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BASIC OVERVIEW ABOUT DIGITAL FACTORY AND VIRTUAL COMMISSIONING

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Keywords: digital factory, product lifecycle management, virtual commissioning, simulation
Abstract: The paper deals with PLM systems, which are using for management of products during their lifetime. For that it is necessary to have some special tool for it. Especially if we want to handle pre-production phase. The main philosophy is to get fully functional virtual system before it will be created in real production. This virtual system needs to be modeled according to requirements of product and its process of production. This concept is called virtual commissioning. Environment, which contains machines, robots, equipment, workers and products, needs to be simulated with all possible scenarios before it will be implemented to real production. The resolution of this idea is not only cost saving, but also shorter time of production planning.

1 Introduction

Digital factory is supported by special software solutions. One of the tools, which are useful for pre-production phase, is Process Simulate with its package named Virtual Commissioning. Process Simulate is a part of package named Tecnomatix, which is produced by Siemens company. Using this software package it´s not a problem to create a realistic simulation, where we can test all production processes, their time, posssible collisions, human ergonomy and many others. Higher level from this usage is to connect this software with real production. For that we use module Virtual Commissioning.

2 Process Simulate Virtual Commissioning

Process Simulate with its realistic 3D simulation of production processes have a one big advantage. Module Virtual Commissioning is used for connection between real production process and software Tecnomatix Process Simulate. It can easily create a realistic shadow of the production environment, test and debug PLC codes [1].

First of all, Process Simulate Virtual Commissioning looks like a classic simulation. It works with the same 3D.jt (.cojt) models, but those objects have the same parameters as the real machines, robots and human in the production process. It means the same size, shapes, color and of course behavior.

On the Figure 1 there is a basic schema of Virtual Commissioning environment. Engineer, especially software expert, creates production layout, which will be tested in the software simulation [2], [3]. After test and debug there is a possibility to export PLC (programmable logic controller) program for real production system.

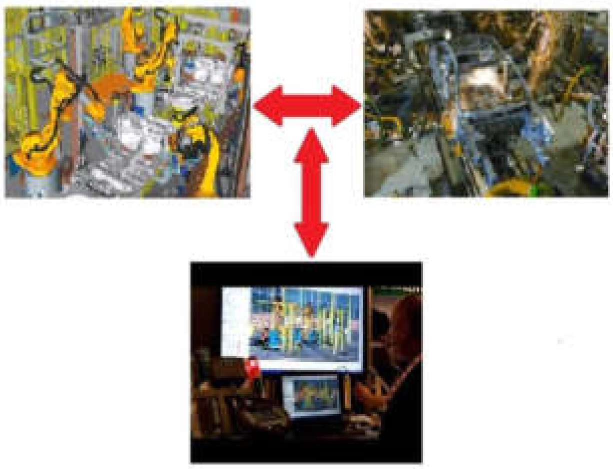

Figure 1 Virtual Commissioning environment

Figure 2 represents traditional concept of production planning. It starts with creating engineering and automation part of production line. So now we need to prepare all necessary objects which will be set up in the realization phase of the project [4], [5]. The whole layout with product will be tested and after time consuming debug it will be pushed to start the production. The same workflow is here for the changes too. If there is a change needed(e.g. new machine, new product, issue or collision on the production line), then we need to go step by step all over the procedure. Make a real model, test it, resolved issues and bottlenecks and finally start the production again [6], [7].

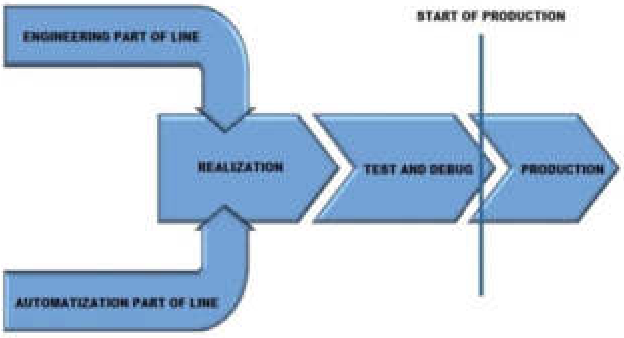

Figure 2 Traditional concept

Figure 3 represents innovative concept of Virtual Commissioning. Difference from the traditional concept is in the beginning of planning phase of project. After engineering and automatization part of line there is a Virtual Commissioning phase which includes virtual testing of production system. Virtual Commissioning consist of PLC programming, hardware configuration, material flow, logistics, collisions, machine's capacity, security. All that stuff is necessary for every production process, but if it is in the virtual environment, there is a chance to time and cost saving [8], [9].

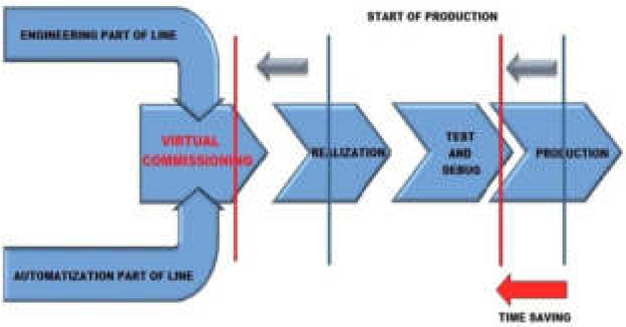

Figure 3 Innovative concept

3 Workflow of Virtual Commissioning

Process Simulate Virtual Commissioning (Figure has the following phases during the project creation:

1. Creation 3D models of all workplace's objects (models are in the .jt or .cojt format, designed in the NX software or downloaded from the producer of machine – ABB, KUKA, etc.).
2. New project in the software Process Simulate.
3. Library creation (Navigation tree), which consists of parts (product parts) and resources (machines,robots, human, etc.). Parts assignment to library.
4. Layout creation using imported 3D models.
5. Operation Tree – modeling of process structure (type of process, relationships between processes).
6. Welding operations – welding points assignment.

7. Robot controller:
   a. default robot controller – included in the Process Simulate – robot movements corresponds to 80 % with real robot movements
   b. customized controller settings – robot movements corresponds to 95 % with real robot movements - consist of RCS (Robot Controller Simulation) and OLP (Off Line Programming package). OLP package needs to be installed and RCS module needs to be downloaded for a specific robot
8. Robot program – program inventory – creating a new robot program or download default robot program where we can make a change according to process requirements.
9. Simulation can be:
   a. time based simulation – predefined sequence of operations dictates the simulation of the process
   b. event based simulation – line simulation mode – simulation based on events and signals
10. For Virtual Commissioning we need to use event based simulation.
11. Virtual Commissioning – need to create OPC connection – connection between PLC and Process Simulate.
12. Virtual Commissioning consist of PLC and logic blocks.
13. Virtual Commissioning works with 4 types of signal, and the most important (for Virtual Commissioning) are Resource Input Signal and Resource Output Signal, which give us signals about start or finish the operation. All signals can be showen and edited in the Signal Viewer window.
14. Each operation must have own default input signal, where we can generate output signal.
15. Sensors definition.
16. Logic blocks – represents relationships between input and outpu signals (e.g. if the signal change from 1 to 0, then 1st event will be executed.
17. Creating a connection between Process Simulate Virtual Commissioning and PLC through OPC server or SimbaBox.

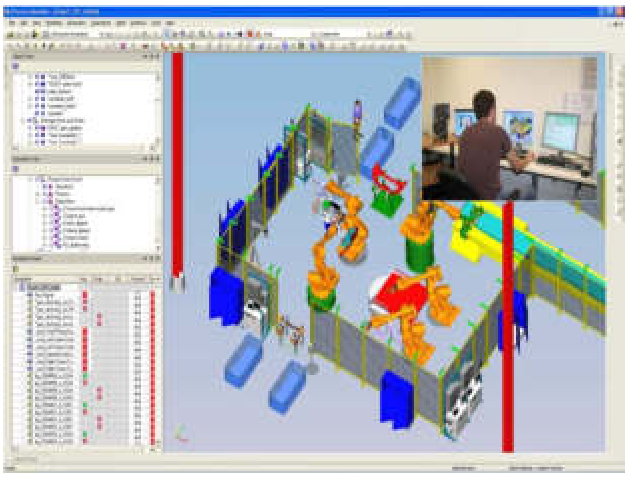

Figure 4 Process Simulate Virtual Commissioning

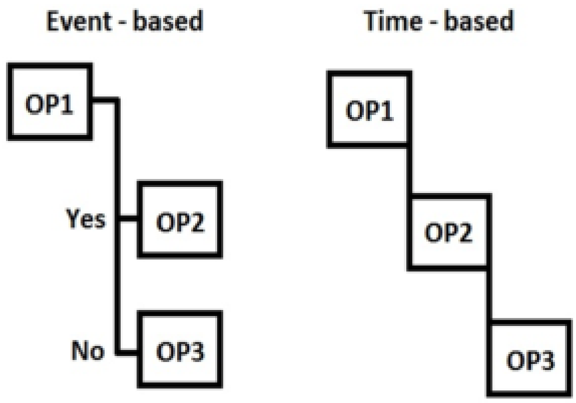

Figure 5 Event based simulation

4 Event based simulation

The Event-Based Simulation module enables you to use Process Simulate to carry out the two stages of design on a single platform, reducing the time of on-site integration and the cost of changes. The Event-Based Simulation module provides a simulation environment that supports the design and verification of sophisticated production stations. The module can simulate production stations where a variety of robots, manufacturing resources, and control devices must function in full synchronization. Process Simulate's Event-Based Simulation module offers an approach that is much more accurate than conventional time-based (sequence) simulations, creating programs off line and an event-based and flow control simulation that enables you to simulate multiple robots and the surrounding devices in the production station [1], [10].

