# Clothing Production Logistic Process Designing

Inese Ziemele[1], Dana Belakova[2], [1-2] *Riga Technical University*

***Abstract* – Clothing style designing and mass production tasks and regularities have been researched using average complexity women coat designing tasks or the time sequence of events as the basis, by means of the PERT (Program Evaluation and Review Technique). On the PERT graph of the women's coat designing and production, three homogenous stages can be distinguished: I, II, III.**

**The task execution process from the first event to a finished prototype of style (stage I), in the case of classical designing work organization, happens almost sequentially, adding about 45 working hours. Stage III – at the final stage after the preparation of the markers to handing over the finished order to the consumer a sequential task chain is accomplished, too. At stage III, the total time of women's coat assortment event process will take up to 15 hours for one unit if a series of tests is produced in advance, and only 2.5 hours if a series of tests is not produced.**

**At the stage II of the graph, three situations characteristic of apparel producers have been analyzed: reception of raw materials and control within two weeks during the model production season; the distribution of model project carried out during its production season; model project distribution, which is not necessary any more (the designing of collections has begun one season before the mass production of the model), and the reception of raw materials. The average expectable duration of stage II, based on the hypothesis on the working time distribution law, is 59.74 hours. Useful free time reserves have been found in the designing process of women's coat of medium complexity and mass production processes.**

***Keywords* – clothing production, logistics, process designing**

## I. Introduction

Modern logistics includes practically all business fields; thereby, logistics is an impressive weapon for the company. Logistics helps organize and control the activity of the company, allowing it to be competitive and make profit.

Nowadays, apparel production companies are forced to adapt to the unstable economic situation in the world and survive in the fierce competition. The relationship between companies and related logistic chains become more and more complex and demand higher mobility, efficiency and a creative approach.

It is important for apparel production companies to operationally manage model designing and their large-scale production order execution times to be able to function effectively in the common – already traditional – integrated multi-company partner logistics chain within the order flow from the artistic design to the end user.

The production process organization regularities that do significantly influence the production logistics management are as follows:

- the layout of material value flows in the production process;
- the continuity of the production process;
- the rhythmical pace of the production cycles;
- synchronization of the production cycle calendar.

Apparel model designing and mass production tasks and regularities have been researched and analyzed based on the tasks related to the designing of the women's coat of medium complexity or the time sequence of events.

Basing on the designing and production process analysis, a project graph has been developed using the PERT (Program Evaluation and Review Technique). 47 tasks with their minimum and maximum duration times have been isolated in the analyzed project and the task execution probability has been determined, namely, it has been set which task determines the possibility of beginning next task. The farthest task sequence between the initial and final tasks of the graph is the critical task execution sequence. All events and tasks that are located on this path are also critical [1].

## II. PERT Graph

Any critical task execution time amplification causes the amplification of the whole task complex execution time. At the same time, the non-critical task delays may not influence the setting of the final event. The following important practical conclusions arise from this conclusion: the manager, first of all, has to keep track of the execution of the critical tasks to guarantee that materials and working resources will not affect the final term of the project; secondly, the manager has to compare final terms by means of graphs with standards (if no standards are developed, then the comparison has to be made, for instance, with competitors). If the term determined by the developed graph is longer, the critical tasks have to be examined, decreasing their execution times as much as possible.

In its turn, the analysis of non-critical tasks allows determining the inner working time reserves, which can be used appropriately.

On the PERT graph of the women's coat designing and production, three homogenous stages can be distinguished: I, II, III (Fig. 1). These stages are considered below.

1) The task execution process from the first event to a finished prototype of style (stage I) in the case of classical designing work organization happens almost sequentially, adding up about 45 working hours. Almost all events are located on the critical path. Therefore, it is important to determine precisely and follow the duration of each event. The determination and control of pattern designer's working time expenditure is very essential. (Time saving possibility – to hire a designer with the skill of a pattern designer);

