans who developed small factories to produce armaments and pottery, but as in Greece these trades were dominated by foreigners, Greeks and Oriental freedmen. The Romans did establish state joint stock companies (state corporations) to raise money for state projects by selling stocks, but prohibited joint stock companies for private enterprise.

The early Church also prohibited usury, or interest on borrowed money. As the Roman Empire gave way to the domination of the Roman Church in the West, the avenues for raising capital, either through selling stocks or through borrowing, were simply not available to create large private or public companies.

For most of our history, across all continents, mankind has lived in societies more dependent upon agricultural production than upon manufactured goods. As land has been owned by an aristocratic and chieftain class who governed in a traditional fashion, the notion of "business" management simply did not emerge as an important concept.

2 Management from a historical point of view

In the following, we present a historical point of view of Management.

2.1 Adam Smith: the economics of capitalism

Factories as an organized and localized production activity, before the Industrial Revolution, were used for limited products, mostly armaments and pottery. The first modern-like textile factory appears in 1769. The Scotsman Richard Arkwright built a textile plant that combined the new technology of the spinning jenny for weaving fabric. Steam power did not replace water power in textile manufacturing until 1785. Textile manufacturing dominated the earliest period of the Industrial Revolution. During the period from 1770 to 1860, an ever expanding array of manufactured goods displaced traditional crafts and cottage-based industry, and started to create markets. The Industrial Revolution made possible the production of new products at low costs for wider markets, which could be reached by the new technologies of steam trains and steam ship transportation.

Adam Smith's book entitled "An Inquiry into the Nature and Causes of the Wealth of Nations" [1] comes at the earliest beginnings of the Industrial Revolution. Adam Smith constructs the theory of modern laissez-faire capitalism before the use of interchangeable parts in the production of manufacturing goods, a technology introduced by Eli Whitney in 1780, permitting standardization and mass manufacturing. At this dawn of the Industrial Revolution, Adam Smith's work provided a framework by which the emergent modern economy could be understood. His explanation is rooted in a basic understanding of man's behavior, found in his rational, persistent pursuit of self-interest: "It is not from the benevolence of the butcher, the brewer, or the baker, that we can expect our dinner, but from their regard to their own interest." The word "capitalism" was not used by Adam Smith. It was Karl Marx who later coined the term "Laissez faire" economics, which in French suggests that governments should leave the economy alone. This was a direct attack on the mercantilism of the period. The essential tenants of capitalism, as developed by Smith, included:

1. the means of production, land and capital, are privately owned. "Capital" here, refers to the plant and equipment used to produce goods and services,
2. the economy is organized and coordinated through the interaction of buyers and sellers (or producers) in markets,
3. suppliers, the owners of land and capital as well as laborers, pursue their own self-interests. They seek maximum gain and profits from the use of their resources. Buyers of goods and services similarly spend their money to yield the greatest satisfaction,
4. with suppliers and buyers pursuing self-interest a market is constructed in which the value (or price) of goods and services is determined through a negotiation process between the seller and the buyer,
5. with a competitive market of buyers and sellers following self-interest, the economy is self-regulating and there is little role for government. The sovereign is necessary mainly to protect society from foreign attack, uphold the rights of private property, guarantee contracts, and assist, where necessary, in the creation of the necessary infrastructure such as roads, canals, and similar public goods.

What makes this view engaging is the fact that people are linked together by producing and buying.

The British philosopher Thomas Hobbes argued that the social glue was the sovereign, who by absolute power holds society together against the chaos of individuals pursuing self-interest. The British philosopher John Locke and the France philosopher Jean Rousseau stated that the social glue that held people together in community was the "social contract" where by individuals, from whom legitimate authority rested, collectively to unity through government. In Adam Smith's formulation, though, we have a social contract theory by which the economy binds society through every man acting in his own self-interest, acting out of a nature "propensity to truck, barter, and exchange", and finding harmony in the interaction of supplying and demanding. The individual is organized into community by virtue of economic markets based on individual needs and production.

The Wealth of Nations is an "inquiry" into the nature and causes of national economic development. Smith places at the center of his treatise that greater productivity is derived from manufacturing. In his visit to a pin factory he observed that the traditional craftsman might manufacture one pin a day. The pin factory, however, using ten men created 48000 pins a day. Smith attributed this leap of productivity to organization and technology: the division of labor in which one man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds the head, and so on; and, to the ability to utilize time saving machinery by which one laborer can do the work of many.

