ISBN 978-1-84626-xxx-x
Proceedings of 2011 International Conference on Optimization of the Robots and Manipulators (OPTIROB 2011)
Sinaia, Romania, 26-28 Mai, 2011, pp. xxx-xxx

Production Planning Process in a Flexible Manufacturing Cell

Claudia Raluca Tudorie [1]

[1] Politehnica University of Bucharest
Romania (Tel: +4021.402.9314; e-mail: raluca.tudorie@cimr.pub.ro)

Abstract. Production Planning Process also named Sales and Operations Planning (S&OP) is an important function of the Supply Chain Management, because it continuously assesses and adapts the supply and the demand, based on analyses of forecasts, current situations and operational plans. It is a monthly process which consists in several steps, and involves a lot of roles inside a company. This paper represents an overview of the process and also its position regarding other important concepts related to logistics, objectives of production planning, tips and tricks about how to make it successful. Finally, it will be presented a production planning process in a manufacturing cell that exists in University Politehnica of Bucharest, Centre for Research & Training in Industrial Control, Robotics and Material Engineering.

Keywords: Production Planning (PP), Sales and Operations Planning (S&OP), Supply Chain Management (SCM), flexible manufacturing cell (FMC), industrial robots.

1. Introduction

In any enterprise, there are different departments that contribute to the processes that occur from the moment the raw material is purchased until the point a product is delivered to the customer. In order the business to be successful, these departments are supposed to collaborate and decide together, that is why a mechanism to ensure this has been created. This mechanism is called Sales and Operation Planning (S&OP) or Production Planning. S&OP brings all the people together in order to asses future market demand and generate change in the business, if needed.

The S&OP plan includes an updated sales plan, production plan, inventory plan, customer lead time (backlog) plan, new product development plan, strategic initiative plan and resulting financial plan.

The current demand and supply challenges are the ones that spice up the sales and operations planning: poor coordination of demand and supply (lost sales, incorrect inventories, lost/lower profitability); lack or no technology to do the "what if" modeling and gaining agreement; lack processes to manage new product development, innovation and feasibility; breakdown in communication due to the lack of quality and availability of data; lack of leadership in getting agreement on S&OP plans; lack the right metrics to drive value; lack integration with the financial budgeting process; internal business processes do not facilitate delivery of right product/ price/ quality/ quantity at the right time, to the right customer.

2. S&OP Overview

"S&OP is a set of decision-making processes to balance demand and supply, to integrate financial planning and operational planning and to link high level strategic plans with day-to-day operations" [1].

"S&OP is the process that provides management with the ability to strategically direct its business to achieve competitive advantage on a continuous basis by integrating customer focused marketing plans for new and existing products with the management of the supply chain" [2].

Usually, the S&OP is done for the following 18 months, in average, but meeting happen once a month. It starts with an updated sales forecast covering the next year or more. All of the important functions of an organization are participating in the S&OP. In this way, all of them are synchronized and reconciled with each other. In contrast with the overall business plan of the company, which is focused on the financial part, the S&OP is focused on sales and production: bookings, demand, supply, standard hours, units, etc.

Because of its nature, S&OP creates feasible plans, because during this process the plans are verified by the lower levels and different functions of the organization. The final goals are to keep the right balance between the supply and the demand and ship the products at minimum costs, energy and effort. The concept of *product family* is related to S&OP and it refers to the clustering of products based on similarities. The planning is done on product families, because it is easier to operate with them rather than with the whole range of products (see fig.1).

To sum up, the need for S&OP is to manage:

- absence of teamwork and shared risk management among internal functions;
- supply interruption, leading to production delays, on-time delivery issues, lower profits or customer loss;
- lack of confidence in planning systems;
- excessive on hand inventories and obsolesce;
- ineffective utilization of resources and/or lack of resources when needed;
- poor collaboration among stakeholders – internal or external (finger-pointing);
- unacceptable lead times.