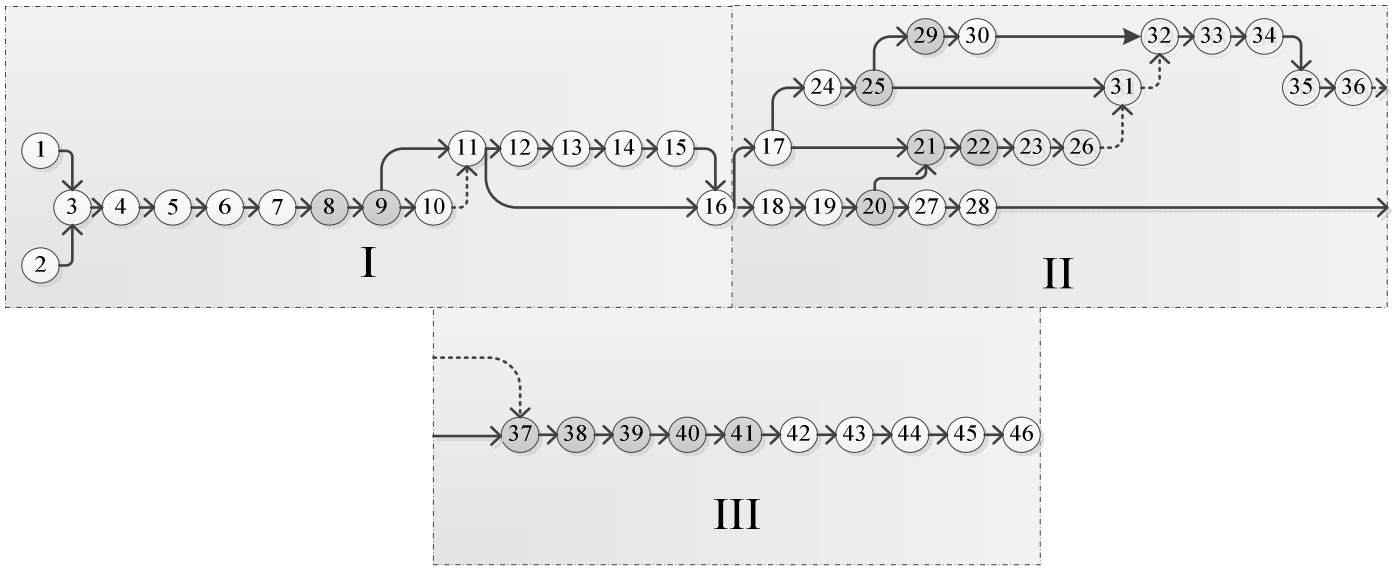


Fig. 1. PERT graph of women's coat designing and production

2) Graph stage III (Fig. 1) – at the final stage after the preparation of the markers to handing over the finished order to the consumer a sequent task chain is accomplished too, where each event is important in terms of duration – all events are located on the critical path. To save time production, units often refuse to produce a series of tests, which is risky for orders over 300 pcs. The level of risks and cost of risks have to be evaluated carefully. At stage III, the total time of women's coat assortment event process will take up to 15 hours for one unit if a series of tests is produced in advance, and only 2.5 hours if a series of test is not produced;

3) In the middle part of the graph, stage II (Fig. 1), there are events which are dedicated to the improvement of style construction before production, material supply and handing over to production. Four possible critical paths can be separated here [3]:

A – The production is planned for another company (not the place where the style designing takes place).

The critical time is the relocation of the order to another production unit. The duration of this stage will be at least 15.83 hours.

B – The production is planned in the same company where the designing takes place. Duration of the stage is at least 14.58 hours.

C – A model is designed without a preliminary production order and wholesale distribution is used.

The duration of a stage is at least 13.92 hours. The critical event is multiplication and distribution of the model, which can take additional 50h or more.

D – Planned cloth and accessory delivery delays, no stable cooperation with suppliers. The critical path shifts to the material collection event, which can take up to two months. The duration of the stage is at least 11.83 hours.

Based on the data from the previous experiment [3], the critical tasks of stage II, which determine the development of the critical paths of the process, are as follows: reception/ control of raw materials (24-25), distribution of the model project (20-21-22) and handing over the model order for production to subcontractors.

The unmentioned tasks are difficult to standardize, their execution times are proportionally enormous compared to other tasks.

Model Order Designing and Production (MODP) is most substantially influenced by the raw material delivery time, which is not acceptable in the present lean production conditions, but has to be dealt with in the real conditions.

Three MODP situations have been reviewed. *Situation one*: reception and control of raw materials, which take two weeks (4800 min) during the model production season, basically leads to the prolonging of all processes at stage II to 88.83 hours (Fig. 2).

