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OPTIMIZING THE TIME OF WORK PERFORMANCE IN THE PROCESS OF SEWING WOMAN SHIRT

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ABSTRACT: *The optimization time of sewing is a basic precondition for achieving quality production and ensuring a stable working process. In the frame of this paper one model of elegant woman shirt is observed. Sewing time was optimized by making a working plan and determining the time that is required to perform the operations of sewing the model. A method of current observations for statistical observation of effective work, planned and unplanned losses of time was also applied. With the use of coefficient of additional time the real norm was obtained. Observation also provides results that can lead to choose the optimal potentials of workers on specific working operations.*

Keywords: *working plan, quality, production.*

OPTIMIZACIJA VREMENA IZVRŠENJA RADA U PROCESU ŠIVENJA ŽENSKE KOŠULJE

APSTRAKT: *Optimizacija vremena šivanja osnovni je preduslov za postizanje kvalitetne izrade i obezbeđivanje stabilnog radnog procesa. U okviru ovog rada razatran je jedan model elegantne ženske košulje. Vreme šivenja je optimizovano izradom radnog plana i određivanjem vremena potrebnog za obavljanje operacija šivenja modela. Primenjena je i metoda trenutne opservacije za efektivno statističko posmatranje planiranih i neplaniranih vremenskih gubitaka. Upotrebom koeficijenta dodatnog vremena dobijena je realna norma. Posmatranje takođe daje rezultate koji mogu pomoći pri izboru optimalnog potencijala radnika za određene radne operacije.*

Ključne reči: *plan rada, kvalitet, proizvodnja.*

1. INTRODUCTION

The main characteristic of industrial clothing production is the division of the work, which, thanks to timely adjustment and extensive workplace connectivity, provides a standard quality product with much lower quality costs. For time adjustment and

workload, a technology sheet is applied, and for a given spatial connection of working places, the process plan is developed.

The process plan of the confection (ready to wear) industry manages the movement of the parts in the process from start to finish, and involves handling with the material and equipment. A good process plan has to modify flexibility in order to meet product line requirements, shipment deadlines and anticipated product volumes. The basic unit for the production of clothing is the production line under the leadership of a line manager. Heads of departments develop a working plan for line managers, while they organize, coordinate, and control the work of the direct executives on their working places. With the labor analysis, optimal form of the production by adapting the workplace and working conditions is enabled, real time required for preparation and calculation of the norm, and thus optimal performance of tasks at different times of day, week and month as an organizational standard for human-form of work is achieved.

1.1. Technological preparation

The technological process in confection industry is defined as a system of making a certain type of clothing that specifies the methods of work, the time of making and the way of work that is applied in the process of clothes production. The goal of the technological preparation is to find the favorable conditions for work in the production process. It contains the following activities:

1. Technological analysis of the clothes production items and choosing the work equipment,
2. Making montage plans,
3. Choose the type of the production line,
4. Disposition of the equipment and work resources,
5. Selection of the system for the technological process,
6. Selection of the inter-phase transport system,
7. Selection of the working places embedded system,
8. Develop a technology process plan,
9. Shaping the working places,
10. Study of work [1, 2].

1.2. Plan of technology operations

In the apparel industry, a plan of technological operations for the technological processes of cutting, sewing and finishing is developed for each clothing item. The plan of technology operation usually contains the name of the clothing item, description of the model of clothing item, model designation, designation of the technology operation, designation of working equipment, category of work and technological operation time [3, 4].

1.3. Plan of technological process

This plan is developed based on technological operations with the help of mounting plans. The plan is made to distribute workplace operations and train workers. The

following data should be computed in order to prepare the technological process plans: Number of workers, daily capacity of the production line, quantity of working equipment, tact of the group, degree of workload (on the working places), daily capacity per worker, daily capacity after technology operation and degree of production.