Smith's pin factory, however, is not the modern business firm. Absent in The Wealth of Nations and, indeed, in most of the literature on industry prior to the beginning of the 20th century is the modern concept of Management as a distinct and noteworthy business activity. The notion of a business firm was a factory, shop, retailer, bank, or other economic agent owned by a single person, or by a few owners, operating at a single location, producing a single product or service, under the supervision of a proprietor-manager. In these types of ventures, ownership is indistinguishable from the management. This will remain the dominant form of enterprise until near the 20th century.

2.2 Frederick Winslow Taylor: father of modern management

Modern Management is the collaboration of people and machines to create value. In the early days of industrialization, the innovators of machines and the innovators of organization and management were

engineers. Engineers, after all, were the ones closest to the machines, and this fact placed them at the interaction of workers and machines. This certainly helps explain Frederick Taylor's invention of "Scientific Management".

Taylor began his career as an apprentice foreman and common laborer, positions from which he quickly advanced to chief engineer. Taylor's early resume, however, belies the fact that he was born into an affluent Philadelphia family. His direct observations of men at work led him to develop what we would later call motivation theory, although this is a psychological term that was imported into the Management vocabulary much later. Taylor's own point of view drew an analogy between human labor and machine work: something that could be engineered to achieve efficiency. His theories on management would be promoted worldwide (and maybe were more popular in Japan than in the U.S. or Europe) and would receive controversial reactions. For instance, the growing Labor Movement regarded "Taylorism" as exploitive.

Taylor delineated his Management theories in his book "Shop Management" [2], making it arguably the first scholarly work on Management. Although there were already books and published work on what could be defined as "Management", Taylor approached the manager as a general role with specific functions with respect to collaborative work. The problem, as Taylor saw it, was that workers were inefficient because:

1. workers tended to ration their workload or work less than they could, because working faster and harder would mean that there would be less or no work to do in the future,
2. management failed to structure work effectively and to provide appropriate incentives.

It should be pointed out that Taylor wrote before the establishment of a "minimum wage", so the notion of what is "a fair day's work for a fair day's pay" was arbitrary. A day-rate or hourly-rate was a common practice at the turn of the century. Taylor viewed these wage practices as rewarding for attendance, not performance. While another common practice was the "piece-rate" system that paid workers on the basis of output, this generally failed because standards were poorly set, employers cut rates when workers earned too much, and workers would conceal their real capacity for production to keep standards low.

The solution, according to Taylor, lay in discovering the appropriate work standard and fitting wages to the standard. Management should

establish specific work-targets, pay workers for the tasks and goals met, and provide regular feedback. The main elements of his theory were:

1. management is a true science. The solution to the problem of determining fair work standards and practices could be discovered by experimentation and observation. From this, it follows that there is "one right way" for work to be performed,
2. the selection of workers is a science. Taylor's "first class worker" was someone suitable for the job. It was Management's role to determine the kind of work for which an employee was most suited, and to hire and assign workers accordingly,
3. workers are to be trained. It is Management's task to not only engineer a job that can be performed efficiently, but also to train the worker on how the work is to be performed and to update existing practices as better ones are developed. This standardizes how the work is performed in the best way currently available,
4. scientific Management is a collaboration of workers and managers. Managers are not responsible for execution of work, but they are responsible for how the work is done. Planning, scheduling, methods, and training are responsibilities of the manager.

The scientific approach towards work led Taylor to investigate work through task allocation. The latter meant that a job should be studied by subdividing it into discrete tasks: each element of the job would be investigated to discern the optimal efficiency by which it could be accomplished. The elements of the job, if properly designed, would be reconstructed as an efficient job. The criticism of this approach is that it omits the worker's own contribution to the design of work and, thus, alienates the worker from the job. Still, what Taylor did is link national wealth and company profits to how effectively work is performed, and he defined a cooperative role between labor and Management in wealth creation.

Taylor's system was widely adopted in the United States and the world until its demise in the 1930's as organized labor pushed for a minimum wage based on hourly pay, as opposed to Taylor's contention that pay ought to be based on performance. In practice "Taylorism" too often fell short of collaboration between labor and Management and, frequently, was a mask for business exploitation of workers. The enduring and unquestionable contribution of Frederick Taylor is that Management is firmly established as something

done by trained, professional practitioners and is elevated as a subject of legitimate scholarship.

2.3 Frank and Lillian Gilbreth: the notion of motion studies

Frank and Lillian Gilbreth were associates of Frederic Winslow Taylor. The Gilbreths, unlike Taylor, had experience in unionized industry which presumably limited their enthusiasm for timing jobs.

Frank Gilbreth was interested in standardization and method study during his early career. He first observed that no two bricklayers at construction sites (where he worked) used exactly the same method or even the same set of motion when working fast as opposed to slow, and then decided to try to find an optimized method.