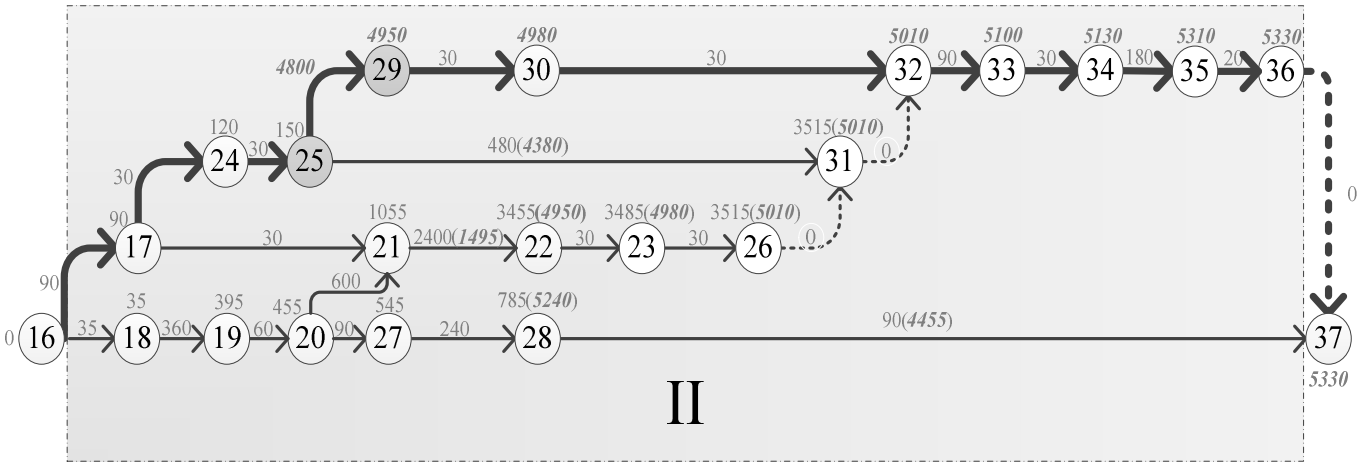


Fig. 2 Graph in the first situation

In this case, the MODP list of tasks can include the model distribution (tasks 20-21-22) that can last up to 64.92 hours and handing over the model order for production to subcontractors (25-31), which can last up to 73 hours, without further time loss.

A relatively large general time reserve appears for the tasks 16-18-19-20-27-28-37 (74.25 hours) (see Table 1).

TABLE I

NON-CRITICAL TASKS IN THE FIRST SITUATION

| Non-critical events | | Event duration, min | Latest time of occurrence, min |
|---|---|---|---|
| 20-21 | Repeated making of samples (10 pcs) for wholesale | 600 | 2550 |
| 21-22 | Wholesale of the style | 2400 | 4950 |
| 22-23 | Introduction of style into the production program | 30 | 4980 |
| 23-26 | Introduction of style into the production program | 30 | 5010 |
| *Total reserve of free time, min 20-21-22-23-26* | | *1495* | |
| 25-31 | Delivering the order into production | *480* | *5010* |
| | *Reserve of free time, min* | *4380* | |
| 16-18 | Repeated cutting of sample | 35 | 4490 |
| 18-19 | Repeated making of sample | 360 | 4850 |
| 19-20 | Repeated fitting, evaluation, confirmation of sample | 60 | 4910 |
| 20-27 | Preparation of production patterns | 90 | 5000 |
| 27-28 | Grading of production patterns | 240 | 5240 |
| 28-37 | Making of markers for the test series and order | 90 | 5330 |
| *Total reserve of free time, min 16-18-19-20-27-28-37* | | *4455* | |

*Situation two:* if the delivery of the materials happens without any delays, but the model project distribution has to be carried out during its production season, then the distribution of the model should be limited to one week. The stage II of MODP will now last 63.92 hours (Fig. 3). Material reception/ control time can take up to 55.08 hours, and handing over the order to a subcontractor – up to 56.08 hours.

TABLE II

NON-CRITICAL EVENTS IN THE SECOND SITUATION

| Non-critical events | | Event duration, min | Latest time of occurrence, min |
|---|---|---|---|
| 25-29 | Reception and control of source materials – clothing and accessories | 180 | 3455 |
| 29-30 | Testing of clothing characteristics | 30 | 3485 |
| 30-32 | Cutting the production sample (preferably excluding basic size) | 30 | 3515 |
| *Total reserve of free time, min 25-29-30-32* | | *3125* | |
| 25-31 | Delivering the order into production | 480 | 3515 |
| | *Reserve of free time, min* | *2885* | |
| 20-27 | Preparation of production patterns | 90 | 3505 |
| 27-28 | Grading of production patterns | 240 | 3745 |
| 28-37 | Making of markers for the test series and order | 90 | 3835 |
| *Total reserve of free time, min 20-27-28-37* | | *2960* | |

Obviously, it is helpful to balance the raw material supply and model project distribution periods by their duration.