In event-based simulation, the logic of the process and the events that occur during the simulation determine the course of the simulation. The sequence of the operations is only one element of the complete logic definition. Because the events that occur during a simulation can vary, each simulation of the same process can be unique.

Conclusion

Nowadays all automated systems in the manufactoring processes are handled by PLC programs. Software Tecnomatix Process Simulate with its module Virtual Commissioning we can create, test and debug PLC codes for that machines before it is implemented to real production environment. Those simulations include all movements, signals, material flow and safety parameters which have the same behavior as the real production system. By virtual testing we can detect and eliminate possible errors or bottlenecks, which can cause high financial issues in the future. By those simulations we can confirm that robots and other automated machines will work as expected, which bring up reducing of system startup time, or system change time.

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CLARKE AND WRIGHT SAVING ALGORITHM AS A MEANS OF DISTRIBUTION STREAMLINING IN THE ENVIRONMENT OF A CONCRETE COMPANY

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Keywords: Clarke and Wright saving algorithm, transportation planning, distribution, optimization
Abstract: Reducing costs forces of companies to look for reserves also in field of management, support and implementation of material flow. This is connected with the optimization of costs for product distribution, which forms a significant part of the total cost of the company. In practice, it happens that making plans for distribution of materials within a distribution space is left solely to the implementers of distribution and it drivers of vehicles. As a result is uneconomic material distribution and unnecessary cost increases to his distribution. The objective of the paper is to propose a methodology for optimization of transport planning from DC Prešov to the individual Tesco units within the region that comes under this distribution centre. The methodology is based on the Clarke and Wright saving algorithm.

1 Introduction

The international retail chains entering the Slovak market and the competitive struggle for customers have introduced the need to open logistics and distribution centers in Slovakia, which is why optimization of distribution within the frame of logistics is a hot issue. Distribution of products is one of the main functions of Alfa Prešov distribution centre (hereinafter only DC Prešov) within the scope of Alfa Stores a.s. in Slovakia, and that is why improving of product distribution remains one of the opportunities leading to cost cuts in activities connected with distribution from the producers to the final consumers – customers [1]. The objective of the paper is to propose a methodology for optimization of transport planning from DC Prešov to the individual Alfa units within the region that comes under this distribution centre. The methodology is based on the Clarke and Wright saving algorithm.

2 Clarke and Wright saving algorithm

Alterations of methods and algorithms have led to the situation when various distribution parameters can be monitored at the same time, thus creating transport planes according to precise requirements of the customers and the system itself. The savings algorithm developed by Clarke and Wright in 1964 [2] seems to be the most suitable option from the viewpoint of speed and simplicity [3]. It is probably the reason of its wide utilization in commercial routing software systems (see e.g. [4]).

The algorithm results from a hypothetical arrangement of places *Sn* (where *n* is number of places), which are supplied from distribution centre *DCx*, according to figure 1. The initial plan of transports, which is gradually improving, lies in individual supply of each of the places. If we mark the distances of places (for example in kilometres) from the distribution centre as d_{xj}, the initial value of transported kilometres $z_{1,\ldots,n}$ is calculated using formula (provided that $d_{xj} = d_{jx}$) [5]:

$$z_{1,\ldots,n} = 2\sum_{j=1}^{n} d_{xj} \quad (1)$$

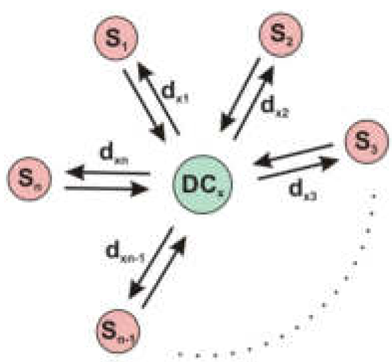

Figure 1 Arrangement of routes [5]

Maximization of savings that can be achieved if the individual places are gradually included into the circle is the criterion for creating the circle. If we, for example,

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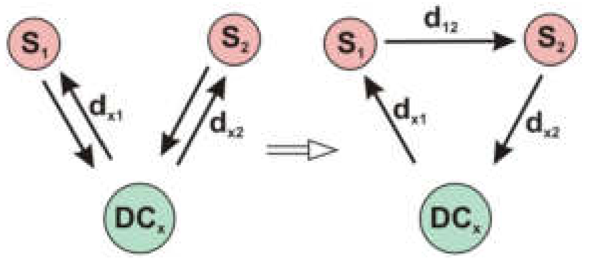
replace the first two circles for a single one (Figure 2) and mark the distance between place S_1 and S_2 as d_{12}, we will obtain savings u_{12} in the amount of:

$$u_{12} = 2d_{x1} + 2d_{x2} - (d_{x1} + d_{12} + d_{x2})$$
$$u_{12} = d_{x1} + d_{x2} - d_{12} \quad (2)$$



$z_{12} = 2d_{x1} + 2d_{x2}$ $\qquad$ $z_{12} = d_{x1} + d_{12} + d_{x2}$

Figure 2 Creating the circle for n = 2 [5]

If we generalize it, we can express the total savings $u_{1,\dots,n}$ as follows:

$$u_{1\dots n} = (d_{x1}+d_{x2}-d_{12})+(d_{x2}+d_{x3}-d_{23})+\cdots+(d_{xn-1}+d_{xn}-d_{n-1n}) = u_{12}+u_{23}+\cdots+u_{n-1n} \quad (3)$$

The objective is to maximize the total savings $u_{1,\dots,n}$ The simple version of the Clarke and Wright saving algorithm rests in two steps:

1. Calculation of savings u_{ij}.
2. Selection of max (u_{ij}) if the connection is possible, i.e. if:

- The circle is not closed prematurely or.
- Other requests are not fulfilled, for example capacity ones.

Many variations on the savings algorithm have developed. Mole and Jameson [6] generalize the definition of the savings function. Altınel and Öncan [7] report enhancements due to Gaskell [8], Yellow [9], Paessens [10], Golden et al. [11], and Nelson et al. [12] and propose new saving criterion [13].

3 Analysis of distribution system in Alfa Company

DC Prešov was established because there was a need of more efficient supplying of Alfa business units (hereinafter only BUs) in Eastern Slovakia, and mainly because the distribution centre in Beckov had failed to cover the needs of all BUs in Slovakia. DC Prešov supplies Eastern Slovakia with fresh food goods named Fresh Food, and dry food and dry goods with a common name Ambient [1], [5]. There are 19 BUses in the region:

- Department stores: Košice, Prešov.
- Supermarkets: Svidník, Stropkov, Veľké Kapušany, Moldava nad Bodvou, Krompachy, Kráľovský Chlmec, Medzilaborce.
- Hypermarkets: Košice, Prešov, Poprad, Michalovce, Vranov nad Topľou, Rožňava, Humenné, Kežmarok, Prešov 3K (3000 m^2 sales area), Košice 3K (3000 m^2 sales area).

Alfa Company uses road vehicles for distribution of goods. The goods are transported on pallets. Transport plans are done by the Transport Department of DC Prešov. The employees from the department use their own knowledge and the empiric experience for transport planning. The planning system does not use any automatic mode [1], [5].

