Analysis and Research on Intelligent Manufacturing Path of Automobile Industry

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ABSTRACT

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INTRODUCTION

Manufacturing industry is an important support and foundation for the whole economic development, while the automobile industry has a central position in the manufacturing industry. From the domestic automobile industry, with the sustained and rapid development of China's economy and society, China's automobile industry in the number and structure of the show a vigorous development trend. This paper focuses on the automotive industry, intelligent manufacturing started research work, focusing on the automotive companies how to improve the production efficiency through the supply chain, intelligent manufacturing system to achieve intelligent manufacturing.

INTELLIGENT MANUFACTURING

Economic Order Quantity

Economic Order Quantity (EOQ) refers to the order of the production process to ensure the normal operation of a certain period of time to buy and sell goods associated with the lowest total cost of each batch of orders. The value of the supply chain is efficient and accurate. In the context of order production, the quantity of the order is not only related to the cost of the automobile enterprise, but also to the consumer side of the delivery cycle. Therefore, in the choice of the order quantity, Product types and models, taking into account the order cycle, the type of orders and other factors, and ultimately to achieve economic orders.

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In the context of the rapid development of information technology today, this paper in the F.W.Harris, Wilson and other related scholars on the economic order batch model based on the depth of the study. Assumptions:

- \( Q \): single batch parts of the order quantity;
- \( D \): the number of daily real needs;
- \( P \): the number of each component;
- \( H \): the daily inventory cost per component;
- \( C \): the fixed cost of each batch of orders, including transportation, handling and other costs;

Through the above assumptions, we can conclude that:

Total cost = cost per day for all parts + daily transportation costs + daily storage costs, where:

The cost of all parts per day = parts price \( \times \) day demand, that is, \( P \times D \).

If the fixed cost per order is \( C \), the order quantity per day for the assembly plant is \( D/Q \). and the transportation cost is \( C \times D/Q \).

It can be seen that the cost of storage is proportional to the total amount of inventory, which means that the larger the total inventory, the higher the cost of storage. Since the demand rate is constant, the mean value between full and empty stocks is \( Q/2 \), so it can be concluded that the storage cost is \( H \times Q/2 \).

\[
TC = PD + \frac{CD}{Q} + \frac{HQ}{2}
\]

In order to determine the lowest cost, we can set its derivative to zero:

\[
\frac{dTC(Q)}{dQ} = \frac{d}{dQ} \left( PD + \frac{CD}{Q} + \frac{HQ}{2} \right) = 0
\]

The result can be derived:

\[
-\frac{CD}{Q^2} + \frac{H}{2} = 0
\]

Thus, the optimum order quantity \( Q \) of \( Q^* \) is obtained:

\[
Q^* = \sqrt{\frac{2CD}{H}}
\]  

Through the above analysis can be found in the whole process of the supply chain, parts demand, order quantity to delivery time rate of change due to a variety of unpredictable situation occurs random changes in the situation. The order-to-delivery time variation feature can be described in a normal distribution. The fitting of the normal distribution of a random EOQ model can be expressed by the following figure. (R-SS) is the average of the normal distribution during the interval. It can be seen from the figure that if the demand is greater than the reordering point in the interval period, the stock is out of stock The cumulative probability is represented by the 1-F (x) part.
In the enterprise management practice, the security stock is the main content of the enterprise supply chain management, the security stock is not only the number of the pursuit of its cost management is also considered one of the elements. The annual total cost of the safety stock is the sum of the safekeeping and the out-of-stock costs of the safe stock, expressed as the formula:

$$TC_{ss} = C_h C_U (R - d) + \frac{C_b D E(d > R)}{Q}$$  \hspace{1cm} (2)

Where $E(d > R)$ indicates that the demand is greater than the expected value of the reorder point during the time interval. If the total cost of the order point for the reorder, and make it zero, you can get the optimal value. Assuming that the out-of-stock charges for each spare part are known, the optimal out-of-stock probability can be expressed as:

$$1 - F(x) = \frac{OC_h C_U}{C_b D}$$

By referring to the normal distribution table $F(x)$, if you know the variance of the distribution, you can find out $Z$, and can calculate the safety stock. Therefore, the formula for safe stock can be expressed as:

$$SS = \sigma Z$$

The order point order can be expressed as:

$$R = d + SS$$

Where $d$ represents the expected value of the demand for the interval. To determine the expected out-of-stock (EBPC) for each period, you can use the following formula:

$$EBPC = \sigma (E(Z))$$

Where $E(Z)$ is the partial expectation of $Z$, the satisfaction rate formula is:

$$FR = 1 - \frac{EBPC}{Q}$$  \hspace{1cm} (3)

If the order-to-delivery time is fixed and the demand is normally distributed within the interval, the safety stock can be calculated by the mean and variance of the
demand distribution during the interval. If the order time and interval demand changes in a normal distribution, the combined mean is:

\[ \mu = \mu_d \mu_{OST} \]

The Joint Variance is:

\[ \sigma^2 = (\mu_{OST})^2 + (\mu_d)(\sigma^2_{OST}) \]

Thus, the Standard Deviation is:

\[ \sigma = \sqrt{(\mu_{OST})^2 + (\mu_d)(\sigma^2_{OST})} \]

In the real supply chain management process, the optimal order quantity in addition to considering the number of cost factors, in order to avoid the quality of products with the batch of problems, but also consider the unity of the supplier of different suppliers of the problem. With the information supply chain management platform, through the accumulation of data, the model is also a continuous optimization process.