The total time reserve for tasks with production patterns and their marker formation 20-27-28 is 49.33 hours (see Table 2).

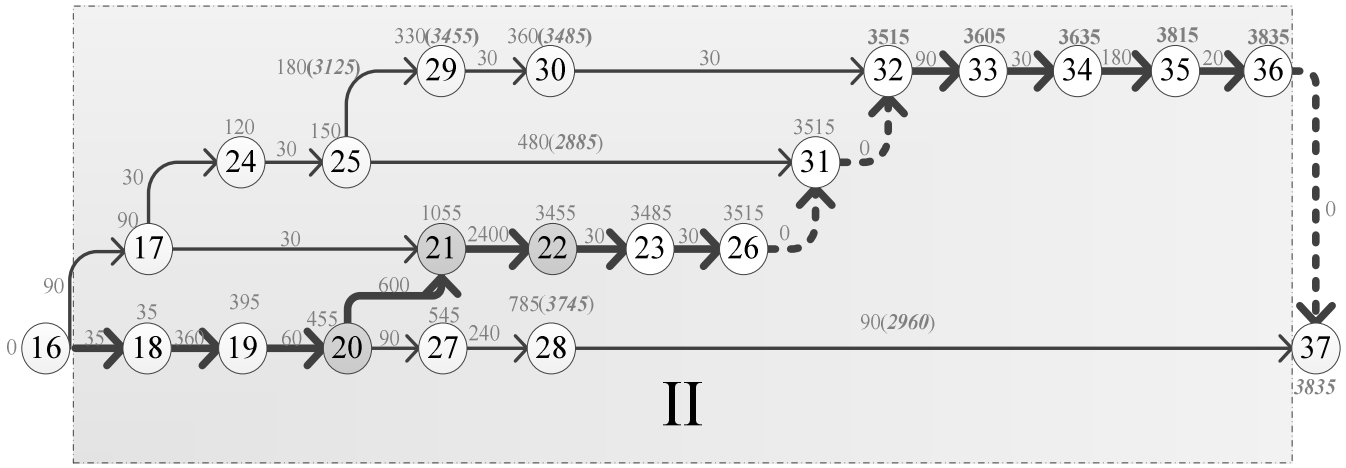


Fig. 3. Graph of the second situation

*Situation three*: if model distribution is not necessary any more (collection designing has been started one season before the production of orders), the raw materials have been received.

In this case special attention has to be paid to the delivery of the order for production to another company and the possibility to carry out the production as close as possible to the model designing area (405 min. away) has to be considered. The more precisely standardized tasks related to the production of the reiterative patterns, processing of production samples and their markers become important in terms of complying with the schedule. In the described situation, the total MODP task duration at stage II of the graph (see Fig. 4) is 13.91 hours.

In the described situation, the order delivery time to the subcontractor and the reiterative model pattern production time have to be coordinated.

TABLE III

NON-CRITICAL EVENTS IN THE THIRD SITUATION

| Non-critical events | | Event duration, min | Latest time of occurrence, min |
|---|---|---|---|
| 25-29 | Reception and control of source materials – clothing and accessories | 180 | 495 |
| 29-30 | Testing of clothing characteristics | 30 | 525 |
| 30-32 | Cutting the production sample (preferably excluding basic size) | 30 | 555 |
| *Total reserve of free time, min 25-29-30-32* | | *165* | |

The average expectable duration of stage II, based on the hypothesis on the working time distribution law [2], can be determined as follows:

$$t_{ij} = \frac{1}{6}\left(a_{ij} + 4\,m_{ij} + b_{ij}\right) = 59{,}74st \qquad (1)$$

where

$a_{ij}$ – the minimal time value or the optimistic value – task execution time under the most favourable conditions (13.91 hours);

$b_{ij}$ – the maximum time value or the pessimistic value – task execution time under the most unfavourable conditions (88.83 hours);

$m_{ij}$ – the normal time value – task execution time under normal conditions (63.92 hours).