The result was that he was able to raise output from 1000 to 2700 bricks per day. From their studies, the Gilbreths developed the laws of human motion from which the principles of motion economy evolved. It was they who coined the term "motion study" to cover their field of research and as a way of distinguishing it from those involved in "time study"; a technique which they believed should always precede method study. This still holds true today. The use of the camera in motion study stems from this time micro-motion study in order to record and examine detailed short-cycle movements as well as inventing cyclographs to observe rhythm and movement.

2.4 Henry Gantt: the psychological perspective of work practices

The third well-known pioneer in early Management was Henry Gantt. Gantt worked for Frederick Winslow Taylor in the USA and is popular for his humanizing influence of management, emphasizing the conditions that have favorable psychological effects on the worker. The Gantt chart for which he will also be remembered, is a visual display chart used for scheduling. A Gantt chart is based on time, rather than quantity, volume or weight. From the doctrines of Taylor and the Gilbreths, rapid developments in machinery and technology followed, and with the improvement of material came the moving assembly line.

2.5 Charles Bedaux: the concept of rating assessment and timing work

Another pioneering contributor to the field of scientific Management was Charles Bedaux.

Although not embarking on his career until after Taylor's death, he had widespread influence, firstly in the USA and later in Europe. Many major European companies were his clients, although many who experienced his work had unscrupulous managers who brought his name into disrepute.

Bedaux introduced the concept of rating assessment in timing work. He adhered to Gillbreth's introduction of a rest allowance to allow recovery from fatigue. Although crude and poorly received at first, his system has been of great influence on the subsequent work of study. He is also known for extending the range of the techniques employed in work study which included analysis.

3 Management from a key competencies point of view

The leading executives are people who are authorized to give orders (commands, mandates), which have binding nature for their receivers. They have responsibilities and authorities that reflect their level in the hierarchy. Everyone who is at a company's level of department head makes a leading executive. Their task is to affect their subordinates positively, so as to be effective and productive at their job.

The successful progress of a company depends, to a great extent, on its leading executives' quality. Quality refers to the competencies that the executives should have. These competencies vary depending on the hierarchical level that the executive belongs and the responsibilities which have been assigned to him.

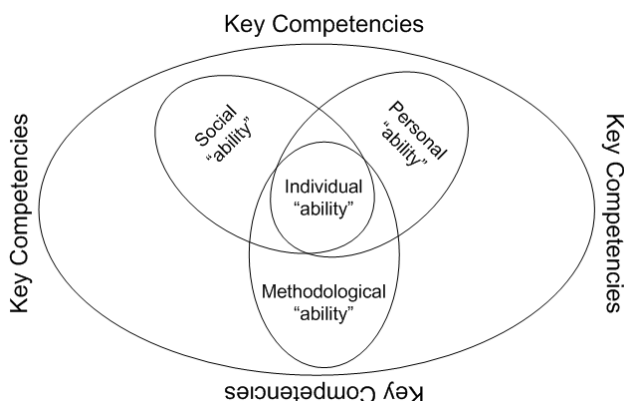


Fig. 1. Key competencies of a leading executive [1]

The leading executives are obliged to cooperate within the groups' bounds, so as to solve the complex company problems in collaboration with other people. Therefore, they must have a wide

spectrum of abilities that compose the so-called "key competencies". The latter are a prerequisite of a leading executive's individual action ability [3]. These abilities are grouped into three categories: (a) social, (b) methodological, and (c) personal (see Fig. 1).

4 Management from a hierarchical point of view

Management includes three levels: the top, the middle and the lower level (see Fig. 2).

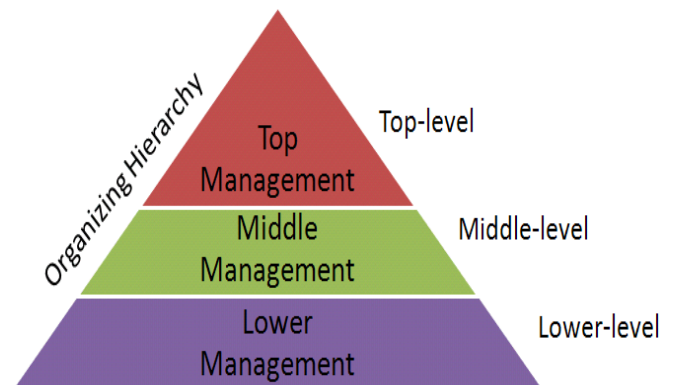


Fig. 2. Levels of Management

4.1 Top management

It is composed by a top executive or executives, who are not charged with the administration practice. In accordance to the legal form of the company, these people can be:

- in an individual company, the businessman himself,
- in a Partnership Company (PC), the company's manager,
- in a Limited Liability Company (LTD), the General Assembly or the manager,
- in a Corporation company, the board of directors,
- in a Partnership, the board of directors.