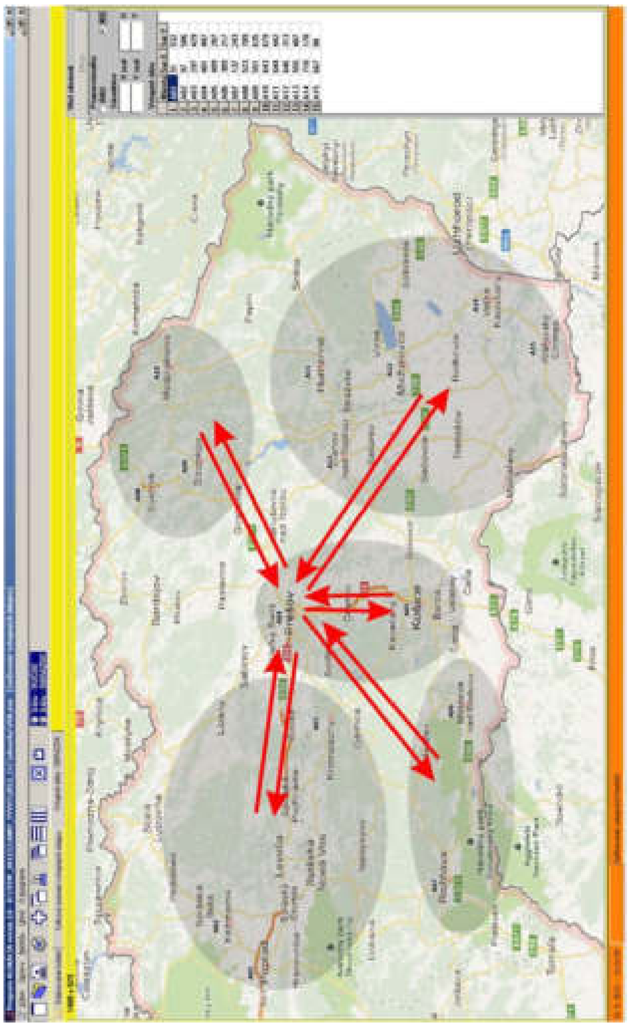


Figure 3 Quadrants of DC Prešov distribution region

The plans are put together using the orders from BUs on daily basis. Number of ordered pallets for the given day is the decisive criteria. Requests for pallets with Fresh Food have a priority before pallets with Ambient goods, which means the transports are planned in such a way to satisfy the requirements of BUs asking for fresh foods first. In case the capacity of the vehicle is not used up by Fresh Food pallets, we either add pallets with Ambient goods to be delivered in the same transport to the BU, or a combined delivery is created between 2 or more BUs with

Fresh Food pallets only, and then the requests for Ambient pallet types will be satisfied during the next transport which will be either direct, according to higher requested volume or, again, combined with other BUs [1], [5].

DC Prešov distribution region is divided into 4 quadrants (Figure 3). During the creation of combined transports only cities within a single quadrant are taken into consideration. BUses in Košice and Prešov have a special position. They are looked upon as intersections of quadrants in the distribution region and that is why they belong to each of the four quadrants. It means that in the combined transport plan within the frame of one quadrant we can also consider the option of combining BUs in Košice or Prešov.

4 Application of Clarke and Wright saving algorithm for solution of concrete problem with distribution

Proposed methodology is based on calculation of savings between individual BUs according to formula (2). Number of BUs is 19. Possible connections respect quadrants from figure 3. The calculated savings are organized in ascending order according to the amount of saved km (Table 1). Connections of BUs where the saved km equal 0 or less are excluded from the list, as it is irrelevant to think about combined transport in these BUs, because there are no saved km.

Table 1 List of savings between the individual BUses in km

List of savings a km														
Connection		km	Connection		km	Connection		km	Connection		km	Connection		km
3	6	206	6	18	71	4	14	26	10	14	11	11	15	6
10	15	172	4	6	70	8	14	25	12	19	11	11	19	6
3	11	145	2	14	68	2	6	23	1	18	10	2	15	5
4	13	139	6	8	66	12	13	23	9	16	10	2	18	5
10	13	132	3	18	66	4	12	22	4	9	10	3	10	5
13	15	121	3	13	65	10	16	22	12	15	10	6	16	5
11	14	118	1	14	64	8	12	21	14	15	10	6	19	5
3	14	117	11	17	64	18	19	21	14	16	10	7	9	5
6	14	117	3	4	63	9	10	19	1	8	9	7	10	5
6	11	116	3	17	62	15	17	19	5	16	9	7	16	5
7	14	107	11	18	62	3	5	18	5	19	9	3	15	4
2	7	95	3	8	59	5	11	18	8	9	9	7	19	4
12	14	92	11	13	59	9	15	17	1	5	8	2	8	3
1	2	91	4	11	58	9	19	17	1	13	8	2	19	3
1	7	91	7	12	57	10	19	17	1	17	8	7	15	3
17	18	91	8	11	57	10	17	16	9	12	8	11	16	3
13	17	90	2	11	54	1	10	15	12	16	8	2	5	2
11	12	88	2	3	53	10	18	15	1	4	7	2	9	2
13	18	88	4	10	46	5	6	14	1	9	7	2	13	2
4	17	86	1	12	41	9	13	14	1	16	7	2	16	2
5	13	86	4	5	40	15	16	14	1	19	7	2	4	1
3	12	85	5	17	40	15	19	14	2	17	7	6	10	1
4	18	84	5	18	39	8	10	13	3	19	7	16	17	1
5	10	83	1	11	37	15	18	13	5	12	7	16	18	1
7	11	83	1	6	36	16	19	13	5	14	7	5	7	0
8	17	83	1	3	35	9	17	12	6	9	7	6	15	-1
3	7	82	2	12	34	9	18	12	8	16	7	7	17	-6
8	18	82	4	15	34	17	19	12	8	19	7	7	18	-7
4	8	82	5	8	34	14	19	12	10	11	7	7	13	-8
8	13	82	14	17	32	13	19	12	13	16	7	4	7	-9
6	7	81	14	18	30	4	19	12	2	10	6	7	8	-10
5	15	81	1	15	29	10	12	12	3	9	6			
6	12	80	12	17	29	5	9	11	3	16	6			
6	17	77	13	14	28	4	16	11	9	11	6			
6	13	72	12	18	27	8	15	11	9	14	6			

The capacity of a transport vehicle is a limiting factor [1], [5], [14] when planning daily transports from DC Prešov to the individual BUs. The limit of vehicle capacity is 33 pallets. Daily requirements of the BUs regarding the number of pallets from DC Prešov vary. Larger BUs, mainly hypermarkets, requires several times more pallets than the capacity of the vehicle is. In such case, direct deliveries in these BUses with maximum utilization of the loading capacity of the vehicle are planned when the daily transport plan is being prepared [1], [5].

If the daily requirement of a concrete BU cannot be satisfied by direct transports using the maximum capacity of the vehicle, which means the request is not a multiple of 33 without any space left, a direct transport of 33 pallets will be scheduled and the remaining requested pallets will be included in combined transport planning process [1], [5].

With regards to the fact that there are days when some of the BUs, especially supermarkets, do not have any request for pallets from DC Prešov, the connections of these BUs must be excluded from the list of saved km. It is obvious that there is no need to visit the BU that day, i.e. include it in the transport plan.

It is convenient to exclude also connections of BU couples the combined requirements of which exceed 33 pallets, i.e. the vehicle capacity, from the list of km savings. It is obvious a combined transport to these couples of BUs cannot be planned.

The methodology can be summed up as follows:

1. Excluding the connections with BUs which have 0 pallet requests from DC Prešov for the following day from the list of km savings.
2. Specifying the direct transports with maximum utilization of vehicle capacity to those BUs requesting more than 33 pallets.
3. Including the remaining pallet requests of these BUses to combined transport planning.
4. Excluding the combinations of these two BUses the combined number of pallets of which exceeds 33 from the list of km savings.
5. Planning the combined transports according to the application of Clark and Wright algorithm.
6. Setting direct transports to these BUses the request of which is lower than 33 pallets but it was not possible to plan a combined transport to them.
7. Setting the sequence of realization of planned direct and combined transports according to the priority of Fresh Food.

5 Evaluation of Benefits

The main benefit of efficient distribution planning is an economic one. The costs of transportation represent one of the most significant cost elements in comparison with the other logistics activities in the distribution center. Efficient planning of distribution, with regards to economic factors such as price of fuels and labour, is very important when cutting the overall costs of transportation.

Daily transport plans in DC Prešov were monitored so as to quantify the economic benefits of the designed methodology. There were achieved these average daily results [1], [5]:

- Decrease of the number of transports by 10 %.
- Decrease of the number of km driven by 7 %.
- Decrease of consumption of fuels by 7 %.
- Increase in the capacity utilization of the vehicles by 9 %.

Another benefit which is not insignificant is the saved time. On one side, the time necessary for elaborating the daily transport plan is shorter and, on the other side, the time necessary for transporting the goods from DC Prešov to the individual BUs is shorter as well. Expressed in time when 1 km driven by a vehicle represents 1 minute, decrease in the number of kilometres by an average 186 km a day means approximately 3 saved hours a day.

Last but not least, there are also the ecological benefits. Reduction of the number of transports and the number of driven kilometres reduced the impact on the environment caused by motor traffic.

Conclusion

The designed methodology has brought mainly increased efficiency in the planning and distribution process, above all with regards to the time necessary for elaboration of such daily transport plans by using convenient information technology, such as software application designed for the needs of DC Prešov.

The benefits of optimized transport planning showed themselves in the economic area connected with distribution, namely in lower number of kilometres driven during the daily transports. This methodology results from the conditions and possibilities of the DC Prešov, but, through small modifications it can be used to optimize distribution in other distribution centres run by Alfa Stores a.s., not only in Slovakia.

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INFORMATION SECURITY IN LOGISTICS COOPERATION

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Keywords: information security, supply chain, logistics outsourcing, ISO 27001 standard, contract
Abstract: Cooperation of suppliers of raw materials, semi-finished products, finished products, wholesalers, retailers in the form of the supply chain, as well as outsourcing of specialized logistics service require ensuring adequate support of information. It concerns the use of appropriate computer tools. The security of information in such conditions of collaboration becomes the important problem for parties of contract. The objective of the paper is to characterize main issues relating to security of information in logistics cooperation.