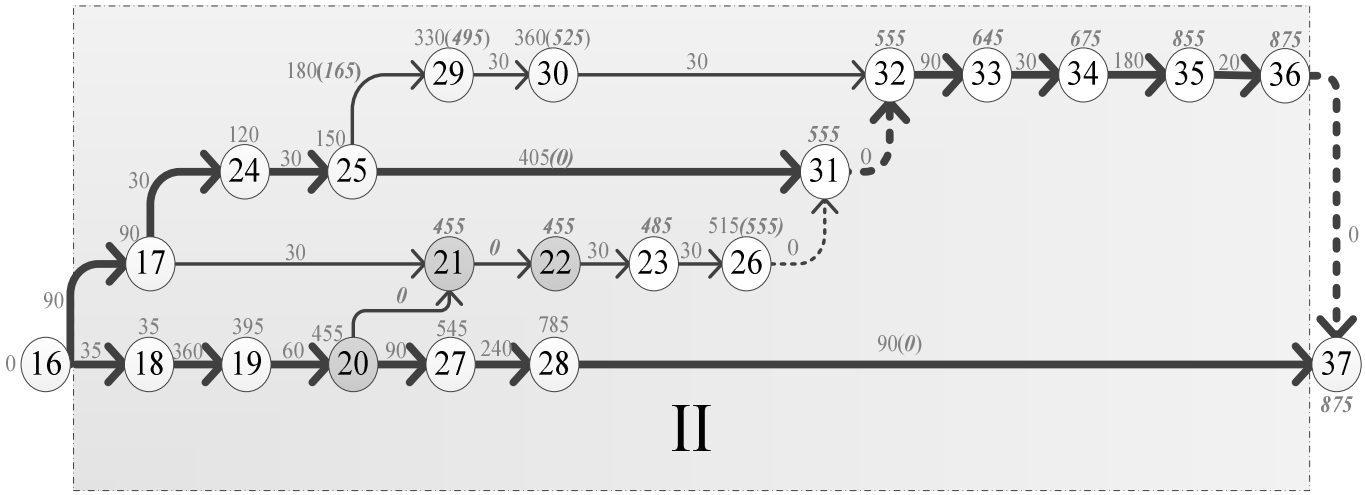


Fig. 4 Graph in the third situation

## III. CONCLUSIONS

Under the present fierce competition conditions, apparel manufacturers have to be able to precisely plan production preparation and order execution process, which can happen under different conditions. Therefore, it is preferable to carry out process designing beforehand, and when conditions change, it is possible to use the available labour force resources appropriately, simultaneously determining the optimal process procedures.

To analyze outdoor clothing model designing and mass production tasks and organizational regularities, the PERT has been used. Four critical task execution sequences have been determined, which depend on the situation in which the company designs and produces the particular model. Critical tasks for outdoor clothing order designing and mass production are as follows: raw material reception/control (24-25), model design distribution (20-21-22) and handing over model order to a subcontractor for production.

Three situations characteristic of apparel manufacturers have been determined and analyzed: raw material reception and control within two weeks during the model production season; model project distribution carried out during its production season; model project distribution, which is not necessary any more (the designing of collections has been started one season before the mass production of the model); and raw material perception.

Useful free time reserves have been determined in the designing process of women's coat of medium complexity and mass production preparation processes.

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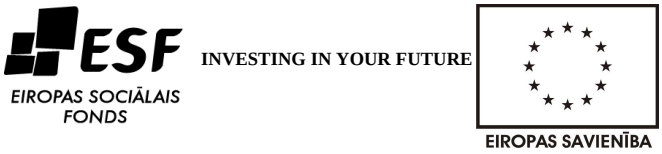


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**Inese Ziemele**, Dr.sc.ing.
She was a Senior Technologist at LLC "Solutions", Riga, Latvia (1998-2007); since 2007 she has been working as a Researcher and Assistant Professor at the Institute of Technology and Design of Textile Materials, Riga Technical University, Faculty of Materials Science and Applied Chemistry, Riga, Latvia. The main field of research include apparel production technologies, design of production processes in sewing companies, and apparel logistics.
Address: Riga Technical University, Institute of Technology and Design of Textile Materials, Āzenes Str. 14/24, Riga, LV-1048, Latvia.
E-mail: inese.ziemele@rtu.lv

