

Research on Scheduling and Optimizing Design in the Upper-making Processes of Men's Shoes

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Abstract: Production efficiency of a sewing machine process has a direct influence on production efficiency of a related shoe factory. Because there are many upper-making processes with complicated techniques, it is essential to arrange and optimize the upper-making process. Through the research on both action and time of these processes, this paper shows examples that illustrate how to analyze the techniques of a sewing machine, ascertain the procedure and order of a process, and finally how to optimize and arrange all processes. The focuses of this study are that, managing the production time around an advantageous mode of production, reasonably arranging the employees, space layout and the performance of machines, putting forward a proposal for improving production efficiency, and further summarizing the upper-making process of men's shoes with efficient productivity.

Key words: men's shoe upper-making process; production efficiency; optimization design

China, as a giant footwear producer, lags obviously in shoe factory production efficiency behind that of developed countries. For positively responding to market demand and ensuring the smooth progress of various tasks, enterprises must have the ability to quickly produce on the basis of constructing assembly lines for upper-making and shaping which can respond rapidly and adapt resiliently to the fashion and variety of shoes.

Because there are various complicated upper-making processes, including some operated manually among the procedures of shoes production, the production efficiency level of upper-making directly influences products. The efficient running of the tasks on upper-making assembly lines depend on analysis and optimized scheduling of production techniques, which are the key points for fulfilling production objectives.

This paper studies examples of scheduling and optimization of upper-making processes of men's shoes including: dividing process, ascertaining operative time, issuing the details and scheduling of

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process, and arranging and balancing of process. It stresses the research on production time management of each process, for which is not only the important basis for arranging production schedule, but also the significant index for estimating work cost, ensuring quality and proceeding smoothly. Around the advantage mode of production, it puts forward the proposal of improving production efficiency of the upper-making assembly line, and constructing a men's shoe upper-making process with the ability to respond quickly.

1 Research condition

By means of measure, analysis, summary and time management, this paper analyzed the process scheduling and assembly line arranging. The purpose of production time management is to ensure the punctual completion of production.

With advanced management standards, improved production assembly line and various products, the production enterprises selected for this practical measurement research guide the development of the shoe industry and are regarded as the optimal research objects. The operators in this research are all moderately skillful workers, whose operating time for completing a prescribed process with reasonable speed under standard operative condition was measured.

2 Experimental researches

2.1 Operation unit dividing and time test

Practical measurement research firstly requires dividing productive processes into units, and then measuring operation time in order to ascertain the standard time.

2.1.1 Unit dividing

Unit dividing, for precisely recording the operative time of each operation, needs different methods because of various kinds and properties of units.

When testing the operative time, the production process can be divided into 8 units according to different properties which are as follows: repeated unit and intermitted unit based on whether operation is repeated or not; constant unit and variable unit based on whether time is variable or not; machine unit and manual unit based on operating by machine or worker; control unit and foreign unit, etc.

2.1.2 Standard time

Standard time refers to the time taken by the moderately skillful operator for completing prescribed process with reasonable speed under standard operative condition. The computational method is as follows:

$$Tt = Tr + Tr * S$$

Notes: Tt represents standard time, Tr represents practically measured time, S represents coefficient of relaxation.

Practically measured time refers to the time measured practically in each procedure of production, which must be exact. Coefficient of relaxation depends on a practical condition, commonly defined in shoe factories at 8~10%.

2.1.3 *Methods of time measurement*

The methods of time measurement contain resilient measurement and continuous measurement. The former refers to switching on a stopwatch at the beginning of each unit, shutting down at the end, and returning to zero after recording; the latter refers to switching on a stopwatch when testing, and not stopping until the end of whole processes.

In this research, the resilient measurement was used to measure the time of each unit among the whole process for upper production, meanwhile the continuous measurement was used to measure the time from putting materials into practice to completing upper products so as to verify whether the arrangement of operation process was reasonably optimized or not.

2.2 *Arrangement of upper-making process of men's shoes*

A Shoe factory has to plan the production schedule according to the order and shipment date before producing. The production schedule concerning several departments should not be changed randomly after being ascertained, so the arrangement of process must be reasonable.