1. Introduction

Rapid changes in the business environment, including the changing expectations of customers caused the increasing importance of logistics activities to achieve competitive advantage. The ability of quick supply of goods to clients became the important factor of success on markets. Such circumstances resulted with both, the integration of logistics activities between companies producing and supplying goods to clients, as well as the growth of interest in logistics outsourcing. At the same time, toegether with objective to increase the rate of delivery of goods to customers, the supply chain concept is treated as a way to reduce the cost of storage and movement of goods.

Organizing cooperation both between suppliers of raw materials, semi-finished products, finished products, wholesalers, retailers in the form of the supply chain, as well as outsourcing of specialized logistics service it is important to ensure adequate support of information. It requires to use appropriate computer tools. The security of information in such conditions of collaboration becomes the important problem for parties of contract.

The objective of the paper is to characterize main issues relating to security of information in logistics cooperation. Presentation of nature of such cooperation, importance of information security, as well as guidelines, how to ensure information security in logistics collaboration are included in the paper. Mentioned guidelines are based on well known ISO 27001 standard.

2. Characteristics of logistics cooperation

The supply chain concept was created as an alternative to the traditional perception of the relationship between suppliers and clients, which was characacterised by antagonisms, using their own bargaining power, and consequent transfer of obligation to incurr the increased costs to a partner [6]. The development of supply chain can be also treated as a consequence of the need for cooperation in pursuing partners' objectives in an environment, where the frequency and scale of change has significantly increased. This approach to cooperation decisions about design and development of individual companies should take into account the relationship with other units on the market. Although the regulations of law impose on each company to draw up a proper documentation of its effects of performance, however, these results are usually dependent on both, the solutions within the enterprise, as well as the achievements of other cooperating parties.

In the supply chain cooperation, concerning production and delivery of products to clients, the relationship between achievements of individual enterprises play a special role. This approach is related to the necessity to adapt methods of delivery, as well as subsequent after-sales service to the individual needs of each buyer. The fulfillment of these expectations is difficult, because suppliers want to provide fast inventory turnover and at the same time to ensure low operating costs.

Considering the requirements of information systems, supporting the supply chain it should be noted, that the achievement of sufficient flexibility to changing clients expectations depends mostly on close cooperation of suppliers and flow of relevant information between these units. Fast and undistorted customer service, in accordance to their expectations is also difficult without the exchange of information between final buyers and distributors, which allows on one hand quick ordering, affecting the production and supply planning, as well as information on changes of preferences, and on the other hand informing notifying clients on the status of their orders. It should be emphasized, that suppliers seek to maintain more complete control of their own business, but planning and coordinating the flow of raw materials, semi-finished products, finished products, waste, recyclable materials, relevant information and financial resources should be carried out in the whole chain.

The role of information in activities of supply chain is reflected between principles of supply chain management, formulated by APICS (American Production and

Inventory Control Society, now organization named as: The Educational Society for Resource Management). Such principles are described in detail in the work of W. Walker [4]:

- velocity – concerns tasks performed from receipt of order to the point of obtaining financial resources for goods supplied to customers, which is associated primarily with the provision of adequate infrastructure,
- variability – associated with reduction of variability, which results with reduction of the need for network inventory, also logistics and quality costs,
- vocalize – concerns ensuring the flow of information between cooperating units, appropriate in the form, place and time – in particular on the demand for finished products, reported by customers, also ensuring an adequate level of inventories of raw materials, semi-finished in each partner's firm, as well as determination of the required terms of deliveries and ensuring cash flow needed for inventories of individual units,
- visualize – associated with the awareness and understanding of expected results of cooperation – related mainly to agreement (contract) of partners, concerning expected results across the chain and the use of appropriate performance indicators,
- value – emphasizing the need to recognize and take into account the expectations of all stakeholders in supply chain operations.

Usually logistics cooperation in the supply chain includes suppliers of raw materials, semi-finished products, finished goods manufacturers, wholesalers and retailers. There is also important role of service providers, involved in the loading, movement, unloading and storage of goods. Cooperation with such companies may be associated with a focus on reducing the costs of contracted services. Taking into account the important role of logistics in achieving competitive advantage the cooperation with providers of logistics service can also be treated as part of the strategy of the client. In the case of wide range of outsourced service, core business of the client may be significantly influenced by the activities of providers.

Basic models of activities of specialized logistic units, which were formed on the basis of the different orientation of the principals, concerning required range of logistics services is presented in one of the studies the IBM Institute for Business Value [1]:

- providers of simple service, such as transport or storage, sometimes taking into account also customs clearance, settlement between the client and the service provider shall be implemented on the basis of transactions,
- units referred to as 3PL (third party logistics) - offering logistics services for client in such areas as procurement, distribution and movement of goods in the manufacturing process, taking into account the packaging, marking goods, warranty and post-warranty, performance of these tasks is similar as in previous case under a contract with the client, specifying mutual expectations, obligations and rights of the parties, the settlement take place on the basis of a fixed rate for an agreed range and quantity of services.
- units named as the LLP (Lead Logistics Provider) – managing logistics activities of several or even all partners cooperating in the supply chain, from suppliers of raw materials, semi-finished products, producers of final products up to deliveries to buyers of finished products, such units operate like the previous primarily on the basis of contract with individual principals, settlement takes place on the basis of a fixed rate for probably range of services, but also participate in the sharing of risks associated with joint ventures, such individuals often rely on the help of other service providers, providing individual types of services, e.g. transport, or shipping,
- units acting as an integrator in the supply chain, often regulate flows (to eliminate "bottlenecks") between cooperating companies in manufacturing and supplying purchasers of products, also referred to as the LLM (Lead Logistics Manager) – in this case a partnership between the client and the service provider is shaped by the terms of the contract between parties, but to a greater extent related to the implementation of joint projects, in which there is both risk-sharing between the client and provider, but also the sharing of benefits after the completion of the project, the benefits of this project are considered as the basic form of compensation for the involvement of the service provider,
- units known as 4PL (fourth party logistics) - a term coined by Andersen Consulting to determine the companies referred to previously as 3PL, that developed offers to a wide range of logistics services, far beyond the transport and storage, such units generally shall cooperate with others, specialized service providers, entrusting them to perform different types of tasks within a comprehensive service harvested principal, 4PL may also have expertise in the field of supply chain management.

Taking into account presented distinction of types of logistics service providers it should be noted, that among them are both, units implementing simple tasks for individual companies in the supply chain, as well as providers of comprehensive logistics service to all participants of the chain. Problem of information security applies to each of cases considered. The differences concern the range of data and information used in cooperation. From the point of view of comprehensive service of all supply chain partners units described as LLP play most important role. It should be noted that their activities in the supply chain, as well as coordination of subcontractors requires the use of complex information systems that enable the rapid flow of a wide range of data and information.

3. Support of information in logistics cooperation

Logistics cooperation is associated with the use of different computer tools, depending on the scope of information required. The example of description of software offered by SAP, named mySAP SCM can be used to present wide range of types of information used in most complex supply chain cooperation. Names of main components of the software reflect the range of data and information collected, created, used and transferred:

- supply chain planning,
- supply chain execution,
- supply chain collaboration,
- supply chain cooperation.

Data and information useful in mentioned areas, grouped in main functions available are presented in Table 1.

Table 1. Types of information used in supply chain cooperation

Types of actions	Description
Supply chain planning	- supply chain design function enables centralized overview of the entire supply chain, contains key performance indicators, as well as weak links and places of potential improvement, at also supports strategic planning, by enabling tests of various scenarios, concerning the influence of changes in market conditions and customer demand on the results of activities of cooperating parties, - demand planning takes into account historical demand data, causal factors, marketing demand, results of market intelligence, sales objectives, it enables cooperating parties also working on single forecast, - function of supply planning concerns materials management, production, distribution, as well as transportation requirements, also constraints of activity.
Supply chain execution	- materials management function contains inventory and procurement order information, it supports plan-driven procurement, inventory management and invoicing, with a feedback loop between demand and supply to increase responsiveness, - collaborative manufacturing refers to sharing of information, supporting coordination of production and to increase visibility and responsiveness, there is a continuous information flow across engineering, planning and execution for optimization of production schedules across all cooperating parties, - collaborative fulfillment includes global available-to-promise (ATP) feature, that locates finished products, components and machine capacities (in a matter of seconds), it also manages flow of products through sales channels, matching supply to market demand, it results with managing with transportation and warehousing.
Supply chain collaboration	- inventory collaboration hub uses Internet to gain visibility to suppliers and manage the replenishment process, it enables to gain data and information about the status of parts at all plants and to receive alerts concerning too low levels of inventories, as well as to respond quickly, - collaborative replenishment planning (useful especially in the area of consumer goods flow and in retail industry) enables exception-based collaborative planning, forecasting and replenishment process, that allows adding retail partners without a proportional increase in staff, - vendor managed inventory (VMI) enables vendor managed replenishment, without the need of cyclic ordering by client, concerns continuous updating inventory data at the destination point - enterprise portal enables personalized access to a range of information, applications and

	services supported by the system, it uses role-based technology to deliver information to users, according to their individual responsibilities in supply chain network, also the ability to use Web-based tools to integrate third-party systems in the firm's supply chain network should be emphasized, - mobile supply chain management can be treated as supplementary function, it enables planning, execution and monitoring of activities using mobile and remote devices, availability of data and information also should be personalized.
Supply chain coordination	- supply chain event management concerns monitoring of events (supply chain actions) as: issue of pallet, departure of truck, it is especially useful for product traceability, - supply chain performance management enables to define, select and monitor key performance indicators, measuring results of activities and generating alerts in cases of differences, between results and plan

Source: own study, based on: [3].