**The choice of Intelligent Manufacturing System**

Throughout the 20th century, dedicated production lines (DML) and flexible manufacturing systems (FMS) have emerged, dedicated production line in the first half of the 20th century occupy a dominant position, its greatest feature is relying on mechanical automation, to achieve high yield, low cost target, with the market Competition in the case of more choices in the consumer, the private production line can not achieve the optimal allocation of organizational resources, and flexible production systems rely mainly on intelligent tools such as machine tools to achieve, so the lean production model has been widely promoted, with fast The ability to produce new products. Reconfigurable Manufacturing System (RMS) refers to a sudden change system that can be quickly transformed into a starting point in structure and hardware and software so that capacity and functionality can be quickly adjusted within a family to respond to market or regulatory requirements.

Through the research and comparison, it is found that the special production line and the flexible manufacturing system appear before and after, but the two are related relationship. Compared with the former two, the reconfigurable management system has the advantages of the first two, and it is the standard manufacturing of the intelligent manufacturing era mode.

| TABLE I. COMPARISON OF THREE MANUFACTURING MODELS. |
|----------------------------------|---------|---------|---------|
| Category                        | DML     | RMS/RMT | FMS/CNC |
| System structure                | Fixed   | Transformable | Transformable |
| Machine structure               | Fixed   | Transformable | Transformable |
| System concerns                 | Components | Part family | Machine tool |
| Extensibility                   | No      | Yes     | Yes     |
| Flexible                        | No      | Customizable | General |
| Capacity                        | High    | High    | Low     |
| Life cycle cost                 | Low     | Middle  | Reasonable |

Source: Global Manufacturing Revolution
According to the above analysis, the choice of manufacturing system by the product type, market status, economic strength and many other factors, different industries, different products, different economic strength, talent reserves and other factors will affect the choice of manufacturing model. When the size and efficiency of enterprises to a certain extent, to achieve the combination of the three models is the best choice.

And the same product, the manufacturing system also has its life cycle, and the choice of manufacturing system should also be with the enterprise's development strategy, product vitality, market segments, customer groups are closely linked. The NPV approach can be used to measure how much investment in a new manufacturing system is added to an enterprise if it is taken into account from the perspective of input-output, which measures the cash flow from a financial point of view Surplus or loss of the situation. According to the metric, if the net present value (NPV) is greater than 0, it indicates that the investment in the manufacturing system can bring value to the enterprise, and it is worth investing. If the net present value (NPV) is less than 0, it means that the investment in the system Leading to the value of corporate losses should be rejected. The formula is as follows:

\[
NPV = \sum_{i=1}^{n} \frac{NFC(t)}{(1 + k)^i} - I
\]

In the formula, \(NFC(t)\) represents the net cash flow for the \(t\) year; \(k\) represents the discount rate; \(I\) represents the initial investment amount; and \(n\) is the estimated useful life of the project.

If, by contrast, the NPV of the flexible manufacturing system is greater than the NPV of the dedicated production line, the investment in the construction of the flexible manufacturing system is more cost-effective. Therefore, the enterprise to choose which kind of manufacturing model, the choice is based on accurate measurement and pre-judgment data.

**SUGGESTIONS**

(1) Development of personality and common core technology

In essence, the coupling between the automotive industry and the information technology industry is a technical coupling, is the development of their respective industries to a certain stage after the inevitable trend. As the information technology and automotive enterprises engaged in technology research and development, we can adopt different development strategies and development methods, such as automobile enterprises can use their own in the market, consumers and other aspects of positioning, increase R & D investment and development of personalized core technology; Production and research methods, the use of national key laboratories and other research institutions, the development of high and difficult core technology; even with counterparts to develop common technology.

(2) Using Enterprise Alliance to Promote the Deep Coupling of Automobile Enterprises and Information Technology Industry

The coupling between the automobile industry and the information technology industry involves multiple companies in various industries, whether it is Germany, the
United States or Japan. This coupling cannot be borne by a single company or several companies. Therefore, according to certain boundaries, it is vital to establish an industry alliance with a certain goal as a result. In this industry alliance, each subject conducts relevant research work in related fields according to his own advantages. From a more macro perspective, different industry alliances should also establish coordination mechanisms, even in some interfaces and so on to share.

(3) Build enterprise data maps and data maps

Since the birth of the software, has been used to improve the efficiency and reduce the cost of the mission, with the statistics, metrology and other related disciplines of the development and maturity, and now, the value of software has risen to change the work itself, and gradually become the carrier of data. And the platform, in the system life cycle management mode, the data is the basis of business decision, product design, personnel management and other activities. However, the analysis is only the basis of the value of the data, its greater value and use lies in the next stage of the decision-making and forecasting, therefore, must be based on business activities, for various objects using software to establish data maps.

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