4.2 Middle management

The middle management is responsible for the administration of the operational sectors or departments. Its aim is to put into practice the top management's decisions and take decisions concerning the departments (e.g. productions, commissions, sales etc.). The middle management's executives are in the middle of two groups with conflicting interests. On the one hand, they have to

satisfy the expectations of their department heads, and on the other hand they owe to also meet the expectations of their subordinates.

4.3 Lower management

Lower management consists of the heads of the groups, such as the foremen, the office's department heads etc. Their task is to influence the behavior of the group members, so as to direct their efforts towards the accomplishment of the company's goals.

5 Management from a procedural point of view

The management procedure involves various administrative functions. Internationally, these functions were commonly grouped into five categories: "Planning", "Organizing", "Staffing", "Leading" and "Controlling" [4].

The management procedures penetrate all the functional actions of the business. Decision taking (i.e. choice of the most appropriate solution among many alternatives) constitutes the most important part of executives' everyday activity. These decisions concern the functions of the business (commissions, production, and sales) and they are rationalized by the contribution of management functions, the character of which is supplementary and not competitive.

It is well-accepted that the planning/scheduling process has an autonomous nature. The rest administrative usages of management are just tools, necessary for the implementation of the program. However, important problems of the business activity are impossible to be solved without the appropriate configuration of the organizing, leading and controlling.

The new perception of management's strategic procedure has the possibility to confront all the administration problems. This can be achieved by the strategic designing, which facilitates the strategic action of the business. Nevertheless, there is always a danger of deviation from the predictions that the business has adopted. Strategic controlling is invaluable for a system's surveillance. The fragment that is created is suitable for problems searching, such as effectiveness, innovation, flexibility etc, with the assistance of management usages. The naming of the usages keeps on remaining the same, however all of them acquire autonomy and their content is fundamentally re-determined. [6]

Strategic management is oriented to the shaping of the relationships of the business with the environment. The necessary strategic measures for each specific occasion, aim to the review and modification of the organizing philosophy and the subsystems of a company, which in this way, they are upgraded into strategic management's tools [7].

5.1 Planning

Administrative executives try to foresee future events, so as to be able to formulate the company's future consciously. Planning includes the transformation of the aim and goals of the activities into subcategories of tasks (partition of business activity e.g. at the basic functions of business), the practice of which is assigned to separate units of the system.

Planning and scheduling in a company is of paramount importance given that decisions must be constantly taken. The process of generally mapping out the orientation that gives birth to the expectation of future positive results is known as Planning/Scheduling. The formulation of general orientation has as a starting point the fundamental goals and the strategic planning.

Strategic planning forecasts in which markets and with which products/services should a business become involved, as well as in which way and when it will face competition. The result of this process of strategic planning is the formulation of a specific program that includes activities, such as: (a) new ideas for products with high market value, (b) improvements and rationalization of processes, and (c) new investment programs.

Strategic planning constitutes the frame of orientation for the taking of key decisions, while the mission of functional scheduling is to guarantee the orientation for the current work. Functional scheduling drives the daily, weekly, monthly and annual activities of an executive. Strategic planning includes programs that constitute general formulation of objectives which are not described in detail, because details are, as a rule, connected with uncertainty.

These programs have to be revised each year and to be adapted in each topical level of information. At the same time, the projection of a short-term functional program, for each year, is required, so that at the beginning of each year a total complete five-year program will exist. Such a system of planning, known also as "Rolling Planning", means that while the program remains binding in regards to its orientations and objectives, it is liable to periodical readjustments that become necessary due

to unanticipated changes in the business environment.

Consequently, the aim of planning is the conscious configuration of the future of the business, and the comprehension and recording of the decisions that should be taken both from a functional point of view, as well as in regards to their time dimension (see Fig. 3).