As presented in Table 1, main users of such information system are suppliers of raw-materials, semi-finished products, final products, wholesalers and retailers. Functions of system allow also the involvement of logistics service providers in the network.

The problem of information security can be analyzed with the transaction cost theory [5], agency theory and incomplete contract theory [2]. According to transaction costs theory, bounded rationality (associated with asymmetry in access to information), opportunism of parties to transaction and the specificity of the assets used in transaction were recognized by O. Williamson as main sources of transaction costs [5]. Using agency theory assumptions it should also be noted that agents typically act for their own benefit and they represent the opportunistic attitude [2], [5]. Considering information security, the use of information needed for the transaction by one party for its own purpose, as well as limiting access of other party to information may be examples of opportunistic behaviour. Limiting access to data and information, as well as the use of data and information for individual purpose of one party are also important factors of incompleteness of contract.

Taking into account the problem of reducing the risks associated with limited access to data and information important for cooperation, as well as improper use of data and information, it is worth paying attention to the role of regulations in the contract, concerning informational support of cooperation (creation of information, use, transfer, access etc.). ISO 27001 guidelines may be useful, as the inspiration in the formulation of regulations concerning the principles of cooperation.

4. ISO 27001 as proposal of basic rules for enhancing information security in logistics cooperation[1]

Development of the information technology accelerates growth of globalization, however, this relationship is two-directional. Global economy affects the ways of thinking about information management. Awareness of this fact among the companies executives grows, but still is insufficient. The major roles in top management decisions are played by economic effects, whereas information security problems are often overlooked.

Correct calculation of the cost should, however, take into account the risk of security problems. The awareness and appreciation for information security of personnel can be significantly less in some countries. Moreover, there should be considered other threats, e.g.: political risk, industrial espionage, intellectual property theft, as well as disaster recovery issues. The cost cutting results also in reduction of audits number in overseas departments. Lack of control can lead to loosening of security procedures, and increase of security incidents.

Information Security Management System (ISMS) is meant to be the answer to such problems. It was first published in 2005 and updated in 2013. Its scope comprises the development of security policy at the strategic level, the evaluation of risks, the determination and implementation of security controls aimed at eliminating threats, and also the monitoring of the system with the aid of internal audits and a management review. It has been reflected in the structure of ISO 27001:2013 standard that comprises of eleven chapters. The first four chapters contain an introduction, a description of the scope of the standard, normative references, and also terms and definitions. Key chapters focus on the organisational context and stakeholders, information security leadership and high-level support for policy, planning an information security management system, supporting it, making it operational, reviewing its performance and corrective action. Such a structure corresponds to other standards established by the ISO that

[1] The chapter presents results of own study based on: [7], [8], [9], [10] and [11].

relate to management systems. Current standard was significantly changed in comparision to previous version. Its structure and clarity of requirements is much higher than in ISO 27001:2005.

The key part of ISO 27001:2013 is Annex A that contains a list of security controls concerning among others: information security policy, system organization, security of staff, assets management, access control, cryptography, physical and environmental security, security of systems operation, communication, development of systems, relations with suppliers, incidents management, business continuity, compliance with the law. The security groups are strictly related to the contents of the ISO 27002:2013 standard, where detailed guidelines concerning the implementation and monitoring of security controls may be found. It should be noted that in many cases the ISO 27002:2013 standard deals with an information technology system, however, in the case of implementing the information security management system, it should be interpreted more broadly, as an information system.

Apart from ISO 27002, implementation of information security management system requires knowledge related to other standards of this family: implementation guidance (ISO 27003), principles of measurement (ISO 27004), risk management methodology (ISO 27005, which refers to ISO 31000).

While developing standards for management systems, the International Organisation for Standardisation complies with the principles of their compatibility and complementarity. Apart from ISO 27001, the most popular standards in this field also include systems of quality management, environment and occupational safety. The compatibility is seen in the application of similar management methods and tools, e.g. principles of supervision over documents and records, the development of organisational policies, carrying out management system reviews, internal audits, identification of non-conformities, corrective actions. This approach makes ISO 27001 standard easier to implement in organizations, which already have certified ISO 9001 system.

Organization's interfaces are particularly vulnerable to information security problems. It is no different in case of cooperation with suppliers. The standard mentions in appendix A six main controls related to information security management in context of relationships with suppliers: - A.11.1.6. Delivery and loading areas, - A.15.1.1. Information security policy for supplier relationships, - A.15.1.2. Addressing security within supplier agreements (contracts), - A.15.1.3. Information and communication technology supply chain, - A.15.2.1. Monitoring and review of supplier services, - A.15.2.2. Managing changes to supplier services.

The main provision of ISO 27001 concerning suppliers is information security policy for supplier relationships (A.15.1.1). This is new requirement, which was added in amendment of 2013. It is expected, that requirements of information security should be agreed between organization and supplier, and also documented. It should reduce risks related to supplier's access to organization assets. This is legal protection, which should be reinforced by additional organizational, technical and IT protection. The organization should identify groups of suppliers, evaluate their access to information, determine and implement restrictions of access which will improve security and at the same time won't worsen conditions of cooperation. Suppliers can influence the business continuity, therefore organization should discern its fault tolerance. In case of close cooperation, it may be desirable to plan staff awareness training not only for own personnel, but also for supplier's employees.

In case of suppliers who are able to access, process, store, transmit information or provide ICT infrastructure, organization should establish contracts to ensure that duties of both parties are known and well understood (A.15.1.2). The common misunderstanding about ISO 27001 controls is their limitation to ICT problems, while most of them relate to whole organization. This control is good example. In fact most of suppliers have access to organization's information, which should be protected (tenders, specifications, technical documentation). Contracts should regulate issues of methods of protection used by both parties, rules of acceptable use of information, intellectual property, dealing with incidents and others.

ISO 27001:2013 introduces new requirement, concerning communication in supply chain management (A.15.1.3). Sensitive information in supply chain can be transferred not only to direct supplier (of goods or service), but also to subcontractors. It is important to implement information security policy, that will embrace not only individual organization and its suppliers, but all participants in the supply chain.

Supplier service should be monitored and reviewed on regular basis (A.15.2.1). Monitoring should include service level, accordance with the requirements of the contract, review of supplier reports, incidents management and audits if appropriate. Monitoring is important part of maintaining supplier relationship. Organization can identify early signals of problems and help solve supplier problems before they induce problems within the organization cooperating with such supplier. To improve communication, both parties should appoint personnel responsible for relationship management and problem solving.

All changes to supplier service should be managed to assure compliance with current information security policies, procedures and controls (A.15.2.2). According to requirements of ISO 27001 new contracts, as well as all changes should be examined in the process of risk assessment.

According to A.11.1.6, organization should supervise delivery and loading areas or other points, where unauthorized persons may try to enter. This includes identification an authorization of personnel having access to loading areas, reorganization of loading areas and procedures to allow suppliers to operate without need of special authorization, verification of supplies for hazardous materials and violations during transport before further transfer, recording supplied materials, physical separation from outgoing deliveries. Those requirements may entail reconstruction of delivery zones. Suppliers should be informed in advance about procedures of delivery.

Apart from above mentioned controls, cooperating companies should share some common policy of information security incident management, aspects of business continuity management and intellectual property rights.

ISO 27001:2013 focuses on the planning of cooperation processes which includes: identification of risks, determination and implementation of legal, organizational and technical protection means. Information security management system shouldn't be restricted to logistic cooperation, as it will work properly only when all controls will be implemented. Thanks to the system approach and compatibility with other management systems standards, it allows the company to enhance information security in whole organization.

