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Material Requirements Planning for S.C. SPORT S.A.

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Abstract: *This chapter discusses the application and development of a management resource planning in a sports company, starting from analyzing the forecasted demand of a final product. Taking into account the final demand's period, the planning will have the role to predict the needed quantity of raw materials, as well as the proper delivering period, in order for the company to be able to deliver the final product on time. Every possible (unexpected) delay in the raw materials' production and delivery will result in a delay of the final product.*

Keywords*: management resource planning; master production schedule; inventory.*

The company SC Sport SA has entered the sport articles' market 10 years ago, in the exact same moment when they put up for sale the "collection" bicycles, and among the best-selling articles were the Pegas bicycles.

Nowadays, the production manager, Mr. Șerban Ion realized that people's desire for sport is increasing and so, he decided to launch a new model of a Pegas bicycle, for daily use, for adults and children as well.

Before this action will take place, the production manager must develop a material requirement planning, in order to produce bicycles over a 10 week period. Mr. Ion estimates that the time frame between the launching moment and the production itself, of a complete bicycle, is 2 weeks.

Now the company has an inventory of 30 bicycles, without having a safety stock (the safety stock refers to the stock kept as a reserve in order to meet customer demand when and if necessary).

The forecast customer demand is as following:

- 50 bicycles in week 3;
- 100 bicycles in week 6;
- 150 bicycles in week 8;
- 80 bicycles in week 10.

In order to better visualize the forecast demand, we will present the data in the table below:

	1	2	3	4	5	6	7	8	9	10
Demand	0	0	50	0	0	100	0	150	0	80
Initial stock (inventory)	30	-	-	-	-	-	-	-	-	-
Orders	x	x	x	x	x	x	x	x	x	x

In the table above, we can observe the demand for each of the 10 weeks period plan. Initially, the company has an inventory of 30 bicycles and if this entire inventory will be consumed for meeting the 50 units demand from week 3, then the company would remain with a stock equal to 0 products (50-30=20) by the end of week 3.

What is for sure is that the company would still have to order a number of bicycles to honor all the forecasted demands from the 10 weeks plan.

Material requirements planning (also known as MRP) represents an informational and computerized system developed for helping the producers to better manage the dependent demand's stock and thus to plan the replenishment of inventories when is necessary.
The **inputs** of a MRP system are:

- Master production scheduling
- Bill of materials
- The beginning inventory

With the help of these inputs, the MRP system identifies the actions that need to be taken so the products could fit in the program. Also, MRP transforms the master production schedule and other demand's sources, like the independent demand for the exchange pieces and other maintenance elements, in requirement for all subassemblies, components and needed raw materials for creating a parent-product.

- *The master production schedule* results from dividing the aggregate plan in concrete products on a planning horizon, which, normally, varies between 40 and 50 weeks. However, the master production scheduling must not be bigger than the total production's supplied time.
- *The bill of materials* is created by a structural division of the Pegas bicycle on different hierarchical levels (as it can be observed in the figure below).
- *The list for beginning inventories* presents the calendar structure for obtaining a product. Basically, the beginning inventory represents the actual amount of quantity on hand from the previokmus period.

Thus, the final product – the Pegas bicycle (level 0) – is composed from the following elements:

a) Handlebar (*level 1*)
b) Seat (*level 1*)
c) Top tube (*level 1*)
d) Fork crown (*level 2*)
e) Seat post (*level 2*)
f) Wheel (*level 2*)
g) Brakes (*level 2*)
h) Pedal (*level 2*)
i) Spokes (*level 3*)
j) Brake hoods (*level 3*)

k) Chain ring (*level 3*)
l) Crank set (*level 3*)

