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WINDMILL FARM ASSEMBLY PROCESS USING A MRP MODEL

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Abstract: *The wind turbine sector is growing rapidly. The transportation and installation/assembly of wind turbine components are crucial phases for a wind farm project. The aim of this study was to improve the supply of part for windmill, improving the assembly planning system and to avoid waiting time and bottlenecks, to reduce the total time. The MRP model is presented to be use at the final assembly process for a windmill farm.*
Key words: *windmill, MRP, assembly process, BOM*

1. INTRODUCTION

Wind energy is among the world's fastest-growing sources of energy. The wind turbine sector is growing rapidly both with regards to the number of installed wind turbines, and the capacity of newly developed and manufactured machines (Torsten, 2009). A wind turbine is a machine that converts the wind's kinetic energy into rotary mechanical energy, which is then used to do work. In more advanced models, the rotational energy is converted into electricity, the most versatile form of energy, by using a generator (Moubayed, 2009).

Windmill farms are arrays of windmill set in areas of favorable wind production. The great number of interconnected windmill is necessary in order to produce enough electricity to meet the needs of a sizable population.

The transportation and installation/assembly of wind mill components are crucial phases for a wind farm project. Booming demand in the wind industry has focused attention on the complex supply chain of components which lies behind every mill delivered to the market. There where bottlenecks in delivering and the production have to catch up (Supply Chain: The race to meet demand, 2007).

Despite the transformation of the turbine manufacturing sector into a streamlined, efficient mass producer of high tech equipment, it has found it difficult to keep up with the surge in demand. The result has been some customers unable to source turbines for their projects and a rise in prices.

2. ASSEMBLING PROCESS

A typical wind turbine will contain up to 8,000 different components (Supply Chain: The race to meet demand, 2007). To cope with the continuing uncertainty of supply, some turbine manufacturers have to make difficult strategic decisions about whether or not to produce more of their components in-house. The leading manufacturers have historically produced all their main components within their own business structure.

GE, on the other hand, has outsourced more, including its blades, considered by many to be the most vital component. Outsourcing raises issues not just of secure supply but of quality control and design confidentiality.

2.1 Components/parts

A windmill (WM) consists of three basic parts (Wind Turbine, 2010): the tower (T), the nacelle (N), and the rotor blades (RB). The tower is either a steel lattice tower similar to electrical towers or a steel tubular tower (TT) with an inside ladder (L) to the nacelle.

Most towers do not have guys, which are cables used for support, and most are made of steel that has been coated with a zinc alloy for protection, though some are painted instead.

The nacelle is a strong, hollow shell that contains the inner workings. Usually made of fiberglass, the nacelle contains the main drive shaft (MDS) and the gearbox (GB). It also contains the blade pitch control (BP), a hydraulic system that controls the angle of the blades, and the yaw drive (Y), which controls the position of the turbine relative to the wind. The generator (G) and electronic controls (EC) are standard equipment whose main components are steel and copper.

Wind turbines also include a utility box (UB), which converts the wind energy into electricity and which is located at the base of the tower. Various cables connect the utility box to the nacelle, while others connect the whole turbine to nearby turbines and to a transformer.

2.2 The Assembling Process

The final assembly process of a windmill is made at the site of the farm and start with the preparation of the site (roads cut, land graded and leveled). Then a concrete foundation is made with the underground cables.

The tower is assembled on site and erect with a special crane. The fiberglass nacelle is assembled with inner workings off site (main drive shaft, gearbox, and blade pitch and yaw controls). At the site, the nacelle is lifted onto the completed tower and bolted into place.

The blades are usually bolted onto the nacelle after it has been placed onto the tower.

The utility box for each wind turbine and the electrical communication system are installed simultaneously with the placement of the nacelle and blades.

3. CASE STUDY

The development and maintenance of windmill farm must be realized by elimination of numerous subcontractors in order to minimize delays in production, transportation and installation, for cost cutting and energy efficiency. The aim of this study was to improve the supply of part for windmill, improving the assembly planning system and to avoid waiting time and bottlenecks, to reduce the total time.

Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes (Reid, 2002). Most MRP systems are software-based, while it is possible by hand as well.

An MRP system is intended to meet objectives such as: ensure materials and products are available for production and delivery to customers; plan manufacturing activities, delivery schedules and purchasing activities.

For the MRP model we need the bill of materials (BOM). A bill of materials is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, components, parts and the quantities of each final product.

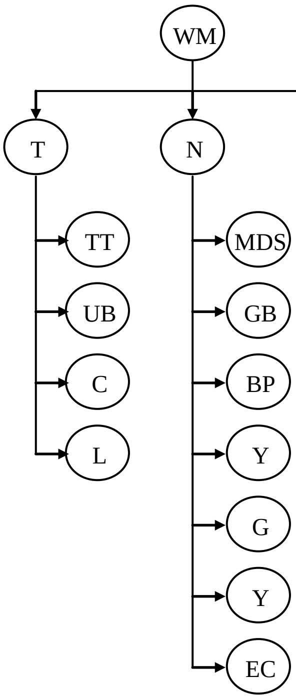

Fig. 1. The bill of materials (BOM) for a windmill

A BOM can also be visually represented by a product structure tree.

For our case, the figure 1 present the bill of materials (simplified) for a windmill and the table 1 present a MRP model that can be use for the final assembly process at a windmill farm site.

Reference			1	2	3	4	5	6	7	8	9
WM	1	D									25
	2	N							25		
T	1	D							25		
	2	N					25				
N	1	D							25		
	3	N				25					
RB	3	D							75		
	1	N						75			
TT	1	D					25				
	1	N				25					
UB	1	D					25				
	1	N				25					
C	1	D					25				
	2	N			25						
L	1	D					25				
	1	N				25					
MDS	1	D				25					
	1	N			25						
GB	1	D				25					
	2	N		25							
BP	1	D				25					
	2	N		25							
Y	1	D				25					
	2	N		25							
G	1	D				25					
	3	N	25								
EC	1	D				25					
	1	N			25						

Tab. 1. MRP model for a windmill farm

This simplified MRP model use for input the following information: bill of materials/components, quantity needed for every part (P) and assembly time (T).

The output is the time schedule for components, what, when and how many are necessary for a windmill farm of 25 wind turbine. The total time needed for this case is 9 weeks and the table 1 shows for each component/assemblies when is the due date (D) and when is necessary to start the assembly process (N).

This MRP model has minimum but sufficient input and output information for assembly process planning. Next, there can be use a similar model for their sub-assemblies, sub-components, components, parts, raw materials and so on. This way it is easy to read the models and can focus on the specific issue when is needed.

This MRP model can be extend to include information such as: batch size (optimum for production/transportation), stock level, quantity needed when we have already a stock, supply rules, production (manufacturing) time and transportation time (to integrate information from suppliers).

The benefits of this model are the simplicity, easy to track and evaluate components requirements, a database of components but with limited decision capability. Other limitations of the model are the: accurate and up-to-date inputs (schedules, bill of materials, inventory records) and integrity of data.

4. CONCLUSIONS

We proposed here a way of analyzing and a MRP support tool for planning process for a windmill farm.

With all the given information presented on the table, the production managers can decide the optimum way for assembling process, for a maximum of productivity, or for a maximum of workplace loading, for a minimum of workers. Here is very important to integrate also information from suppliers or for own production lines for components, to known exactly when all components are available.

The integrated methodology provides a feasible way to build an automated process planning.

The dynamic scheduling for assembly process is solved incrementally before it expands into a large problem and the complexity of the problem is reduced.

The future research plans, based on the customized MRP model will approach:

- An estimate of the operations and maintenance cost of the project broken down over the main accounts;

- A comparative analysis reports, describing the different operating conditions of a generic turbine and how these should be recorded and used to calculate availability.

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