5. Conclusions

The problem of information security is particularly important in changing environment, where individual suppliers of goods (raw materials, semi-finished products, wholesalers, retailers) cooperate with companies, competing in various supply chains. Under these conditions also logistics service providers collaborate with customers, competing with each other. Taking into account the possibility of opportunism in such conditions it should be emphasized, that there is the ability to reduce the risk of incorrect management of information by relevant provisions in the contract. Considering the use of ISO 27001 as a guide to creation of information security system and assuming a positive attitude of parties to cooperation (based mostly on mutual trust and understanding), the following examples of solutions can be also applied:

- submission and explanation of every doubt concerning regulations on informational support of cooperation,
- application of regulations influencing motivation of parties and discouraging opportunistic behavior (mutual benefits resulting from improvements of long-term cooperation, further joint investments, the ability to extend the range of cooperation etc.),
- specification of required compatible, reliable computer tools,
- the ability to renegotiate the terms of contract if (specified) changes influencing information management occur,
- requirement of agreement of any change in terms of cooperation, introduced by each party,
- description of procedures for informing about the changes of those responsible for cooperation in each cooperating company,
- preparation of plans for extraordinary situations (concerns activities of parties taken for adjustment to new terms).

It is important to add, that presented guidelines may be applied to any contract between companies in the supply chain. Among main conditions, affecting the flexibility of contracts and enabling adaptation to changing conditions in the environment of cooperation the possibility of renegotiations and consideration of plans for unexpected situations play most important role.

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NEW TRENDS AND CHELLENGES IN AUTOMOTIVE INDUSTRY LOGISTICS OPERATIONS

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Keywords: automotive, logistics, innovation, trends, challenges
Abstract: This paper lays out the main features of the global automotive industry and identifies several important trends. Logistics operations (inbound and outbound) in the automotive supply chain are complex and account for large expenses and therefore are segments in the value chainwhere improvements can be made. Better coordination between inbound and outbound logistics contributes to optimising the supply chains, to reducing inventories and to responding to consumer requests. As economies grow, the competition shifts towards brand image and customisation and here the speed and reliability of logistics operations becomes a critical elements.

1 Introduction

Logistics is the collection of activities associated with acquiring, moving, storing and delivering supply chain commodities (i.e., products in all stages of manufacture, service and information). Logistics encompases the business functions of transportation, distribution, warehousing, material handling and inventory management, and interfaces closely with manufacturing [3].

There are four levels of manufacturing logistics systems:

- Production Unit,
- Supply Chain,
- Production Facility,
- Enterprise.

An enterprise is a business entity that consists of multiple manufacturing plants as well as other aspects of the business such as design, engineering, marketing, and sales. Also, practical logistics problems are at enterprise level [3].

For the products such as automobiles, which feature multiple products, technologies, and process the supply chain becomes more complicated. The material planning, and logistics supply chain for an automotive company is shown in the Fig. 1, which illustrates the complexity of the chain, spanning from automotive dealers back through multiple levels or tiers of suppliers. The automotive company's supplier network includes the thousands of firms that provide items ranging from raw materials, such as steel and plastics, to complex assemblies, such as transmissions, brakes, and engines.

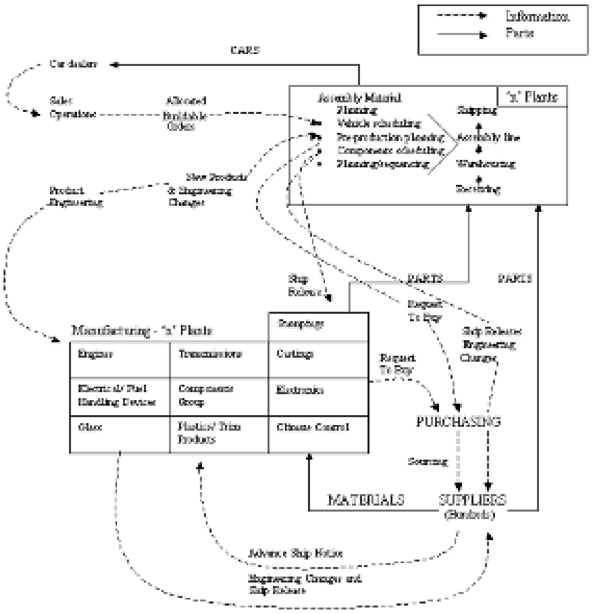

Figure 1: Automotive supply chain [3]

2 Automotive logistic process

Automotive logistics is entity flow of automotive producer's raw materials, components, vehicle and spare parts on steps of automotive purchase, production, sales (Fig.2). Automotive logistics include inbound logistics of raw materials and components,garage logistics of production process, sales logistics of vehicle and spare parts logistics, that is including object purchasing, transportation, storage, loading and unloading, distribution processing delivery and information processing.In macro way, Logistics includes recycle of waste as well [4].

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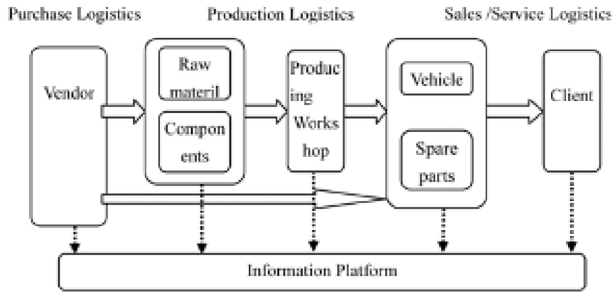

Figure 2:Automotive logistic process

Automotive Logistics is an important composing part of automotive enterprises, and also is a logistic activity with highly complex degree in logistics industry. Comparing to other logistic activities, Automotive Logistics have characteristics of capital-intensive, technology intensive and knowledge intensive [6]. With rapid development of our automotive industry and fierceness of competition of automotive market after entering WTO, AutomotiveLogistics must play a much more important role in automotive industry, and reduction of automotive cost [7].

3 Major trends in logistics

Today's global logistics environment is characterized by increasing complexity and a number of important parameters shaping the global environment. Thespeed of change of these parameters isbreathtaking and is driving increasing complexity in the logistics ecosystem. We have labeled these changes as "trends", in that they continue to re-shape the logistics landscape, and provide a shifting set of environmental risks and limitations that either constrain decisions, or alternatively present opportunities which nimble enterprises are able to exploit quickly.

There are possible identify the major trends that are impacting organizations, and follow up with some of the key strategies that successful organizations are applying to cope with or even exploit these trends. The graph shown in Figure 3 shows the importance of identified top trends identified by global executives surveyed in all countries, as well as their relative importance in the next five years. They are shown in chronological order from most important to least important [2].

Several trends demonstrate that a number of major challenges lie ahead, as the world becomes a more complex place to operate logistically [2].

Customer expectations: In essence, logistics and supply chain management should primarily enable a company to satisfy its customers' needs. The most important trends is increasing customer expectations and meeting customer requirements, the number-one logistics objective. But, as customers are becoming ever more demanding and critical, traditional measures often fail when pursuing strategies to satisfy customers.

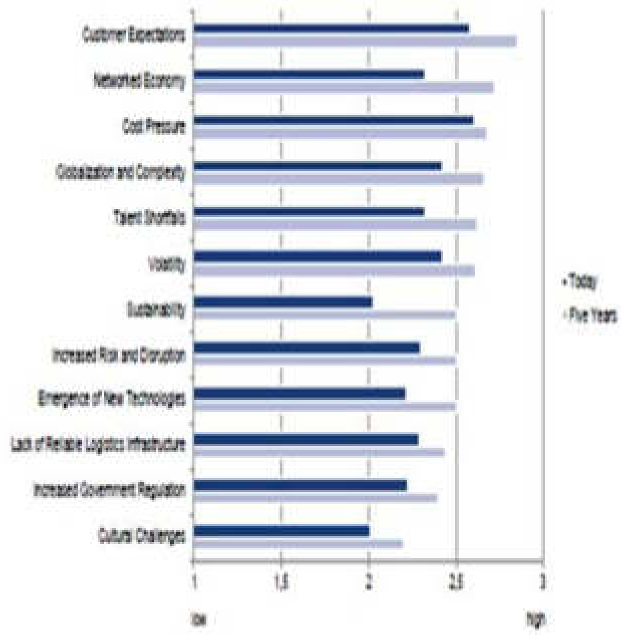

Fig.3: Importance of Logistics Trends

Networked economy: Companies are often forced to collaborate with partners both vertically and horizontally in their extended supply chain network, and these partners expect them to integrate their processes and systems. Companies are forced to adopt network thinking rather than company thinking.

Cost pressure: Logistics costs are playing an important role in reducing overall costs. Logistics costs share of overall revenue is as low as 4% and 6% in the electronics and automotive industries, respectively. The costs are on the rise (larger than 8% on average for manufacturing industries). About 14% of the enterprises cannot estimate their logistics costs.

Globalization: Two thirds of company's logistics capability is negatively influenced by poor transportation infrastructure, which is a problem particularly in emerging markets. In sum, globalization clearly amplifies other trends and leads to an increase in complexity, particularly in regions of growth such as Russia, Eastern Europe, India, and Africa.

Talent shortfalls: The most important strategies to cope with talent shortage are training and qualification programs and strategic cooperation with universities and research institutions. In the United States and Europe, talent shortages are also a function of demographics. In emerging nations strong competition from other fields like finance, strategy and IT contributes to the talent shortage.