1.4. Technological process of sewing clothes

Through the process of sewing and stitching the garment acquires its three-dimensional shape. When making garments, a balance needs to be struck between customer requirements, cost of clothing, and available machinery. There are many types of machines that are divided into groups of related features. Sewing machines are divided according to: Sewing speed (fast and slow), type of sting (grain, chain), type of material, the purpose, the number of needles, type of transport, construction etc. [5, 6, 7].

1.5. Method of current notes

This method does not solve problems, but only points to them. The results obtained in applying this method will only be statistically acceptable if the two most important conditions are met, namely:

1. Have a sufficient number of observations of occurrence, which is a sufficient number of observations for each occurrence.
2. The elements in the sample that are being observed are randomly selected.

The observations are taken above all working day, which need to take care of the periods of observation, concerning the time intervals and schedule of observation tours to be constantly the same [8].

2. EXPERIMENTAL

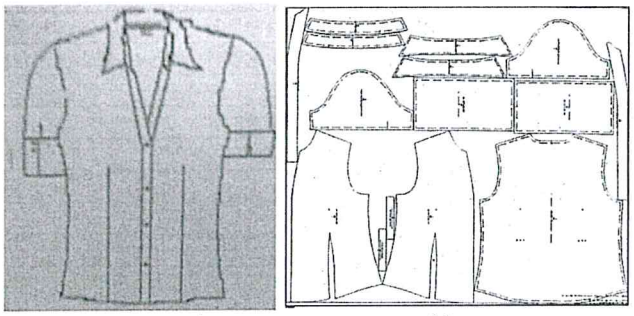
The model of women shirt that is subject to this analysis is shown below (Figure 1).
This women's shirt is made of 100% PES. Shirt is made in a production line with a system of trolleys. This model has 2 darts on the front and 2 darts on the back. The shirt has short sleeves with cuff fastened with 2 buttons, slip and slip selvedge. The shirt is fastened with 4 buttons on the front. One spare button was sewn to the left side stitch 15cm above the shirt's lateral seam. The model has an open collar. Table 1 shows a working plan for the design of a female model of shirt (size 40).

Requirements that are need to be taken regarding to the quality of a model are:

- The side seams should be facing the back of the shirt;
- Darts at the front should be facing each other;
- Button holes should be placed on the right band and buttons on the left band;
- Construction parts: collar, strap, two pairs of sleeves and cuffs should be thermofixed.

Mass tables for the measured dimensions of women's shirt is shown on Table 2. Plan of technological operations, norm, time of production and working equpment are shown

bellow on Table 3.



a) b)

Figure 1: a) Sketch/model of women shirt b) Appereance of cutting layout of the model

Table 1: Working plan for women's shirt construction

Ser.Number	Fabric color	Model	Size/ number of apparel products					
1	520	D1723	40	44	46	48	50	Σ
			60	60	60	60	60	300

Table 2: Mass tables for the measured dimensions of women's shirt

Size (cm)	36	38	40	42	44	46	48	50
Bust size	94	96	100	104	108	114	120	126
Waist size	80	82	86	90	94	100	106	112
Length of edging	98	100	104	108	112	118	124	130
Length -back, rear, middle	57	58	59	60	61	62	63	63,5
Shoulder length	12,5	12,7	13	13,3	13,6	13,9	14,2	14,5
Upper sleeve width	34	35	36	37	38	39,5	41	42,5
Sleeve length	31	31,5	32	32,5	33	33,5	34	34,5
Width of fastened cuff	33	34	35	36	37	38	39	40
Cuff length	10	10	10	10	10	10	10	10
Length of sleeve slit	5	5	5	5	5	5	5	5
Width of the neck on the front part	17	17	17	17	17	18	19	20
First button location	13	13	13	13	13	13	13	13
Spacing between buttons	4	4	4	4	4	4	4	4
Collar length	36	37	38	39	40	41	42	43
Width of collar rear, middle	5,5	5,5	5,5	5,5	5,5	5,5	5,5	5,5
Collar slit	9	9	9	9	9	9	9	9
Width of collar base	4	4	4	4	4	4	4	4