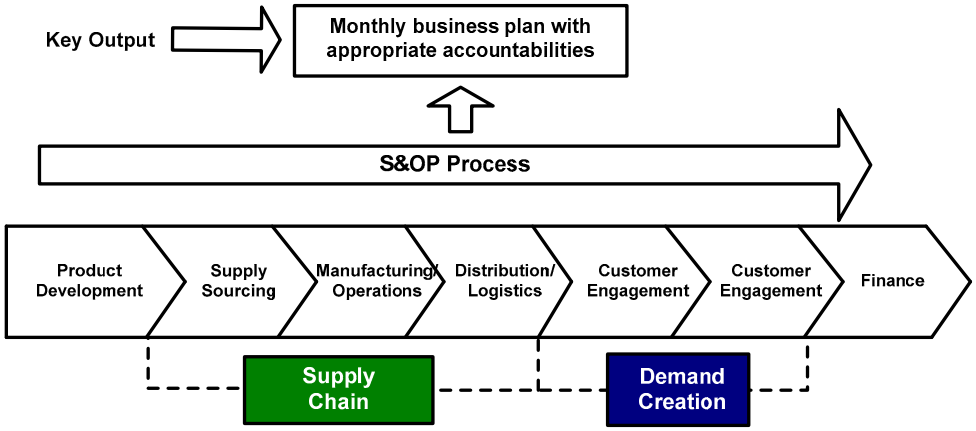

Fig. 1: S&OP Process [4].

The objectives of S&OP are: *(i)* developing for each family of products a sales plan and a rate of production; *(ii)* ensure that the plans are realistic and valid: the proper amounts of resources are available to satisfy customers in a cost effective manner and that the plans support the strategic and business plan; *(iii)* integrate manufacturing with the other activities of the business plan; *(iv)* develop an economic strategy for meeting the demand; *(v)* eliminate hidden decisions; *(vi)* effectively manage change; *(vii)* better manage finished goods inventory.

3. Where Does S&OP Fit?

In order to better understand S&OP, it is necessary to understand where it fits in comparison with other concepts related to: Enterprise Resource Planning, Supply Chain Management and Lean Manufacturing [6].

Enterprise Resource Planning (ERP) is not a set of software, it should be understood as a set of business functions for resource planning. S&OP was initially developed as a part of the resource planning process and started out as Production Planning. S&OP links the Strategic and Business Plans together with Master Scheduling function.

The relation with the *Supply Chain Management* is much closer, because S&OP is actually part of the SCM. It works as a lubricant between the partners in the supply chain and enables it to function with

minimum disruption. SCM extends in two directions: forward to the customers and backwards to the suppliers (see fig.2). If the company that is in the middle of the SCM doesn't correctly balance the demand and the supply, the chain partners will not have correct information about future demand and supply. For the customer, S&OP helps a company provide superior services, while for the supplier the benefits are also significant. If the suppliers are given some of the S&OP results, then they will experience: more stable production rates, volume changes made sooner and smaller, and hence more economically and a greater ability to respond to mix changes, because the volume is under control [3].

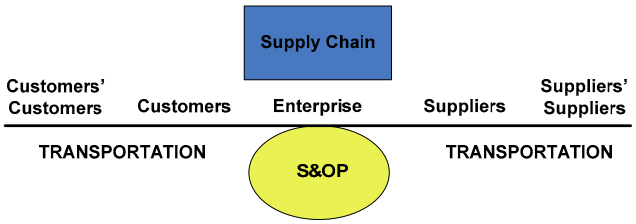

Fig. 2: Supply Chain Management – S&OP [3].

S&OP supports the *Lean Manufacturing* in the same way it supports a conventional manufacturing environment. In order to understand deeply how Lean Manufacturing and S&OP work together, it must be analyzed the differences between the Lean and ERP. Lean is more focused on improving the operational environment, while ERP is a set of planning tools and accepts the environment which is described to it.

Strategic and business planning, forecast and manage of customer demand, plan of future capacity, Master Schedule are things which happen similarly as in ERP. The different elements are: Material Requirements Planning, Plant Scheduling and Supplier Scheduling (see fig.3).

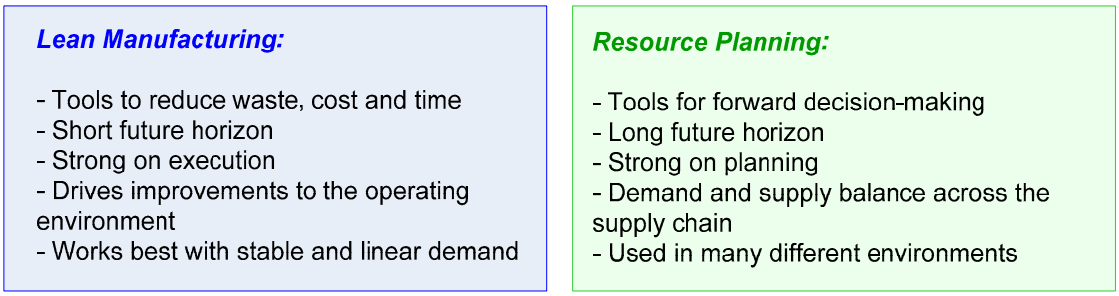

Fig. 3: Lean Manufacturing – Resource Planning [3].

