

Computer-aided method for merger and balance of working procedure in Apparel assembly line

Hongqin Dai

National Engineering Laboratory for Modern Silk,
College of Textile and Clothing Engineering
Soochow University
Suzhou, China
e-mail: dhq1970@163.com

Lili Chen

National Engineering Laboratory for Modern Silk,
College of Textile and Clothing Engineering
Soochow University
Suzhou, China
e-mail: 352715000@qq.com

Guolian Liu

National Engineering Laboratory for Modern Silk, College of Textile and Clothing Engineering
Soochow University
Suzhou, China
e-mail: liuguolian@suda.edu.cn

Abstract—Apparel assembly line involves a set of workstations. It is difficult to attain a perfectly balanced apparel assembly line because of the different production rate of each workstation. In order to obtain a relatively balance of assembly line, it is necessary to make merger of basis working procedures. In the paper, a new method for merger and balance of working procedure in Apparel assembly line is presented. The method can finish merger working procedures on the basis of basic demand of apparel assembly line. Based on the method, a system is developed and case study shows that the system can well finish the work of merger working procedure.

Keywords—apparel assembly line; merger and balance of working procedur; computer-aided method

I. INTRODUCTION

Assembly lines have been widely used in most companies. It is very important for industry because it provides increasing production speed, a considerable planning, and it helps industries to improve their economic problems [1,2]. At present, assembly line management aims to promote line balancing. There are many researches about line balancing such as Whitaker's mathematical model [3], interactive modeling techniques [4] and a knowledge-based approach [5].

Apparel assembly line involves a set of workstations in which a specific task in a predefined sequence is processed. Industrial experience shows that it is difficult to attain a perfectly balanced line because of the different production rate of each workstation. In order to obtain relatively balancing line, it is necessary to merger and balance working procedure on the garment working procedure flow chat. Currently there are mainly two methods to resolve problem on merger and balancing working procedure in garment assembly line. The first method is genetic algorithm [6,7,8]. It adopts genetic algorithm to solve clothing balancing

problems. due to the shortcoming of genetic algorithm, the application of the method is limited. The second method is that designer creates the vector graph and marks off priority area based on predigesting working procedure analytic diagram, and groups organization is finished by priority connection, priority area and assembled range [9]. In the method, a worker may be assigned to operate different sewing machine.

At present, the sewing line supervisors manage garment assembly line by experiences and manual method. the shortcomings of the traditional method are that the efficiency is low and there are bottlenecks in assembly line. With the development of computer technology, the computer technology already has been applied in some clothing field such as clothing design. However, the study and application of computer-aided Apparel assembly line manage are less. In the paper, a computer-aided method for merger and balance working procedure in apparel assembly line is proposed.

II. METHOD FOR MERGER AND BALANCE WORKING PROCEDURE

To improve productive efficiency, apparel assembly line should meet three basic demands:

(1) Reasonably distribute jobs to each workstation according to working procedure flow, avoid the situation of backward flow in assembly line.

(2) Make sure processing time of each workstation approach tempo as much as possible.

(3) Make spare time of each workstation less, load of workstation uniform and ensure the time loss ratio of total assembly line lowest.

Based on above three basic demands, a new method to merger and balance working procedure was presented. The main procedures are as followings.

A. Analyse And Compute Dependent Procedures And Influence Of Working Procedure

In the paper, the dependent procedures and influence of working procedure are defined in order to following process. These working procedures which should be finished before certain working procedure are called dependent procedure of the working procedure. When there is no dependent procedure for one procedure, it indicates that the procedure can be processed now. Influence of working procedure indicates degree how many procedures are dependent on current procedure. According to dependent procedure of each procedure, the influence of each procedure can be obtained.

B. Compute Tempo Of Apparel Assembly Line

The tempo of apparel assembly line is decided by total time and number of worker needed for finishing a piece of garment. The tempo of apparel assembly line is obtained by following equation:

$$\tau = \frac{T}{N} \quad (1)$$

According to define of tempo of apparel assembly line, we can obtain the upper bound and lower bound of tempo.

$$\tau_u = \frac{\tau}{E} \quad (2)$$

$$\tau_l = 2\tau - \tau_u \quad (3)$$

Where τ is tempo, T is time, N is number of worker, τ_u is upper bound of tempo, τ_l is lower bound of tempo, E is planning efficiency.

C. Set Rules Of Merger And Balance Working Procedure

The main rules are:

- (1) The situation of backward flow in assembly line is prohibited.
- (2) Procedures in the same branch are assigned to one merger procedure as much as possible.
- (3) The total time of merger procedure is close to productive tempo or integral multiple of procedure tempo.
- (4) Only these procedures involving same machine can be combined.
- (5) The merger procedure with the biggest total influence of merger procedure in all merger procedures which accord with tempo demand has priority.

D. Operate Merger And Balance Of Apparel Working Procedure

The program of merger and balance working procedure is as following:

- Step1: Compute dependent procedures of each working procedure
- Step2: If all procedures have been finished, then the program is end or else program go to Step3
- Step3: Find out all procedures that do not have dependent procedures and form a ensemble which is sign P.
- Step4: Choose one procedure from P.