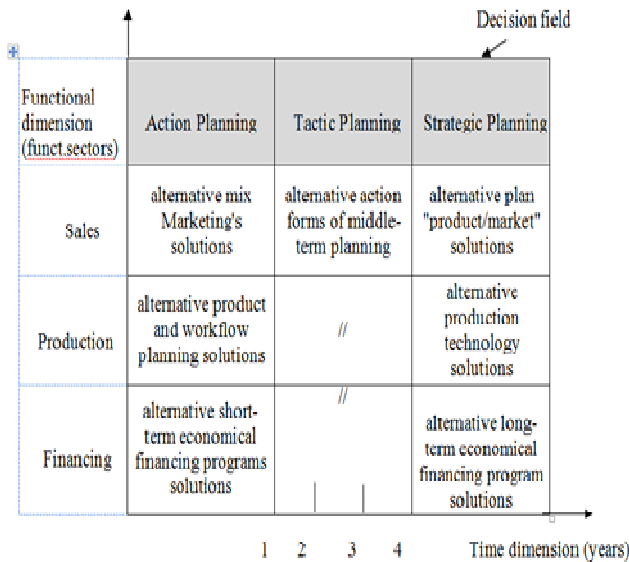


Fig. 3. Company decisions in both functional and time dimensions

The scientific or normative methodology ensures a fair and systematic confrontation of complex problems that takes into consideration all the restrictions and the alternative choices. According to the aforementioned method this process of decision-taking, follows 5 phases depicted in Fig. 4.

The localization of the problem results from two sources, which are the subject of handling of knowledge management: (a) the formal knowledge, that is the systems and the processes of information that the business has at its disposal, and (b) the informal knowledge that the executives of the enterprise have at their disposal, which has not been recorded and often its own existence has not been realized.

In the second phase, the objectives are determined. Examples of such objectives are the increase of profits, the guarantee of high degree of readiness and delivery of the product, the hiring of personnel etc.

In the third phase, an initial planning and a delimitation of the new system or a re-planning of

the old one is attempted. Information considered useful in this phase is the results of the analysis, the knowledge of the market as well as the experience of the past. The resulting solution must be evaluated under different scenarios, so that the possible consequences can become known beforehand as potential unexpected changes of the environment can occur.

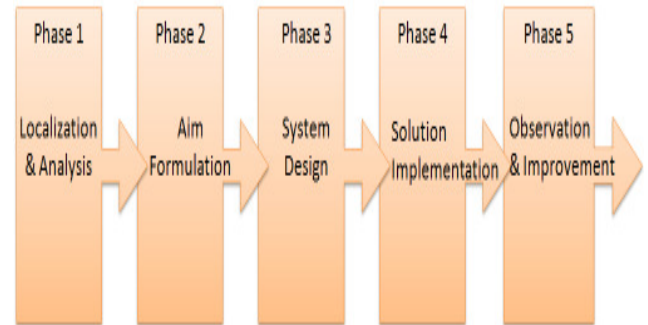


Fig. 4. The scientific methodology of taking decisions [5]

In the fourth phase – the implementation of the solution – actions are taken (where this is essential) for the planning and the growth of the systems and the processes, such as: support of the proposal, change in the chance of the strategy of the organism etc.

In the fifth phase, an evaluation of the performance of the system takes place in order to locate any possible weaknesses and to correct the errors. This follow-up requires the contribution of information systems that the business allocates. The basic technology used is the systems of operational intelligence (Business Intelligence Systems - BIS). An overview of the architecture of such an infrastructure is presented in Fig. 5.

5.2 Organizing

The entirety of problems constitutes a subject of the administrative function. The result of the corresponding actions taken to solve the various problems is also referred to by the same term.

Apart from organizing, an important premise for the accomplishment of business aims is the quality of the workers. All the problems that arise during the staffs search, the output evaluation and the further education and development of the staff constitute a subject of "staffing" function.

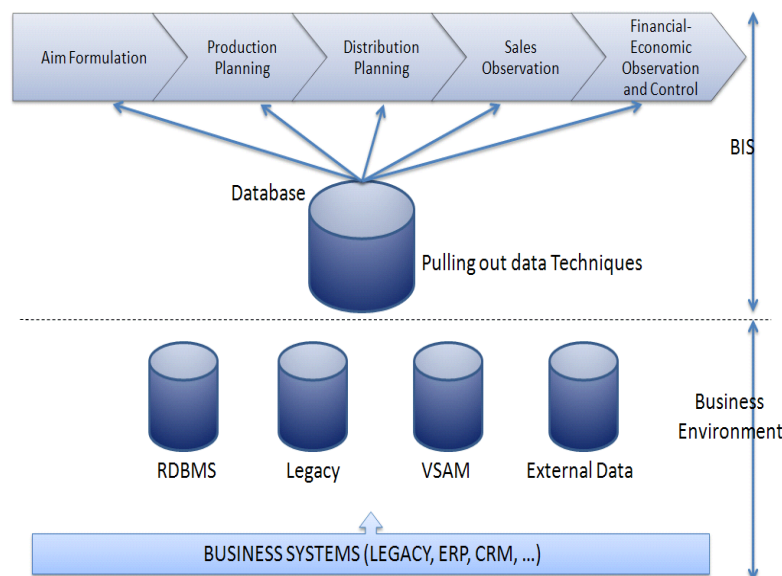


Fig. 5. Business Intelligence systems (BIS) [5]

5.3 Leading

The success of strategic decisions depends on a great number of factors. Within the bounds of an industry's function, the leader's task is to motivate his subordinates to a behavior that is in the same line with the aims of the industry or of the business.

