

Balance Analysis of Many Varieties Small Batch Workshop Production Line

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Abstract

Aiming at the present situation of the circular saw blade production workshop, through the research of TMM0106 circular saw blade manual packaging production line production efficiency, the circular saw blade processing production line balance rate and process efficiency are analyzed quantitatively. The existing problems are found and the reason for it is analyzed, to provide theory basis for improving the production efficiency of many varieties small batch production line.

Keywords: *many varieties small batch, production line balancing, process efficiency*

1. Introductions

With the increasingly market competition, and customer personalized demand unceasing enhancement, production mode of processing workshop has gradually transform from mass production for multiple varieties small batch production, and quality requirements of its production process is more strict [1-2]. Many varieties small batch production process change fast, quality sample data quantity is little, once appear quality problem, often cause product batch repair or scrap. Therefore, how to carry out the workshop production line balance rate, process efficiency and on-site management situation, the low efficiency of this line production has become the problem the general manufacturing enterprises urgently need to solve. In addition, due to the arrangement of the production line and its related equipment work is very complex, and the efficiency of the production line is closely related with the utilization rate of facilities, the quality of the products of enterprises, for enterprises using flowing water production line, production line balancing is an indispensable factor when in the design of production line, also is an important problem in enterprise production and management [3-4].

The improvement of the production line is always around the quality, efficiency and cost, and the efficiency of the production line is the basis of an enterprise operation and management, but also the important economic indicators of enterprise's management level. The key of production efficiency improvement is to eliminate the unbalanced phenomenon between procedures, eliminate various waiting for waste, so that the production efficiency is greatly increased. And line balancing analysis can carry on the average, to the production of all processes to adjust work load, in order to make the technology as much as possible close to the operation time and method, is the production process of the most important method in the design and operation standard[5]. Enterprise facing economic pressure and had to reduce inventory, and make them naturally chose many varieties small batch production mode. Semi-finished products processing industry must be implemented more and more small batch, processing timely supply mode, even in the face of increasingly fierce price competition at the same time. This flexible processing requirement is concerned with the value of each access to the processing steps, and largely in material process [6].

Production line balancing problem comes into being with running water production line production, has been one hundred years. But the problem is by American B. Bryton

in paper the continuous production line balance in 1954, it is officially proposed for the first time, and in 1955 Salveson put forward for the first time in master thesis on assembly line balancing problem, followed by many experts and scholars have launched a lot of research from different angles, and accordingly made a certain degree progress. Wenqiang Zhang and Mitsuo Gen used genetic algorithm to solve the problem of mixed production line balance, they constructed a pareto independent groups based adaptive function to select effective offspring, and achieved good results [7]. Industrial Engineering theory is proposed by the father of scientific management of Taylor, the staff, elements such as materials, equipment, energy, information effectively, reasonable combination and configuration, and continue to improve, to achieve more efficient operation, provide technical support for the management activities and ensure [8-9].

2. Circular Saw Blade Production Line Process

B company is the world leading manufacturers of electric tools and accessories, is a typical type of customized manufacturing enterprise, the machining for many varieties small batch production organization pattern. Circular saw blade is a very important part in electric tool accessories products of B company, takes TMM0106 circular saw blade manual packaging production line as the research object, TMM0106 circular saw blade processing production process by stamping, welding, grinding and packaging of 4 production lines. Among them, packaging production line including painting, microscopy, printing white, printing silver, printing red, oiled and packaging process.

The TMM0106 circular saw blade process flow diagram is shown in figure 1, using a stopwatch to measuring and recording the time for each working procedure operation, the statistics results are as follows: processing 7 times, six in the staging, carrying six times, check 3 times, the total activity for 22, but preliminary findings TMM0106 circular saw blade packaging production line has more temporary situation, more products in production line.