4. Basic Industries Overview

Before presenting the case study, a classification of basic industries that include not only manufacturing is shown in fig. 4. All these basic components are explained below:

- *Production Industries* – are the industries engaged in the production of goods (finished products) that have value in the marketplace. It includes *Process Industries* and *Discrete-Item Manufacturing Industries.*
    - *Process Industries* (named also *Continuous Process Production Industries* or *Flow Production*) standardize non-discrete products in extremely large volumes using a continuous process. The components or ingredients of this industry can't be identified in a finished product. Many times an additional step is needed (eg: cosmetics, food processing, soaps, tires, etc.)
    - *Discrete-Item Manufacturing Industries* is characterized by discrete, countable products and component parts. It produces a single component or unit of product each time an operation is performed (eg: aerospace, automotive, clothing, equipment and machinery, etc.)
- *Project Industries* is characterized by the fact that materials, tool and personnel are brought on the same location where the product has to be developed. This type of industry is based on a single product, that is generally a large one and keeps it busy for months or years (eg. construction, erection of factories, shipbuilding, etc.)

- *Service Industries* represents those industries that don't produce goods, but provide certain services (eg. advertising, financial, insurance, mass media, retail, utilities – natural gas, telecommunications, etc.)

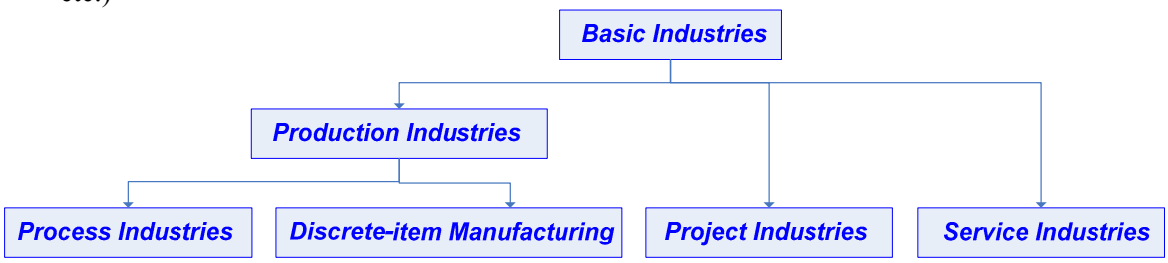

Fig. 4: Types of Basic Industries [2].

Next section presents a framework for planning and controlling components for a manufacturing cell that exists in our laboratory. This cell, conforming to the earlier classification can be included in discrete-item manufacturing industries. The proposed planning structure involves three levels: production planning and control system level, scheduling level and machine level. There are two types of data: those used in information flow and those for work parts and tools.

5. Study Case

The flexible manufacturing cell from our laboratory is an assembly structure composed by five robotic workstations linked by a closed loop conveyor system (see fig. 5). The final products are the result of executing a number of mounting, fixing and joining operations made by one or by several robots. The industrial robots are able to communicate with the PLC using digital I/O lines and also using Ethernet TCP/IP, and so they can exchange information about their status and information regarding the manufacturing process. The conveyor is controlled by the PLC that enables all mechanical actions to be taken in the transport system [5].

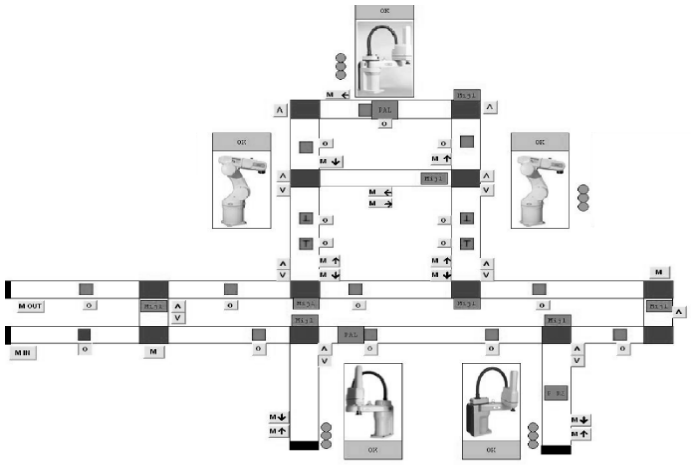

Fig. 5: Flexible Manufacturing Cell.

The goal of production planning process is to balance demand and supply; this means that it has inputs from customer and outputs to vendor. This is why PP process must to connect with other processes: *Sales and Distributions*, *Material Management* and *Finance and Controlling* (see fig.6).