Table 3: Plan of technological operations, norm, time of production and working equpment

Ser. Number	Name of operation	Time (min) /piece	Norm/ Piece	Working equipment
1	Marking, collar plastering and insert thread	1,05	400	RM[1]+HW[2]
2	Flip and cut collar	0,45	700	HW
3	Upper stitch + closure around	1,09	385	RM
4	Measure and cut collar	0,15	2800	HW
5	Collar base stitch	0,49	857	RM
6	Fastens two-sided label	0,58	724	RM
7	Gouge, mark collar, assembling collars	1,4	300	RM + HW
8	Flip and cut collar base	0,42	1000	HW
9	Cutting collar along her length	0,21	2000	HW
10	Ironing finished collar	0,46	913	Iron
11	Batten ironing from both sides using pattern	0,84	500	Iron
12	Sewing batten on the front part	1,4	300	RM
13	Upper stitch on stitched batten	1,23	341	RM
14	stitched batten closure	1,05	400	RM
15	Darts assembling along the length of the rear part	1,05	400	RM
16	Darts assembling on the front part with overlock	0,53	792	SM[3]
17	Selvedge sewing	0,26	1615	RM
18	Sewing selvedge on the sleeve slit	0,65	656	Apparatus RM
19	Sleeve slit fix	0,50	840	RM
20	Selvedge cut on the sleeve slit	0,14	3000	HW
21	Cuff ironing along length	0,35	1200	Iron
22	Assembling double cuffs along its side	0,84	500	RM
23	Cut and flip cuff along its side	0,52	807	HW
24	Finished cuff ironing	0,52	807	Iron

[1] Regular machine
[2] Hand - work
[3] Special machine

25	Assembling shoulders with overlock	0,55	763	SM
26	Sewing sleeve with overlock	0,96	437	SM
27	Assembling cuff on folded sleeve	0,84	488	SM
28	Sewing cuff on sleeve (one-fold)	1,68	250	RM
29	Overlock fringe	0,78	538	SM
30	Overlock shirt (straight)	1,20	250	RM
31	Sewing collar + cut neck opening	1,56	269	RM
32	Collar closure +sewing the collar base upper stitch	1,86	241	RM
33	8 button holes making	1,10	381	SM
34	Sewing 8 +1 button	1,10	381	SM
35	Cutting thread	1,00	420	HW
	Total time	**28,73≈29min**		

3. RESULT AND DISCUSSION

The recapitulation of times for manufacturing, according to the means of work (Table 4) is:

- Manual operation time: $\sum_t HW$ =2.98min
- Working time with a regular machine: $\sum_t RM$ =17.86min
- Working time with special machine: $\sum_t SM$ =5.88min
- Inter phase ironing time: $\sum_t IPI$ =1,82min.

Based on this calculation the total time is shown is $\sum t$ =29,0 min
The obtained daily production capacity (Cd) of a female shirt for 7 working hours shift (Tr) for 21 workers (R) is: C_d=304,13min
The obtained daily capacity per worker is: C_{dr} = 14,48, and the tact of the group Rg =1,38. The percentage of load per operation is calculated and for operation 1 (table 4) is: So = 76% The norm/piece is calculated by the formula and for operation 1 is:

$$N_p = \frac{T_r}{t_o} = \frac{420}{1{,}05} = 400 \text{ pieces}$$

From the the obtained results it is noted that, working places such as: Ironing finished collar, Batten ironing from both sides using pattern, Cuff ironing along length, Ironing finished cuff are very loaded with percent of load (S = 157%).