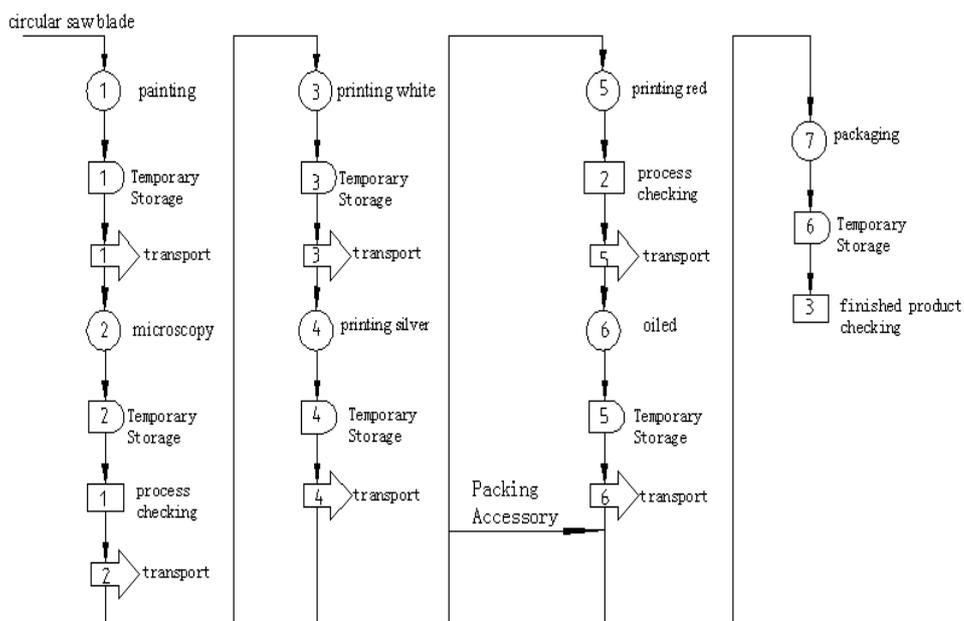


Figure 1. TMM0106 Packaging Production Line Process Program

3. Circular Saw Blade Production Line Status Analysis

From TMM0106 packaging production line balancing rate and process efficiency are carries on the quantitative analysis, and the investigation and research are carried on

production line of site management, thus to study the TMM0106 manual packaging production line production efficiency, found that the problems that exist in the packaging production.

3.1 Circular Saw Blade Packaging Production Line Balance Rate Analysis

In order to accurately and truthfully reflect the TMM0106 circular saw blade production efficiency and balance situation of packaging production line, production for the in-situ investigation and collection of the data. Using a stopwatch time study method for determining the operating time of each procedure, every operation time refers to the process from the process of the operator carrying on the circular saw blade start timing, to work personnel to complete the process to place the circular saw blade in the staging area to end time. Of five different times to determine the operating time, determination of each time period 5 times, for each process collected a total of 25 sets of data, and to calculate the mean and standard deviation of the process operation time.

The maximum capacity of production line is determined not by the fastest operation process, and just depends on the operation speed of the slowest process, the larger of the process fastest and the slowest process gap, the greater the capacity loss, the yield and efficiency of production line will be low. The bottleneck process is refers to the process of production line with the slowest operation speed, it is a production line for all work procedure, operation time in the longest it not only limits the output of the production line speed, also for other processes in the production line to give full play to the production, is a link block the production line more increase effective output or reduce inventory and cost.

Even though the production processes all needed operation time is different, but decided to production line process time is the longest process in time. Drawing the TMM0106 circular saw blade packaging production line all processes balance analysis diagram, as shown in Figure 2.

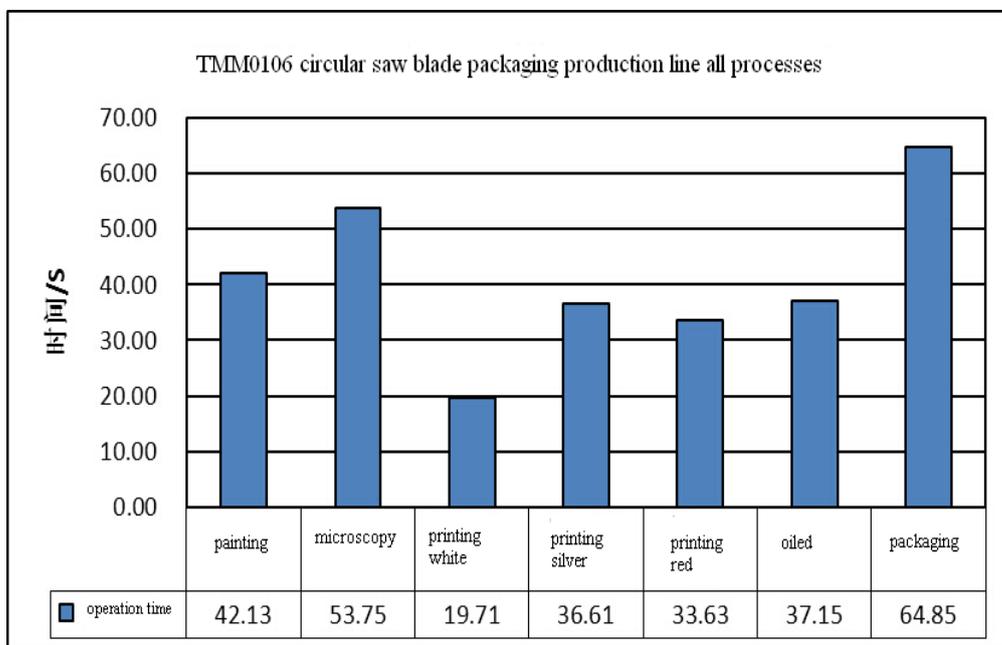


Figure 2. TMM0106 Circular Saw Blade Packaging Production Line All Processes Balance Analysis

According to the Figure 2 can be determined TMM0106 cutter packaging production line bottleneck process is the final packaging process, the line of production beats for

64.85 seconds. According to the beat and operation time of production line of each process can determine the balance rate of production line, to balance the loss of time and balance the loss rate.