Taking for granted that the aims of the workers are not necessarily identical to the aims of the business, this function is indispensable. In order to ascertain how such measures in a business are successfully affected, it is necessary to examine:

1. the role of communication between department heads and subordinates,
2. the motives that constitute the foundation of the subordinates behavior, and
3. the significance that the leading executive's behavior has to the leading's procedure.

5.4 Controlling

Controlling refers to the comparison between the plans and actual accomplishments. The aim of controlling is to verify if and to what extent the aims that were posed by the programming were achieved and to trace the reasons of possible deviation from the schedule.

6 Methods of industrial production management

In today's information era and globalized markets, new challenges appear for the industrial environment in the entire world. Customers demand for smaller product quantities, which are cheaper, delivered always on-time and personalized to their

individual needs. Companies compete to meet these increasingly high expectations by trying to decrease product production and delivery times, and by offering an increasingly wider range of products.

Methods of industrial production management can support today's companies in addressing the aforementioned challenges. Such methodologies typically offer material requirements planning, capacity planning, work scheduling, and demand management. Key goals of these methodologies are to improve planning and scheduling of processes, increase productivity, minimize inventory level, improve responsiveness to changes in demand, improve quality, and lower operation cost.

However, the abundance of available alternative such methods and the wide range of different particularities of the companies make the choice of the appropriate one a complex issue. Choosing the wrong methodology can result in well-planned processes that are not really required for a specific type of company or for a company in a certain context. In addition, such methods typically require a change in the culture and practices of the company. Thus, choosing the wrong one is a very expensive mistake.

In this section, we present a critical review of popular production management methodologies. The methodologies reviewed are Material Requirements Planning (MRP), Manufacturing Resource Planning (MRPII), Enterprise Resource Planning (ERP), and Just in Time (JIT). Each method can be successful, demonstrate disadvantages or even fail under certain conditions. The goal of this section is to present them along with their respective strengths and weaknesses to

assist management stakeholders in the choice of the most appropriate one for their specific company.

Due to space limitations we chose to present only a short description of the most popular approaches. The total number of results returned from Google was used as an index of their popularity. These results were in agreement with our personal past experience derived from discussions with professors in management and administration. Additional details for each method can be found in [8]-[11]

6.1 Materials requirement planning

Materials Requirements Planning (MRP) is a software-based system used to manage manufacturing materials. MRP systems support the coordination of the production-related decisions to ensure on-time availability of materials for production, schedule the distribution of machine parts in the various departments, minimize inventory level and adhere to product delivery dates.

The information required as input to a functional MRP system is the following: a) the Master Production Schedule (MPS), which describes quantities and types of products to be produced based on known orders and forecasts, b) the product structure records or Bill of Materials (BOM), which includes a list of raw materials and how each product is manufactured, and c) the inventory status records, which describe the materials available for immediate usage and those on order from suppliers.

The first output of the MRP system is the Recommended Production Schedule, which presents the minimum start and completion dates and quantities required to meet the demands of the MPS for each step of the end-product manufacturing. The second output is the Recommended Purchasing Schedule, which delineates both the dates that the purchased items should be received into the facility and the dates that the purchase orders should be placed in order to match the production schedules. These are only recommended outputs. A trained manager in charge should review them and also take into account various external factors, such as fluctuation of prices, order delays, and execution of earlier commands that appear to be more important.

6.2 Manufacturing resource planning

Manufacturing Resource Planning (MRPII) is the evolution of MRP. This evolution from MRP to MRPII was gradual and was mainly inspired by the two basic weaknesses of MRP:

1. MRP uses some priorities, but does not take into account the restrictions that concern the

company's productive capacity. Thus, it proposes what should be ideally done, and not what the production can really support. MRPII was the first that started taking into account the capacity of the human potential, machines or any other limited resource,

2. MRP was a system exclusively used for materials management and inventory control. The MRPII was developed with the aim of taking into account all aspects of the manufacturing process, including materials, finance and human relations.

The technical differences between MRP and MRPII are very small. The most important is that MRPII is a closed-loop system. Thus, the modules of MRPII are self-sufficient and there is feedback of expected or unexpected facts that allows a continuous retroaction to the data used for planning. The philosophy of MRPII is to support decision-taking by providing simulations of "what-if" scenarios. In this way, fluctuations in forecast data can be taken into account by including simulation of the master production schedule. An MRPII output is a final labor and machine schedule.