**Dana Belakova**, PhD.
Fields of research: work method designing, time standard estimation, improving the working time estimation in sewing companies. Since 2003 she has been working as a Researcher and Assistant Professor at the Institute of Technology and Design of Textile Materials, Riga Technical University, Faculty of Materials Science and Applied Chemistry, Riga, Latvia.
Address: Riga Technical University, Institute of Technology and Design of Textile Materials, Āzenes Str. 14/24, Riga, LV-1048, Latvia.
E-mail: dana.belakova@rtu.lv

**Inese Ziemele, Dana Beļakova. Apģērbu ražošanas loģistikas procesu modelēšana**

Modernā loģistika aptver praktiski visas uzņēmējdarbības sfēras. Loģistika palīdz organizēt un kontrolēt uzņēmuma darbību, veicinot konkurētspēju un palielinot peļņu.

Apģērbu plašražošanas uzņēmumiem ir svarīgi operatīvi pārvaldīt modeļu projektēšanas, pasūtījumu izpildes darbus un termiņus, lai efektīvi darbotos kopējā - šodien jau tradicionāli integrētajā -vairāku partneruzņēmumu loģistikas ķēdē pasūtījumu plūsmas laikā no mākslinieciskā dizaina līdz pasūtītājam. Sīvās konkurences dēļ apģērbu ražotājiem jāprot precīzi plānot ražošanas sagatavošanas un pasūtījumu izpildes procesus, kas var noritēt dažādos apstākļos. Tāpēc lietderīgi ir iepriekš veikt procesu modelēšanu, lai, mainoties to norises apstākļiem, maksimāli efektīvi izmantotu pieejamos darbaspēka resursus un vienlaicīgi noteiktu optimālo procesu norises secību. Apģērba modeļa projektēšanas un tā plašražošanas darbi, to organizēšanas likumsakarības pētītas, par pamatu ņemot vidējas sarežģītības sieviešu mēteļa projektēšanas darbus jeb notikumu secību laikā un PERT tīkla metodi (Program Evaluation and Review Technique). Sieviešu mēteļa projektēšanas un ražošanas PERT tīkla grafikā nodalāmi trīs viendabīgi posmi, kuros saskatāms: 1) Darbu norise no pirmā notikuma līdz gatavam modeļa pirmparaugam (I. posms) projektēšanas darbu tradicionālas organizācijas gadījumā ir gandrīz pilnīgi secīga, veidojot aptuveni 45 darba stundas. 2) Tīkla grafika III. posmā – no lekālu izvietojuma izgatavošanas līdz gatava pasūtījuma nosūtīšanai patērētājam - arī tiek realizēta secīgu darbu ķēde, kurā katrs notikums ir svarīgs norises ilguma ziņā – visi notikumi atrodas uz kritiskā ceļa. Sieviešu mēteļu sortimentam notikumu norises kopējais laiks III. posmā uz vienu vienību aizņems 15 stundas, ja sākotnēji izgatavo testa sēriju, un tikai 2.5stundas - ja testa sērija netiks ražota; 3) Grafika vidusdaļā – II. posmā nonāk notikumi, kas veltīti modeļa konstrukcijas pilnveidošanai līdz ražošanai, materiālu sagādei un nodošanai ražošanā. Te nodalāmi četri iepējamie kritiskie ceļi: A – ražošana paredzēta citā uzņēmumā (nevis vietā, kur noris modeļa projektēšana). Kritiskais laiks ir pasūtījuma pārvietošana uz ražošanas vietu. Posma ilgums šajā gadījumā būs vismaz 15,8 st. B – ražošana paredzēta tajā pašā uzņēmumā, kur norit tā projektēšana. Posma ilgums vismaz – 14.58 st. C – tiek projektēts modelis bez iepriekšēja plašražošanas pasūtījuma un ir jāveic tā vairumtirgošana. Posma ilgums vismaz 13,9 st. Kritiskais notikums – modeļa tiražēšana un tirdzniecība, kura var aizņemt papildus 50 st. un vairāk. D – iespējama drānu un furnitūras piegādes kavēšanās, nepastāv stabila sadarbība ar piegādātājiem. Kritiskais ceļš pārvietojas pie materiālu saņemšanas notikuma, kurš var sasniegt pat divus mēnešus. Posma ilgums vismaz 11,8 st. Tādējādi noteikti virsģērbu modeļu, to pasūtījumu projektēšanas un plašražošanas kritiskie darbi: izejmateriālu saņemšana/kontrole, modeļa projekta vairumtirgošana un modeļa pasūtījuma nodošana ražošanai apakšuzņēmējiem.