Calculate TMM0106 cutter manual packaging production line balance rate, balance the loss of time and balance loss rate:

(1) Production line balance is measure of production line operation time average status in each process as well as an important index of production line production efficiency. Calculation formula ^[10-11] is as follows:

$$W = \sum_{i=1}^n \frac{t_i \times s_i}{t_0 \times a} \quad (1-1)$$

Among them,

W for production line balancing rate;

t_i for the operation time of process i;

s_i for the operation personnel number of process i;

t_0 for the production beat;

a for the operator personnel number of the production line.

According to the formula (1-1) can calculate TMM0106 cutter manual packaging production line balance rate and loss rate of balance

$$W = [287.82 / (64.85 \times 7)] \times 100\% = 63.4\%$$

$$\text{Unbalanced loss rate} = 1 - W = 36.6\%$$

(2) the imbalance lose time is the sum of each procedure operation time and production beats difference. Computation formula is as follows:

$$T_{lose} = \sum_{i=1}^n (T_{max} - T_i) \quad (1-2)$$

Among them,

T is for unbalance loss time.

T_{max} is the largest value of operating time of all processes;

T_i is the operating time of process i.

According to the formula (1-2) can calculate TMM0106 cutter manual packaging production line unbalanced loss time for:

$$T_{lose} = 166.13s$$

Through the analysis of the data, the main problem is the all processes busy spare degree is extremely uneven of TMM0106 circular saw blade packaging production line. The operation time of the production line bottleneck process and other process operation time difference is bigger, thus the bottleneck process and other process operation load difference is bigger, paint, printing white and oiled three processes have excess production capacity, and packaging process obvious shortage of production capacity, reduce the line balance rate, affect the circular saw blade production line. So TMM0106 cutter manual packaging production line also has very big improvement space, such as reasonable to reduce the bottleneck process operation time; reasonable division of spray paint, printing white and oiled process unit operation, and reasonably adjust the three processes of work load, thus to improve TMM0106 circular saw blade production line production efficiency.

3.2 Efficiency Analysis of Circular Saw Blade Production Line Process

For TMM0106 circular saw blade production line process efficiency analysis, production line all processes free time and operation time in the proportion of each production cycle can be got. Process of free time refers to the workers in the operation time no effective operations at the time of operation, is another important concept in the

production line balance. Because when the production line does not match the beat of all processes, the production processes all equalization degree is low, in addition to the bottleneck process of all other processes will have free time, so free time analysis is also the basis of the process equilibrium improve of production line.

Through the communication to found that B company to TMM0106 circular saw blade production line for each batch of production targets set for 300 pieces; Company every shift workers go to work time is 7 hours 30 minutes, among them, have a 30 minute lunch at noon time, so a shift operation staff to work in real time is 7 hours, namely the line as long as in the 84 seconds of the circular saw blade packaging can meet company requirements. At present, the actual capacity of about 360 pieces every shift the line, or about 70 seconds to complete all packaging production line process with the circular saw blade, so can determine TMM0106 cutter manual packaging production line production cycle to 70 seconds.

According to the production cycle of the production line and production line each working procedure operation time, get TMM0106 circular saw blade production line process efficiency tables, as shown in table 1. Can be found from table1 TMM0106 cutter manual packaging production line of the average operation efficiency of 58.74% and average free rate is 41.26%, the process efficiency is lower, namely, the low utilization rate of labor of production line; In addition to the packaging process, production line of other process there are many free time, basically all the white printing process of free ratio reached 71.84%, so the design of the production beat is obviously unreasonable.

Table 1. Production Process Efficiency Table

process	Production cycle	operation time	Free time	operation efficiency	free rate
painting	70.00	42.13	27.87	60.19%	39.81%
microscopy	70.00	53.75	16.25	76.79%	23.21%
printing white	70.00	19.71	50.29	28.16%	71.84%
printing silver	70.00	36.61	33.39	52.30%	47.70%
printing red	70.00	33.63	36.37	48.04%	51.96%
oiled	70.00	37.17	32.83	53.10%	46.90%
packaging	70.00	64.85	5.15	92.64%	7.36%
average	70.00	41.12	28.88	58.74%	41.26%

4. Reason Analysis of the Circular Saw Blade Production Line Low Efficiency

(1) the operators ambulate too much because the supply of materials handling personnel responsibility is not clear, different types, different stages of the product position management is not perfect.

(2) the process operation load imbalance because of operating unit design is not reasonable, and the workers work style is not reasonable.

(3) the inefficient because every company unreasonable production rhythm of production line.

(4) tools, accessories of chaos because do not have a perfect visual management and position management system, insufficient attention to site management.

5. Conclusion

Through the analysis of many varieties small batch production line balance, the efficiency of the process, using the study of the work time measurement, the scientific and reasonable process standard work time are get, make people, materials, tools, all scientific,

effective combination, thus to provide theoretical basis for the improve the circular saw blade production line production efficiency.

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