Volatility: In the last years, market turbulence on the supply and demand side has increased. This was amplified by the economic and financial crisis, which demonstrated how fluctuations in one part of the world can build up to dramatic problems in other parts of the world. Volatility factor will continue to increase and more than 50% companies consider it to be a very important trend in five years.

Sustainability pressure: This trend has emerged as a very serious topic. Today more that 55% of the companies stated that green issues are part of their logistics strategy. However, there remains a great deal of uncertainty in the deployment of these strategies, especially relative to measurement systems, evaluation and setting goals and strategies for logistics sustainability.

Increased risk and disruption: The majority of companies (irrespective of size, sector, country and position in the supply chain) consider the mitigation of internal and external risks essential. Strategies for managing risk around demand and planning are also considered important. Solutions focused on improving transparency of tier two suppliers, inventory and demand impede mitigation and force companies into reactive strategies. Proactive strategies should include research and development, procurement, production and sales.

New technology: The majority of companies are recognizing the growing need for investments in new technology, with about 60% of the companies planning to invest in "big data" analysis tools within the next five years. Those tools seek to develop capabilities around the comprehensive handling and intelligent connection of data to increase planning and control outcomes.

4 Transport logistic and supply chains

The development of trade networks creates various needs for value-added logistics management and gives rise to a large number of individual trends in logistics and supply chains [1].

Restructuring of logistical systems

Manufacturers are restructuring their logistics systems by concentrating production and inventory capacity in fewer locations. Concentrating production capacity enables companies to maximise economies of scale in production at the expense of making their logistics system more transportintensive and lengthening lead-time to customers. Inventory centralisation, which has been a long-term trend, is now occurring on a larger geographical scale. Companies have been able to enjoy the inventory cost savings, while minimising additional transport costs by geographically separating stockholding and break-bulk operations, with the former becoming more centralised while the latter remains decentralised. Centralisation has also occurred in parcel and mail delivery systems by configuring their logistics systems to "hub-satellite" systems in which all but local traffic passes through a centralised sorting system.

Realignment of supply chains

Companies are realigning their supply chains. In many sectors, companies have been concentrating on core competencies and sub-contracting non-core, ancillary activities to outside contractors. Vertical disintegration of production is adding extra links to the supply chain and increasing the transport intensity of the production process. At the same time, companies have steadily expanded the geographical scale of their sourcing and distribution operations. Also, in order to overcome the tension between centralised production and product customisation, companies are centralising the core production of standard products, often in countries with low labour costs, and delaying their customisation until products reach their regional markets. The number of stock keeping units is minimised until the point of customisation, thus minimising inventory risk and costs, and reducing lead-times.

Rescheduling of product flow

Product flow in the supply chain is increasingly time-compressed. The lengthened supply chains are now under pressure to compress order lead-times (time elapsing from the placing of an order to the delivery of goods) in order to be competitive in a foreign market. There seems to be a variation of lead-times, which can be attributed to differences in trading practices, degree of retail concentration, level of ICT support and size of the country. Time compression of product flow can save inventory costs, enable companies to respond more rapidly to shorter life cycles of products as well as variations in demand, and increase reliability of delivery. One way of rescheduling freight movement is by operating nominated-day delivery to customers and introducing timed-delivery at factories.

Refinement of transport and warehousing management

Transport and warehousing management is refined by optimal use of different transport modes and by the increasing use of Information and Communication Technology (ICT). For example, selective use of international transportation modes is now common in the personal computer industry, in which parts are transported either by air or sea, depending on the degree of added value. Items with low added values are normally carried by sea in order to reduce transportation costs, whereas key parts with higher added values are selected according to demand shifts and transported by air immediately prior to assembly. This enables manufacturers to maintain the quality of parts used in finished products, ensure consumer satisfaction, and at the same time eliminate the risk of declines in the price of product inventory.

Changes in product design

An increase in complexity and sophistication of products will lead to more value added per unit of weight, especially with final products. Increase in Internet sales is converting the direct delivery of CDs, tapes, videos and software into electronic distribution. Opportunities also lie with regard to the integration of logistics and transport implications at an early stage of product design: integrated product design. For example, the participation of the packaging industry and other supply chain actors. Standardisation and the implications for (reverse) logistics (storage, handling, transport etc.) can be taken into account. For example, this could entail the collection of clean waste (i.e. packaging) from retail outlets by the same vehicles used for product distribution.

Integration of logistics

As industrial activities extend globally, logistics will involve more material and information flows throughout a supply chain from sources to customers, which extends beyond national borders. In restructuring supply chains, logistics need to be managed as an integrated process that seeks tooptimise these flows. If all firms involved in a particular supply chain optimise their logistics systems independently of other firms in that chain, the management of flows across the whole chain is likely to be sub-optimal. Integrated logistics attempts to overcome this problem. This concept of integrated logistics extends functional management to include customers, suppliers and manufacturers. Companies can no longer afford to focus on supply-side efficiency alone, they need to use their business strategy to drive them towards integration of their demand and supply sides to build a platform for achieving a competitive advantage. This involves the complete set of activities and organisations relevant to production and distribution, as well as their connecting supply links. It suggests an underlying structure of activities operating within a process of material and product flow. Decisions made in each area impact others so that it becomes a single, interdependent system.

Outsourcing of logistics activities

The need for outsourcing - Efficient logistic activities are indispensable to effective business operations. Therefore, companies that perform these necessary functions exceptionally well are, in multiple ways, adding genuine value to the business operations.

Third party logistics (3PL) - Logistics activities are often outsourced by manufacturers to Third Party Logistics operators (3PL). These operators have greater expertise, which enables increased flexibility of logistic operations to cover wider geographical areas, with lower operating costs and better quality of service. The externalisation of logistical services has been a two dimensional process, with firms increasing both the range of services that they source externally and the volume of traffic entrusted to the third party. Companies have been increasingly demanding an integrated logistics service tailored to their requirements. The best third party providers understand the strategic importance of logistics management, and position themselves to provide more and better services that overcome their client's concerns about relinquishing control of their key competency.

Fourth party logistics (4PL) - Fourth Party Logistics (4PL), a new concept in logistics outsourcing, is emerging as a path to surpass one-time operating cost reductions and asset transfer of a traditional outsourcing arrangement. A 4PL provider is a supply chain integrator that assembles and manages the resources, capabilities, and technology of its own organisation with those of complementary service providers to deliver a comprehensive supply chain solution. Central to the 4PL's success is a "best of breed" approach, which is to integrate the client's supply chain activities and supporting technologies across alliances between the best third party service providers, technology providers and management consultants, thereby creating unique and comprehensive logistics solutions that cannot be achieved by any single provider. The development of 4PL's solutions leverage the capabilities of transport operators, technology service providers, and business process managers to deliver a comprehensive supply chain solution through a centralised point of contact.

5 LEAN Logistic modes

In view of the problems existing in our automotive logistics, in order to accelerate the development of automotive logistics industry and meet the requirements of logistics service well, the automotive industry has tobreak current mode and build a new comprehensive logistics mode as the development of time, realizing the manufacture and logistics mainly based on customers-oriented, which refers to build JIT co-delivery and Lean logistics mode based on E-business platform. (fig.4)

This mode is following the fashion of E-business development, automotive enterprises use advanced information technology to build E-business platform, realizing sharing information with third party Logistics Company, cooperation enterprises and clients, coordinate logistics operation. What's more, in order to increase the logistics operation rate and implement automotive lean manufacture, the enterprises need reduce the cost by carrying out JIT coordinate delivery and lean logistics, and realize logistics operation on time, by meeting the requirement of quality and quantity. To connect each step in logistics into a organic integrity and carry it on, which makes the whole logistics operation process become a value chain of non value added activity, and realize highly effective logistics operation [4].

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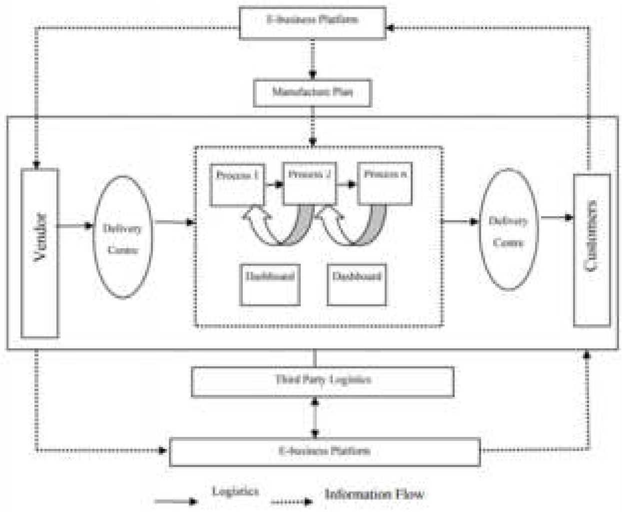

Figure 4: JIT co-delivery and Lean logistics mode based on E-business platform [4]

Through this operation mode, automotive enterprises, third party logistics company and clients can do the logistics information inquiry and communication by E-business platform, which realize follow-up service of logistics operation. And the enterprises carry out JIT manufacture and purchase by customer-oriented, realize zero inventory operation, remove non value added activity in logistics operation, which reduce logistics operation cost dramatically and improve logistics operation efficiency.