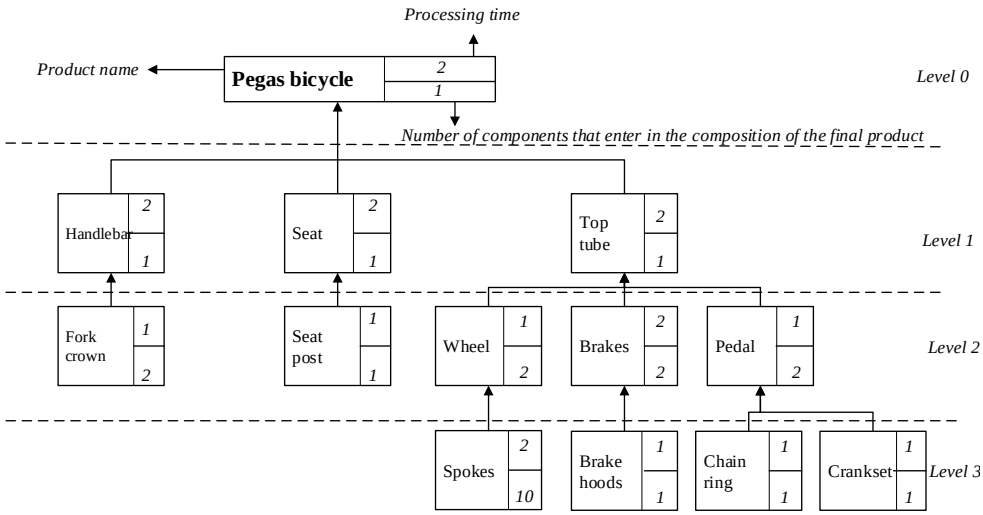

Fig. 1. Bill of materials for the Pegas bicycle

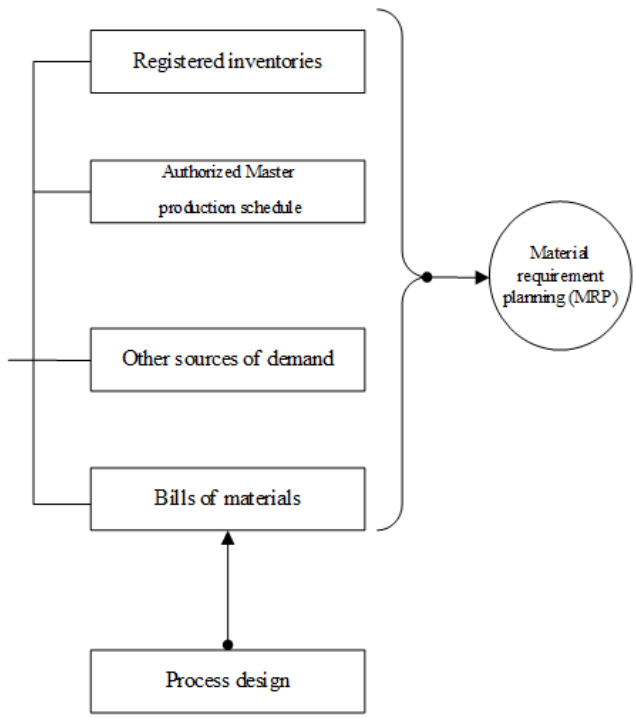

Fig. 2. Material requirements planning (MRP)

The Pegas bicycle is composed of 3 direct raw materials: handlebar, seat, top tube, each one of them being *level 1*. Furthermore, each of these 3 raw materials has other raw materials that enter in their composition.

For example we can easily observe that the *seat (level 1)* is composed of the *seat post* (*level 2)*, in the handlebar's composition (level 1) enters the fork crown (level 2), in the top tube's composition (level 1) enter the wheel (in return, the wheel is also made of spokes – level 3), brakes (brakes are composed also from brake hoods – level 3) and pedals (level 2), composed of a chain ring and a crank set (level 3).

This means that as a start, for the top tube's composition, the company should assemble first the wheels, brakes and pedals.

This process is also known as "MRP explosion" because it transforms the final products' requirement in a material requirements planning which specifies the completion programs of all subassemblies, components and raw materials needed for a the creation of a final product.

In Fig. 2, we can observe a representation of a "MRP explosion" (material requirements planning).

The **outputs** of a MRP system are:

- Projected inventory of finished goods;
- Master production schedule;
- Uncommitted inventory.

Practically, the MRP program is designed so that it would be capable of answering 3 main questions:

1) ***WHAT*** do we need?
2) ***HOW MUCH*** is needed?
3) ***WHEN*** *is it needed?*

The inputs and outputs of an MRP system are presented in Fig. 3.