Trying as best as possible to keep the operative amount of each operator in equalization when arranging processes, thus each operator has the same operative time as others' on the assembly line, and there is neither spare time nor overstock of semi-products, which makes materials circulated smoothly and approaches the ideal state of synchronized production.

Take the shoe in fig. 1 as an example: firstly, analyzing the pattern and process; then, arranging each process of upper-making in order according to style feature; finally, unscrambling the process operation, filling measuring scales of time units, sewing process and unit schedule, figuring out analytical table of sewing machine productivity, and arranging and optimizing process operation based on the above data.



Fig. 1 Shoe style

2.2.1 *Analyzing the pattern and process*

This shoe has 33 parts including the toe part, eyelet parts, tongue, patched pieces and so on, the sewing machine scheme of which is shown in fig. 2.

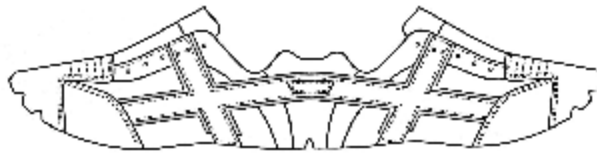


Fig. 2 Sewing machine pattern

In order to arrange the upper-making processes of this shoe, the processes unrelated to sewing such as skiving, line and reinforcing tape, etc. should be separated in advance. Although these processes are not on the sewing assembly line, they also influence the arrangement of whole processes, and hereby should be well prepared beforehand so as to ensure smooth sewing production.


2.2.2 Analyzing time units of machine operation and manual operation

For the purpose of optimizing the arrangement of production process, it requires analysis of the time unit of machine operation and manual operation through methods such as exclusion, combination, rearrangement and optimization. Exclusion is used for avoiding waste and unnecessary operation, laying out reasonably and decreasing transportation; combination refers to analyzing mutual coordinated operations and combining operations; rearrangement means optimizing and innovating production processes by means of order changing or other methods; simplification refers to changing the layout for making production connections reasonable and concise. It requires carefully analyzing the feature of each time unit so as to reasonably analyze and further optimize the process of production.

The sewing processes of this shoe contain the following 5 parts: upper sewing, lining sewing, tongue sewing, upper-lining sewing and other techniques. The designed sewing process and unit schedule are shown in tab. 1, and the measuring scale of time unit is shown in tab. 2.

Tab. 1 Sewing process and time schedule

Process code	1	Process name	Sewing upper tongue lining and lower tongue lining together		
Specification	Trimming the edges of both upper and lower tongue lining, aligning the central point, 3mm of seam allowance, 9-10 needles/inch of stitch length, seaming with sewing machine, cementing, splitting and flat thumping the seam.				
Time unit (second/pair)	a) Seaming with sewing machine		b) Cementing	c) Flat thumping	
	16.00			18.00	
Adhesive	Equipment		Sewing thread	Sewing needle	
Raw rubber	Single needle sewing machine		M40	90#	



Tab. 2 Measuring scale of time unit

Serial No.	Process name	Practically measured time Tr (second/pair)	coefficient of relaxation S (%)	Standard time Tt (second/pair)	Theoretical time (pair/8hrs)
1	Sewing eyelet piece on shoe	65.25	10	71.78	401.22

2	Cementing and flat thumping the seam	20.00	10	22.00	1309.09
3	Sticking reinforcing tape on the seam	24.00	10	26.40	1090.90
4	Sewing eyelet piece and back piece together	22.15	10	24.37	1181.78
5	Cementing and flat thumping the seam	20.00	10	22.00	1309.09

2.2.3 Analyzing productivity

The productivity analytical table is not only an important data table for optimizing the arrangement of men's shoes upper-making processes, but also a basis for arranging an assembly line.

Through analyzing time units of both machine operation and manual operation, 42 operations' time units were tested in this experiment. The standard time was 1682.9 seconds/pair in total, and the arithmetic mean of standard time was 40.06 seconds/pair.

When calculating in accordance with 8 hours per working day, the expected output will be about 718 pairs. But the productivity would probably be lower for practical consideration of the bottleneck processes on assembly lines.