Step5: Set the procedure as current procedure, search any possible merger procedures in the same branch and P according to above rules. Meanwhile judge whether merger procedure is accord with tempo demands and record the information.

Step6: When there are merger procedures according with tempo demands, program go to Step7, or else go to Step8.

Step7: Search merger procedure with the biggest influence, output it as final merger procedure, and go to Step9.

Step8: Search merger procedure which is the closest to tempo demands, output it as final merger procedure, and go to Step9.

Step9: Update dependent procedures of each procedure and go to Step2.

III. SYSTEM REALIZATION

Apparel procedure flow chat shows all procedures and their order. To be convenient for analyzing and handing procedures in computer, it is necessary to present the chat by certain data construct. In the paper, linear list is used to store apparel procedure flow. The structure of node includes working procedure ID, type, time, branch, father branch and insert position. The structure of node in list is shown in Fig. 1.

ID	Type	Time	Branch	Father branch	Insert place
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Figure 1. the structure of node in list

The system is finished by using Microsoft Visual Studio 2008. Fig. 2 is the main windows of system.



Figure 2. main windows of system



Figure 3. Woman's Jacket

IV. CASE STUDY

This case is women's jacket shown in Fig. 3. In this case, tempo is 45s and planning efficiency is 85%. According to Eq. (2) and Eq. (3), we can obtain $\tau_u = 53s$ and $\tau_l = 37s$. There are 50 basis working procedures in the garment. Table 1 shows these working procedures. The result of merger working procedure is shown in Table 1. Table 1 shows that most of merger working procedures accord with tempo demands.

TABLE I. BASIS WORKING PROCEDURES

working procedure ID	Time(S)	Type	Branch	Father branch	Insert place
1	17	handmake	11	11	0
2	28	sewing machine	11	11	0
3	23	double needle machine	11	11	0
4	15	handmake	11	11	0
5	36	sewing machine	1101	11	7
6	20	sewing machine	1101	11	7
7	51	sewing machine	11	11	0
8	47	sewing machine	11	11	0
9	15	sewing machine	11	11	0
10	14	sewing machine	1102	11	14
11	26	sewing machine	1102	11	14
12	65	sewing machine	1102	11	14
13	15	handmake	1102	11	14
14	97	sewing machine	11	11	0
15	39	double needle	1103	11	18

		machine			
16	13	sewing machine	1103	11	18
17	6	double needle machine	1103	11	18
18	24	sewing machine	11	11	0
19	37	sewing machine	1104	11	21
20	38	double needle machine	1104	11	21
21	44	sewing machine	11	11	0
22	38	double needle machine	11	11	0
23	37	sewing machine	11	11	0
24	18	handmake	1105	11	26
25	7	handmake	1105	11	26
26	45	sewing machine	11	11	0
27	238	offline manufacture	1106	11	34
34	56	sewing machine	11	11	0
35	12	handmake	1107	11	36
36	59	double needle machine	11	11	0
37	12	handmake	1108	11	40
38	18	handmake	1108	11	40
39	24	sewing machine	1108	11	40
40	51	sewing machine	11	11	0
41	44	sewing machine	11	11	0
42	19	handmake	1109	11	43
43	48	sewing machine	11	11	0
44	13	sewing machine	1110	11	46
45	19	handmake	1110	11	46
46	32	sewing machine	11	11	0
47	81	sewing machine	11	11	0
48	35	handmake	11	11	0
49	44	double needle machine	11	11	0
50	15	sewing machine	11	11	0

TABLE II. RESULT OF MERGER WORKING PROCEDURE

Merger working procedure ID	Type	Working procedure	Time (S)
1	handmake	35,24,1	47
2	sewing machine	44,5,2	77
3	sewing machine	10,11	40
4	sewing machine	12,6	85
5	handmake	45,25,13	42
6	double needle machine	15,3	62
7	sewing machine	19,16	50
8	double needle machine	20,17	44
9	offline manufacture	27	238
10	handmake	42,37,4,38	64
11	sewing machine	7	51
12	sewing machine	8	47
13	sewing machine	9,14	112
14	sewing machine	18,21	68
15	double needle machine	22	38
16	sewing machine	23	37
17	sewing machine	26	45
18	sewing machine	34	56
19	double needle machine	36	59
20	sewing machine	39,40	75
21	sewing machine	41	44
22	sewing machine	43	48
23	sewing machine	46,47	113
24	handmake	48	35
25	double needle machine	49	44
26	sewing machine	50	15

V. CONCLUSIONS

In the paper, we proposed a computer-aided method for merger and balance of working procedure in apparel assembly line. The method can finish merger working procedures on the basis of basic demand of apparel assembly line. Based on the method, a system is developed and case study shows that the system can well finish the work of merger working procedure.

ACKNOWLEDGMENT

This work is financed by the Project Funded by the Priority Academic Program Development of Jiangsu Higher Education Institutions, China.

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