The proposed production planning process contains four subsystems and three layers:

- *S&OP:* at this layer, sale and production plans are made. There are used data from different sources to set the realistic operating goals.
- *Master Planning*: at this layer, decisions are made for influencing production plans.
    - In *Demand Management*, is chosen the planning and production strategy (make-to-stock, make-to-order, stock orders or production by lot for sales). There are also established delivery dates and the requirement quantities.
    - In *Master Production Scheduling*, are decided what are the parts or products that greatly influence company profits.

- In *Long-Term Planning*, are simulated the effects of the long-term demand program. This means that the capacities and the purchasing budget required to purchase parts can be checked.

- *Material Requirements Planning:* this level controls if the row material is available or not available. The required materials in the correct quantities at the right time will be acquired.
- *Execution methods*

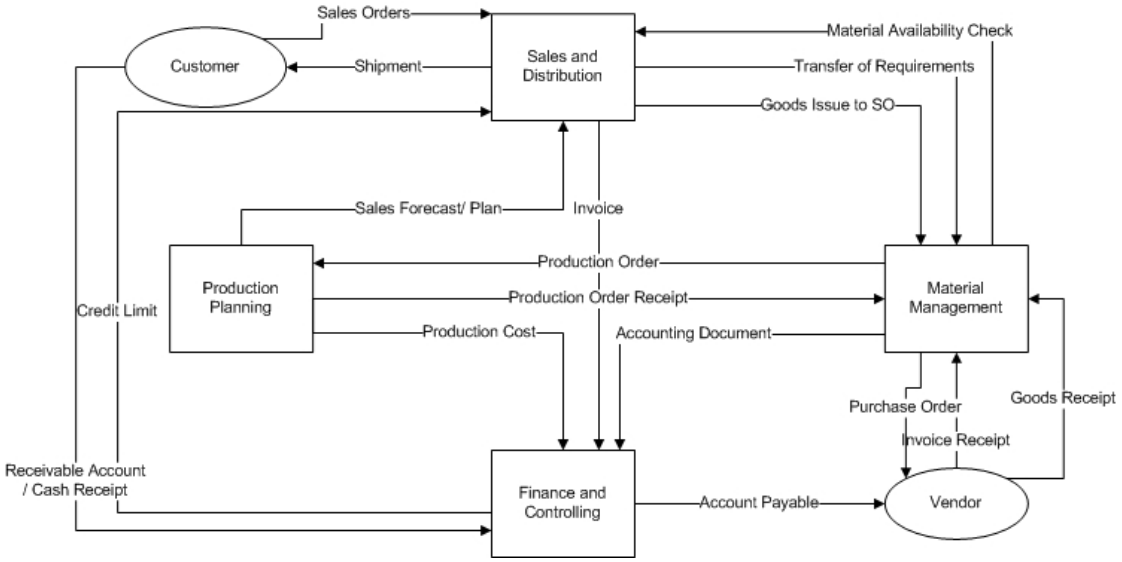

Fig. 6: SAP R/3 integration model [6].

In the FMS, master data process was implemented using an example of defining five products that result after assembling semi-finished parts. The operations that need to be done in the FMS are fixing axes to support the parts, mounting and joining parts and visual inspection.

6. Conclusions

The Sales and Operations Planning is a complex subject, as it is an important part of the Supply Chain Management. Without a proper planning of the demand and supply-chain the performance of the other functions along the Supply Chain would be significantly affected.

The paper gives a summarized proposal for optimization of a manufacturing cell in planning production. This requires complex structure of modules: shop floor control, material requirements planning, demand management, sales and operations planning, basic data, production info system, capacity planning and process management.

7. Acknowledgements

The work has been funded by the Sectoral Operational Programme Human Resources Development 2007-2013 of the Romanian Ministry of Labour, Family and Social Protection through the Financial Agreement POSDRU/6/1.5/S/16.

8. References

[1] L. Lappide. Sales & Operations Planning. PartI: The Process. *The Journal of Business Forecasting*. Fall 2004, pp. 1-6.

[2] S. Khalid. Manufacturing Resource Planning (MRPII). *The McGrow-Hill Company* 2003: pp. 1-591.

[3] T.F.Wallace. Sales and Operations Planning – The How-to Handbook (3rd edition). 2008: pp 1-198.

[4] http://www.thomasgroup.com

[5] Th. Borangiu, P.Gilbert, N.A. Ivanescu, A. Rosu. An implementing framework for holonic manufacturing control with multiple robot-vision stations. *Engineering Applications of Artificial Intelligence- Elsevier* 2009: pp.505-521.

[6] http://help.sap.com