3 Analyzing optimization of upper-making process

In order to avoid overstock and lack of materials which result from interruption, stop and delay made by operators because of their physiological, psychological and environmental influences on assembly line of upper-making. Thus such kinds of occasional matters should be managed by some specialists who are versatile on assembly lines and commonly called "Water Spiders". Generally there should be 2 specialists engaged as water spiders on upper-making assembly line of men's shoes.

3.1 Analyzing optimization of assembly line of upper-making

Since there are many processes in this shoe-making, the assembly line is supposed to be divided into main line and branch line. The main line contains upper sewing, upper-lining sewing and other techniques, while branch line contains lining sewing and tongue sewing. Branch line operations are chiefly the process insertion points for the main line. Through the separation of main line from branch line, the design proposal of assembly line will be ascertained and the processes of upper-making will be optimized, which provides a basis for planning the production schedule and labor cost.

When doing optimization and analysis, some simple operations costing short standard time can be managed by water spiders, and the order arrangement of each process can be changed reasonably to meet the requirements of whole processes.

3.2 Designing assembly line

The objectives of assembly line design are concise and efficient, which require integration of all different processes and forming an entire assembly line in shape of a U. As fig. 3 shows, 1~24 represent

a main line for managing upper sewing, upper-lining sewing and other techniques; 11.1~11.7 represent a branch line for managing lining sewing; 17.1~17.9 represent a branch line for managing tongue sewing.

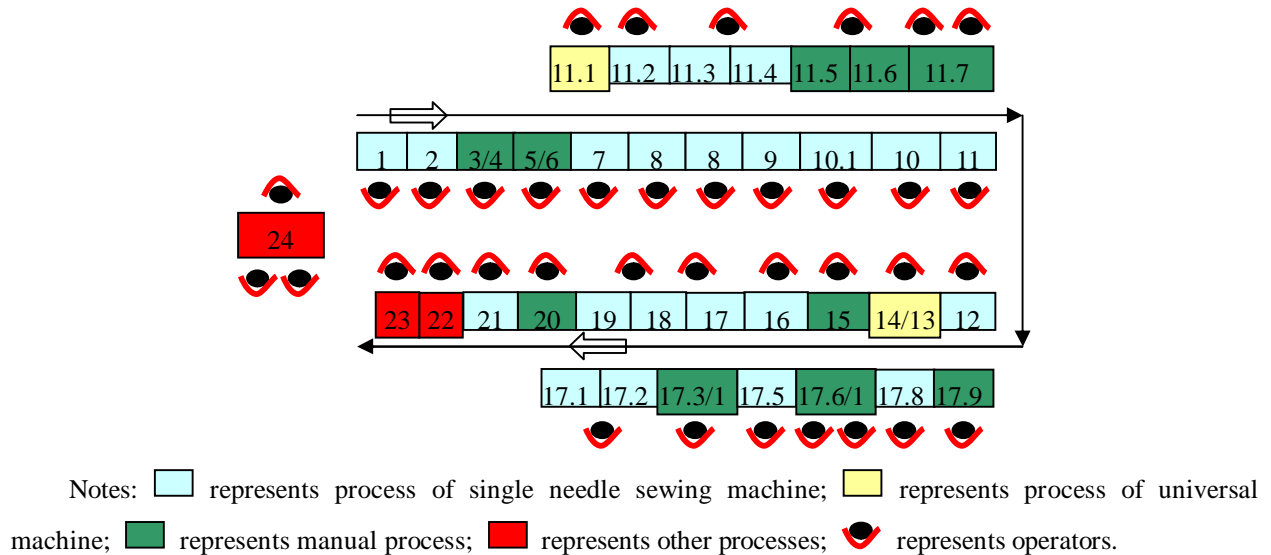


Fig. 3 Layout of assembly line

4 Conclusions

A. The purpose of research on the arrangement and optimization of upper-making processes is to improve the production efficiency of an assembly line, so the research should be in combination with production practice rather than rationalism.

B. It is necessary to analyze the texture of standard shoes, ascertain the features and order of each process, and reasonably combine the time unit of some operations which were divided for labor.

C. The bottleneck processes have to be managed by skillful operators for improving production efficiency; there should be as fewer operators as possible when arranging a schedule.

D. The impact of factors such as operators, equipment, materials and environments on production should be analyzed in detail. All these factors should be controlled effectively before production.

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