Grafa II posmā analizētas trīs apģērbu ražotājiem raksturīgas situācijas: izejmateriālu saņemšana un kontrole notiek divu nedēļu laikā modeļa ražošanas sezonā; modeļa projekta vairumtirdzniecība jāveic tā ražošanas sezonā; modeļa projekta vairumtirdzniecība vairs nav nepieciešama (kolekciju projektēšana uzsākta vienu sezonu pirms modeļa plašražošanas) un izejmateriāli ir jau saņemti. Vidējais sagaidāmais II. posma norises ilgums, pamatojoties uz hipotēzi par darba ilguma sadales likumu, ir 59,74 st. Atrastas lietderīgi izmantojamās brīvā laika rezerves vidējas sarežģītības sieviešu mēteļu projektēšanas un plašražošanas sagatavošanas procesā.

**Инесе Зиемеле, Дана Белякова. Моделирование процессов логистики при производстве одежды**

Современная логистика обхватывает практически все области бизнеса, и является эффективным инструментом организации. Логистика позволяет управлять и контролировать деятельность компании, что повышает её конкурентоспособность и прибыль.

Для производителей одежды важно оперативно управлять как проектированием моделей, так и их массовым производством, чтобы эффективно осуществлять свою деятельность в рамках традиционной цепочки интегрированной логистики нескольких предприятий-партнёров при продвижении заказов от художника до заказчика. В условиях жёсткой конкуренции производители одежды должны точно планировать подготовку и производство заказов в различных условиях. Поэтому целесообразно предварительно моделировать процессы, и заранее определить оптимальный ход названных процессов при изменении условий, чтобы оптимально использовать имеющиеся трудовые ресурсы.

Исследования действий и течение событий во времени при проектировании модели и процесса её массового производства проводилось на примере женского демисезонного пальто средней сложности и использован метод сети PERT (Program Evaluation and Review Technique). На сетевом графике PERT происшествий проектирования и производства модели верхней одежды выделено три однородных этапа - I, II, III, где очевидно: 1) течение работ от первого события до готового первого образца модели (I этап) при классическом методе организации работ происходит почти полностью последовательно и занимает около 45 часов. 2) на III этапе сетевого графика - заключительном этапе проектирования раскладок до сдачи готовой партии заказчику работы также осуществляется в последовательной цепи, где каждое действие является важным с точки зрения времени выполнения, т.е. находится на критическом пути. При производстве экспериментальной серии общее время действий на III этапе займёт 15 часов на единицу и только 2,5 часа – без производства экспериментальной серии. 3) на средней части сетевого графика (на II этапе) находятся мероприятия по усовершенствованию конструкции модели для массового производства, работы заготовки материалов и их передача на производство. Тут отделимы четыре критических пути: A- массовое производство модели осуществляется на другом предприятии (не там, где происходит её проектирование). Критическим временем является время перемещения заказа на место производства. Продолжительность этапа не менее 15,8 ч. B - производство на месте проектирования модели. Продолжительность этапа не менее 14,58 ч. C – модель проектируется без предварительного заказа на массовое производство, при этом необходима оптовая торговля проекта модели. Минимальная длительность этапа 13,9 ч. и дополнительно на оптовую торговлю проекта модели 50 ч. и более. D – возможна задержка поставки сырья, не созданы стабильные отношения с поставщиками. Критический путь перемещается к событию доставки материалов. Продолжительность этапа не менее 11,8 ч. Таким образом, при проектировании и производстве верхней одежды выделены следующие критические работы: поставка и контроль сырья, оптовая торговля проекта модели и передача модели для производства на другое предприятие. На II этапе рассмотрены три типичные для производителей одежды ситуации: первая - поставка и контроль сырья происходит в течение двух недель; вторая - торговля проекта модели производиться в том же сезоне, когда и его производство; третья – сырьё уже получено и торговля модели осуществлена в предыдущем сезоне. Средняя ожидаемая продолжительность II этапа основана на гипотезе о законе распределения продолжительности рабочего времени, составляет 59,74 ч. Найдены резервы полезно используемого времени при проектировании и подготовке к производству модели женского демисезонного пальто средней сложности.