6.3 Enterprise resource planning

Enterprise resource planning (ERP) is the natural outgrowth of MRPII [11]. MRPII evolved into ERP when "routings" (i.e. listing of the work centers and operations needed to make a part) became parts of the standard software activity. A steep increase in the sales of ERP systems was observed in the 1990s due to the "Year 2000 Problem". Many companies took this opportunity to replace their legacy information systems with ERP systems.

ERP systems are a complete cross-functional and enterprise-wide solution that attempts to cover all functions of an enterprise, such as process design and development, manufacturing, finance and accounting, human resources, marketing, inventory control and strategic management. ERP systems can be viewed as having three levels: a) planning, b) execution and, c) analysis. Examples of activities that take place in the planning level are design of the supply chain and the production process, planning of sales and establishment of the annual budget. Accounting management, stock management and human resources are typical components of the execution level. Analysis activities typically include cost analysis, budget analysis and finance tools.

6.4 Just-in-time

Just-in-time (JIT) constitutes a complete solution for

the organization, control and continuous improvement of production systems and products' development. JIT was firstly established and publicized in Japan - mainly by the Toyota Motor Corporation. Japan is a country with minimal raw material and problematic warehousing due to limited land availability. By applying JIT systems, Japan achieved the most competitive industry in the entire world both in quantity and quality of products.

The philosophy of the JIT methodology is to minimize anything considered waste in order to increase overall productivity. Products not immediately used by the enterprise to yield profit are a waste of time, money and space. The time required to prepare a machine to function is a waste of time and should be limited to minimal. The partial use of materials or the low degree of transformation in goods which have some value is a waste of material, material that costs. Faults occurring during the production are a waste of time, work, energy and materials.

The application of the JIT production organization system requires a bottom-up analysis of the entire productive process. Having knowledge of the quantity of products that should be disposed in the market, the last stage of the production chain is planned first, followed by the hierarchically precedent until the first stage of raw material. This is achieved by a series of signals, or Kanban (card in Japanese), which tell production when to make the next part. Due to its bottom-up approach the JIT system is classified as a demand-pull system

6.5 Selecting an appropriate system

The rapid increase in the number of the industries and the internationalization of the market has led to a boost in the levels of competition. The number of the different variants of products and their complexity has been increased with a rapid rhythm. All these conditions have led to the growth and establishment of computerized systems for planning, management and control of the production

Managers need to understand the philosophies of these systems, their strengths and limitations in order to choose what is best for their organizations. All the available systems can be both successful or fail under certain conditions.

Petroni [12] is critical of the low implementation success rate of MRPs, especially amongst small and medium enterprises. Practitioners should also be familiar with typical points of failure for ERP implementation. Yusuf et al. [13] groups implementation difficulties into three categories:

cultural, business and technical. Motwani et al. [14] argue that an evolutionary implementation process supported by management and cultural readiness are of critical importance. Schniederjans and Kim [15] suggest that success depends on how a company prepares itself for integration. One other common mistake is to neglect to analyze the company's organization and processes before implementing an ERP system [16]. In such cases, the organization of the company is usually adapted to the ERP system, instead of adapting the ERP system to the existing processes [17]. As a result, processes can also become less efficient than they were prior to the implementation of the ERP system. Ramaswamy [18] argues that data migration is one of the most important activities in determining the success of an ERP implementation. In addition, ERP systems are usually so expensive that only big companies can afford them. A typical project requires on average 14 months and 150 consultants [19]. The most important advantage of using JIT is waste reduction, which leads to reduction in inventory level and smoother flow of goods. Other advantages include improved working relations between employees, stronger and more reliable working relations with suppliers, higher profits and improved customer satisfaction [20].

Table 1 summarizes the strengths and weakness of the production management methodologies presented. The table is meant to be used as a quick tool to support managerial system selection decision-making.

7 Conclusion

In the classic traditional faculty of Management, all the studies that have as starting point the movement of the so-called "scientific management" are included. First, Taylor [21] began the effort of rationalizing the technical processes of production. He attempted to contribute to the solution of the problem of productivity maximization. Taylor came to the following conclusion: the division and the distribution of work, as well as the exclusion of the worker from every form of preparatory work related to economic motives (e.g. planning) can lead to the maximization of productivity [21].

It was decided, at a later point, that taking equitable measures in the higher levels of hierarchy was necessary due to the given competition, the increasing dependence of businesses on their suppliers, the continuously developing size of productive units and the increase of percentage of administrative employees in the total number of employees.