Also the operation such as: Gouge, mark collar, assembling collars and Flip and cut collar base shown high percent of load (S = 131%). For operations such as: Darts assembling on the front part with overlock; Assembling shoulders with overlock; Sewing sleeve with overlock; Assembling cuff on folded sleeve and frindge overlock shown load with percentage of load (S = 86.6%.). On the folowing operations: Sleeve slit fix;

Overlock shirt (straight) and Sewing collar and cut neck opening; Collar closure and sewing the collar base upper stitch, two operators are provided, and the percent of the load is 104% and 130% respectively. For operations button holes making and Sewing button, both workers shown low load percentage (S = 79%), so they work for another production line. It is noted that only one worker performs manual work (thread cleaning), but he also helps other production lines due to his low load percentage of 72%. In order to see the actual time needed to perform the operations, time losses that do not arise from the fault of the operator, but from an organizational cause should be taken into account. Excused losses in time are also calculated in the norm. For this purpose an method of current observations is applied.

The required number of measurements is determined by assuming that the percent of loss is 20%, respectively p = 0.2 and at $\sum$ = 5% (error allowed), so that D = 6400.
The recording was performed with 3 observations per hour in the production line with 21 operation positions in 7 hours working time. The recording duration is defined by:

$$D = \frac{N}{\left(\frac{o}{h}\right)\left(\frac{h}{d}\right)(RM)} = \frac{6400}{3.7.21} = 14.5 \text{ days}$$

On the basis of the obtained results working part (g) and time loss part (p) are calculated, so respectively g = 77,5% and p = 22,5 %. The effective working time is 77,5 % from the working time. The basic time of 22.5% is due to planned and unplanned losses of time, as well as losses of time due to the fault of the operator. Of this, 15.2% of the time relates to planned losses, while unplanned are 2.1%. The time that operator spent outside the work activities is very high with 5.06%.
According to the planned losses, the highest percentage is due to personal needs 4.1% and to the auxiliary material and the lack of auxiliary material 7.3%. Based on the obtained results, coefficient of additional time (that was need to calculate the real time of performing certain operation) was also calculated (Kd = 0,179).

4. CONCLUSION

In this paper the technological process of sewing of one model of female shirt made in a production line with a system of trolleys was made.
In the production line with 21operators for the design of the model, the total time, daily production capacity (Cd), daily capacity per worker (C_{dr}), The norm/piece, working part (g) and time loss part (p) where obtained.
Working places such as: Ironing finished collar, Batten ironing from both sides using pattern, Cuff ironing along length, Ironing finished cuff shown very high load percentage (S = 157%). Gouge, mark collar, assembling collars and Flip and cut collar base also shown high percent of load (S = 131%). Darts assembling on the front part with overlock; Assembling shoulders with overlock; Sewing sleeve with overlock; Assembling cuff on folded sleeve and frindge overlock shown lower percentage of load

(S = 86.6%.). In the operations collar closure and sewing the collar base upper stitch, the percent of the load was 104% and 130% respectively. For operations button holes making and Sewing button, both workers shown low load percentage (S = 79%), so they work for another production line. It is noted that only one worker performs manual work (thread cleaning), but he also helps other production lines due to his low load percentage of 72%. Realizing the time needed to perform operations the time losses (that do not arise from the fault of the employee) should be taken into account. For this purpose the coefficient of additional time (Kd) was calculated. Effective working time is 77.5% of working time, and the rest of the time is 22.5% of planned and unplanned losses of time, as well as loss of time due to employee fault. Of this, 15.2% of the time relates to planned losses, while unplanned losses are 2.1%. The time spent by the employee outside the work activities is very high by 5.06%. With observations that were made in the production line with 21 operation positions has been noted that workers at the beginning of the working day have a lower percentage of performance, and over time they achieve full work efficiency. Reduced performance has been observed if workers do not feel healthy, perform an operation for the first time, change the operation, but sometimes designedly worl slowly to reduce the norm. For successful production line it is necessary to know the skills of the workers and their ability to perform various operations, so the weaker operators are deployed on operations with a shorter production time, and skilled and fast workers on operations with a longer production time.

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