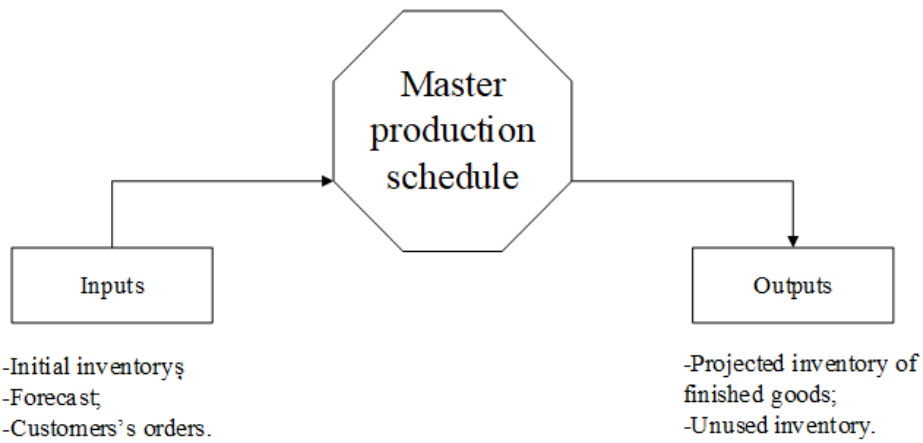

Fig. 3. Inputs and outputs of a MRP system

The dependent demand of the SC Sport SA enterprise

For years, the majority of companies try to manage the production, as well as the inventories of dependent demand, using independent demand's systems, but however, the result was not that often satisfactory because the dependent demand is completely different from the independent demand.

Thus, for better explaining this action, we will take as an example the company for which the case study is realized.

SC Sport SA produces Pegas bicycles. The demand for a final product, which is the Pegas bicycle, is called *the independent demand* because it is influenced only by the market's conditions. On the other hand, the demand for *spokes*, which enter in the bicycle's composition, *depend* on the wheels' planned production. Per se, Sport SA has to forecast this demand. However, Sport SA also keeps other products in their stock (handlebars, pedals, brakes, etc) used for creating a complete bicycle.

Each of these elements has a dependent demand because the necessary quantity varies the production plans for other components held in the inventory (complete bicycles, in this case).

For example, the demand for the handlebars, seat, wheels etc is *dependent* on the production of complete bicycles.

During the MRP program, we will consider the Pegas bicycle (or any other product manufactured from one or more components), a parent. The handlebar, for example, is considered to be a component, because it represents a product that enters one or more operations to be transformed into, or become part, of one or more parents. Thus, the decisions for producing Pegas bicycles, which also take into consideration the assembly costs and the decisions for the design ability at a certain time, determine the demand for handlebars.

It is also considered that a component may have several parents. The *part commonality*, sometimes called *modularity,* represents the degree in which a component may have several direct parents. As a result, the same components may appear in several places of a product's bills of materials, as well as it can appear in the bills of materials of different products.

For example, let us see how the relation parent-component is represented for Sport enterprise:

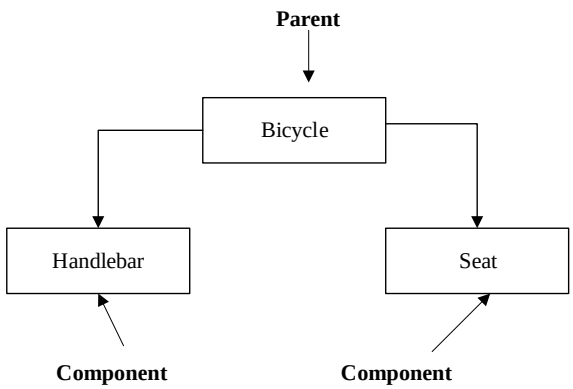

Fig. 4. Parent-component representation

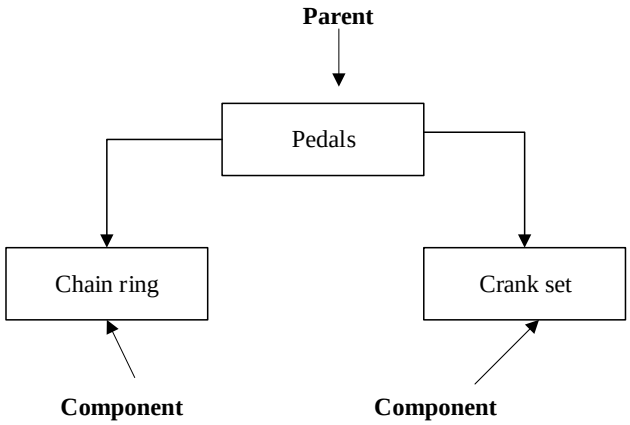

Fig. 5. Parent-component representation

In the above pictures we have chosen 2 situations in order to better represent the relationship created between a parent and a component. In the *figure 4* we can observe that the *parent* is represented by the bicycle, while the components are the handlebar and seat (because a bicycle could not exist without these 2 components, which, after they are assembled, they become part of the bicycle).

In *figure 5* we have illustrated that even a component (the pedals) of a parent (the bicycle), are able to become parents (the pedals) for other components (chain ring and crank set). This situation appears when in the composition of a component enter other materials; in this way, the **component** becomes **parent** for those materials.

Summarizing the above information, the production manager, Mr. Șerban Ion will confront with 2 decisions regarding the orders:

- ***The temporal aspect*** – the moment when the order needs to be placed
- ***The quantitative aspect*** – in what quantity should the materials be ordered

Before determining the material requirements planning, Mr.Ion composes a list in which he mentions the elements participating in the plan, the existing stock, the necessary quantity from each element and their processing time.

	On hand inventory	**Necessary quantity**	**Processing time (weeks)**	**Planned receipt in week 1**
Pegas bicycle	30	1	2	
Handlebar	50	1	2	
Seat	20	1	2	30
Top tube	80	1	2	20
Fork crown	0	2	1	
Seat post	45	1	1	
Wheels	40	2	1	
Spokes	60	10	2	
Brakes	50	2	2	
Brake hoods	15	1	1	

	On hand inventory	Necessary quantity	Processing time (weeks)	Planned receipt in week 1
Pedals	10	2	3	
Chain ring	30	1	1	
Crank set	40	1	1	

According to the above table, we can observe that the enterprise has 2 types of inventory:

a) On hand inventory (at the beginning of the planning period):
- Pegas bicycle: 30 units
- Handlebar: 50 products
- Seat: 20 products
- Top tube: 80 products
- Fork crown: 0
- Seat post: 45 products
- Wheels: 40 products
- Brakes: 50 products
- Brake hoods: 15 products
- Pedals: 10 products
- Spokes: 60 products
- Chain ring: 30 products
- Crank set: 40 products

b) Planned receipt (the products that must be received as a result of their purchase from external suppliers or products that must be received as a result of internal orders placed earlier):
- Seat – week 1 – 30 products
- Top tube – week 1 – 20 products

In the composition of the MRP system, Mr. Șerban Ion will use the following elements:

Element	Description
Gross demand (D_g)	The total demand for a certain product, in each period, without counting the initial inventory.
Scheduled receipt (SR)	Any scheduled receipt planned from previous orders, which now is in the fabrication process.
Stock (S)	Inventory level at the *beginning* of each period if we will produce according to the initial plan and the forecasted demand is correct.
Net demand (D_n) $D_n=D_g-S-SR$	The remaining amount after eliminating the initial inventory (the actual quantity for each period).
Planned order receipt (Pr)	Open orders or else said, the orders that have been placed and are planned to arrive from the suppliers before the beginning of a certain period.
Planned order release (Or)	The moment when the orders must be placed, taking into account the demanded time for the activity.

Taking into consideration the above information, help the production manager, Mr. Ion, to take decisions for the following situations:

a) To calculate the *moment* when the orders need to be placed (in what weeks), as well as the necessary *quantity*, so as the company will not remain without a stock for any of their products and to honor the customers' demands (developing the MRP system).
b) How will the material requirements planning change if the wheel's processing time will increase with 2 weeks, and the pedals' processing time will increase with 1 week?
c) What decisions could be adopted if the products will have a delay? How will the MRP system change if the bicycle's gross demand will be 50 units in week 2, 100 units in week 3, 150 units in week 5 and 80 units in week 7?
Is there any urgent action by the end of the plan?

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