Table 1. Summary of the strengths and weakness of the production management methodologies presented

	Strengths/Advantages	Weakness/Limitations
MRP/ MRPII	<ul style="list-style-type: none"> ✓ Useful simulator to answer what-if questions ✓ Minimizes work-in-progress in each production station. ✓ Reduces manufacturing costs. ✓ Permits monitoring of the production process from purchase order to end product shipment. ✓ Improves production scheduling and planning. ✓ Provides valid, credible priorities that reflect actual, and not implied, needs. 	<ul style="list-style-type: none"> – Proposes what should be ideally done, not what can be really achieved based on capacity (<i>remedied by MRP II</i>) – Only concerned with materials management. (<i>remedied by MRP II</i>) – Requires extremely high accuracy of data (e.g. 99%) – Does not tolerate informal systems/processes that people working together for years typically have. – Assumes production of standard products with well-known product structure and routings.
ERP	<ul style="list-style-type: none"> ✓ Integrated solutions for a wide range of activities of the company. ✓ Better cooperation among departments. ✓ Centralized data management means no synchronism problems, and less risk of data losing. ✓ Data security features. ✓ Eliminates redundant transactions ✓ Enables better analysis and future planning due to tracking/logging of all activities 	<ul style="list-style-type: none"> – Increased integration can cause problems in accountability and responsibility. – Resistance in collaboration may lead to system failure. – Changing company's processes to fit "best practices" of an ERP may lead to a loss of competitive advantage. – Centralized data management can also mean an increased risk of a security breach – Data migration problems may arise. – Can be complex, expensive, time-consuming to install. – Once a system is established, switching costs are high
JIT	<ul style="list-style-type: none"> ✓ Affordable software, even for small companies. ✓ Reduction in set up times, inventory level and smoother flow of goods. ✓ Increased supplier reliability and quality. ✓ Flexible and efficient workforce due to employees' multiple-skills training. ✓ Better scheduling/work hour consistency. ✓ Better relationships between managers and employees. ✓ Improved performance/throughput of employees to meet deadlines. 	<ul style="list-style-type: none"> – Requires standardization of materials/production process. – Risk of delay due to late deliveries, unexpected events (e.g. natural disaster), and shortage of materials. – Slow respond to change in product design, large demand volume. – Adds a sociological point of failure due to bad relationships between workers and management – Typically requires years to provide optimum results due to culture change.

Fayol [22] was the first, who addressed the problem of increasing the attribution of work in levels of Administration. Continuing the work of Taylor, Fayol dealt with the problem of coordination of functional differentiated competences. He separated the Administration into five operations: Planning, Organization, Management, Co-ordination and Control [22]. Moreover, he formulated fourteen fundamental principles of Administration that placed the foundation stone of "Administrative Theory". Other well-known representatives of Scientific Management are: Gulick [23], Mooney [24], as well as Koontz and O' Donnell [4].

A branch of traditional theory of Management is Max Weber's theory of Bureaucracy [25]–[26]. According to Weber, the main question is not how to adapt a person to the machine, but "which form must have the staff that exercises power, so that it is ensured the maximum degree of effectiveness of exercising power" [27]. Accordingly, the interest of Weber is limited to the effectiveness of the structure of Administration. The ideal form of rationalistic

organization of Administration constitutes the "Bureaucracy".

The main characteristics of the organizational structure of Weber's Bureaucracy are the following:

1. division of work in the base of functional specialization,
2. distribution of competences, precise delimitation of competences and responsibilities,
3. hierarchical structure of organization (determination of hierarchy, power, system of relations between the levels of hierarchy),
4. standardization of administration (decisions and commands are determined in written form),
5. binding in rules and standardization of processes for effective implementation of work,
6. formal and impersonal interpersonal relations,
7. ensured possibilities of promotion.

The Neoclassical approach, was created in the decade 1920-1930, when in the context of Scientific Management research endeavors,

experiments were conducted in order to investigate the reasons of workers' lack of satisfaction from the natural conditions of work as an alleged main factor of low productivity in the factories of Western Electric Co in Hawthorne company in Chicago [28]. Initially the aims of the company's Administration were to achieve an increase of the workers' output and to relate wages with the output. However, they did not achieve the expected result. This fact led researchers to assume a causative relation between social factors and productivity. It was realized that the workers that participated in the experiment appreciated the particular attention and friendliness that the Administration of the company demonstrated towards them, so the general level of satisfaction of work that they executed was improved. They showed a feeling of responsibility in completing their duties, which resulted in an improvement of their work.

Consequently, the traditional faculty of Management attempted to improve the output of workers with ergonomic measures and economic motives. The Neoclassical approach realized that unexploited enormous reserves of output exist and should be sought in the human factor. Therefore, the way that leads to the increase of output of the workers, passes not only through the improvement of social climate, but mainly through the satisfaction of those workers' needs, that for various reasons remain unsatisfied in a given moment.

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