Conclusions

Adaptable and flexible logistics systems and networks have the highest absolute potential for innovation within logistics from the participants' point of view. In particular, cooperation across the value chain is regarded as crucial for the realization of improvement potentials. Virtual reality (such as for digital plant planning) and automated control (e.g. by agent systems, RFID etc.) are seen as the most important growth areas for innovations. The key barriers for virtual reality, however, include insufficient degree of detail and reusability of models.

According to logistics study of Roland Berger, [5] logistics is a dynamic market impacted by a number of key trends. Main trends and their impact on logistic with an appropriate measure of relevance is sumarized on the figure 5. The most importand trends that affect logistics is new technologies and outsorcing with cost pressure, and trend that affect at least is sustainability.

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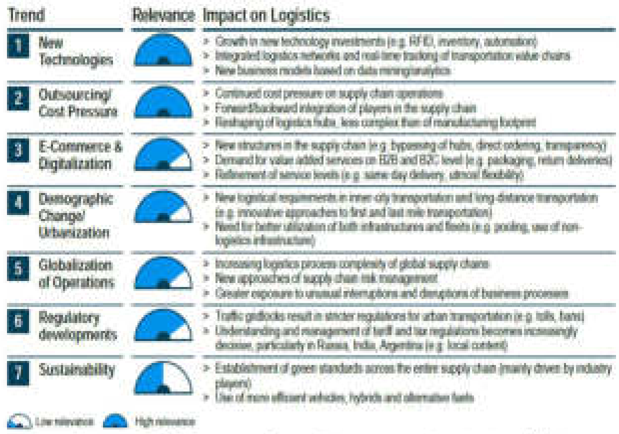

Figure 5: Megatrends and impact on logistics [8]

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PROPOSAL OF SPATIAL OPTIMIZATION OF PRODUCTION PROCESS IN PROCESS DESIGNER

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Abstract: This contribution is focused on optimizing the use of space in the production process using software Process Designer. The aim of this contribution is to suggest possible improvements to the existing layout of the selected production process. Production process was analysed in terms of inputs, outputs and course of actions. Nowadays there are many software solutions aimed at optimizing the use of space. One of these software products is the Process Designer, which belongs to the product line Tecnomatix. This software is primarily aimed at production planning. With Process Designer is possible to design the layout of production and subsequently to analyse the production or to change according to the current needs of the company.

1 Introduction

Optimisation efforts in all areas of production should be a priority for all production companies that want to be successful in the market.

Nowadays there are many software solutions aimed at optimizing the use of space. One of these software products is the Process Designer, which belongs to the product line Tecnomatix. This software is primarily aimed at production planning. With Process Designer is possible to design the layout of production and subsequently to analyse the production or to change according to the current needs of the company [1], [2].

2 Description of selected production process

The production process, which we will deal in this paper, is focused on the production of cable harness used in car´s cooler. It is the assembly production process.

In figure 1 is the current layout of the workplace and we will try to find solution for optimization. Individual objects contained in figure 1 are:

- yellow objects – work tables, on which are made specific assembly operations,
- red objects – containers with material, which wait for assembly, work in process and finished cable harness,
- black objects – personal that perform the assembly operations,
- blue objects – the raw material entering the production process,
- grey objects – finished cable harnesses waiting for optical inspection,
- orange objects – box containing cable harnesses that have any signs of damage, respectively poor quality, which didn´t meet the visual inspection,
- green objects – finished cable harnesses, that wait for transportation to the warehouse of finished products.

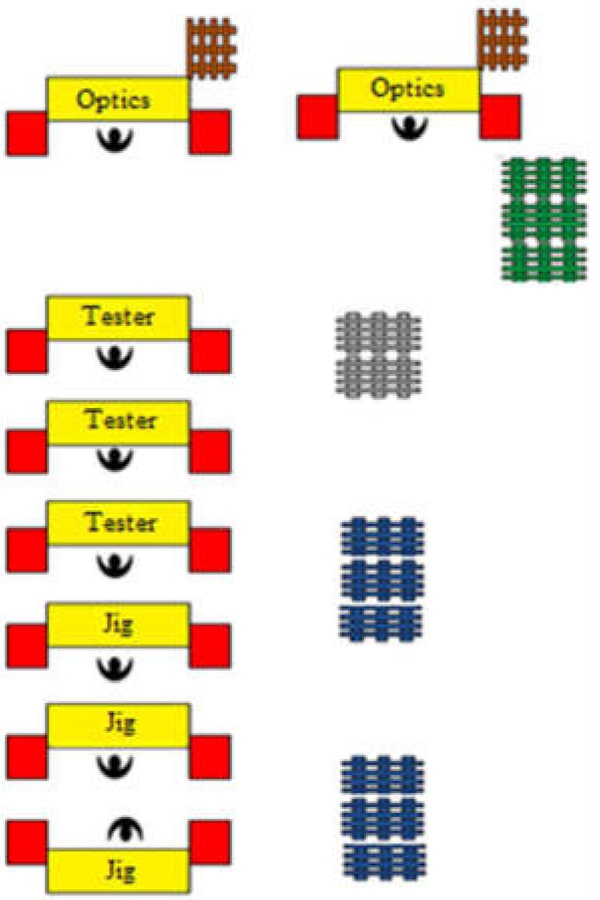

Figure 1 Current workplace arrangement

The output of the production process is the cable harness, which is used in the coolers of cars (see Fig. 2). On the figure 3 is the detail of the produced cable harness.

Figure 2 Usage of cable harness in the car

Figure 3 Produced cable harness

3 Production process procedure

The production process, with which optimization we will deal, consists of the following steps:

1. Assembly of red and black cable – this assembly operation is performed on the first three workplaces of the production process. Processing step starts by placing "house" into the jig. There are blinded holes on the jig for assembly green and brown cable to avoid errors. These assembly operations perform workers manually. Workers at the assembly must ensure the correct position of the red and black cable.
2. Assembly of green and brown cable – assembly of these cables is done at three workplaces. "House" already fitted with red and black cable is plugged into the module 1 on the control measure. Then worker manually install green and brown cable.
3. Assembly of insulation tube and control – this working step is carried out in the same workplaces as previous step. Worker moves the wiring harness on the control measure from module 1 to module 2. The control measure will automatically implement Push – back test, while worker manually mount insulation tube on the cable. Push – back test result is displayed on the control measure. Based on this result worker moves cable harness to another workplace, respectively devalued it by shortening the cables in case of negative results to avoid false harness cable from the production process.
4. Visual inspection – visual inspection is the last step of the production process. In this step, workers don´t use any jigs or production equipment. Workers visually assess if there are any errors through assembly and they try to avoid mechanical damages on "house". Control of the cables is very important. It assesses whether there has been any curvature, respectively whether the cables are in the correct chambers. Workers also visually evaluate the correct position of the cable seal. Seal on the cables can´t exceed house.

In table 1 are listed characteristics of the time duration of individual work steps as well as the number of pieces that can be made.

Table 1 Production characteristics in terms of time and number of pieces

Working step	Time for one piece [s]	Pcs/work shift
1. Assembly of red and black cable	12	2250
2. Assembly of green and brown cable 3. Assembly of insulation tube and control	22	1250
4. Visual inspection	7	4500
Sum	**41**	

For single shift it can´t be made more than 1250 pieces, because of the bottleneck in the step 2 and 3.

In determining of the production time of cable harness in this case we don´t take into account the buffer stores, while the residence time of work in progress in the buffer stores is always different and depends on the current situation of production in the company, i.e. work in progress after the second operation may be located in

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the buffer stores two days to gather a sufficient number of semi-finished products for visual inspection.

Considering the nature of this paper we will not further describe each step of workplace creating in Process Designer, but whole workplace with a layout of individual units can be seen in figure 4.

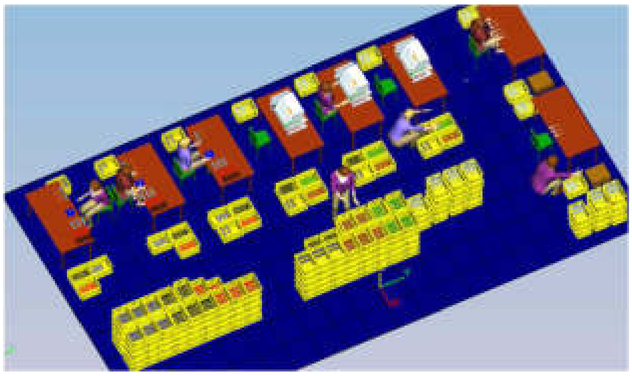

Figure 4 Workplace created in Process Designer

4 Deficiencies in the production process

Based on the implemented analysis we can identify some deficiencies in the spatial organization of the production process.

In table 1 it can be identified the bottleneck in the production process, which is represented by the second and third step that are realized at one workplace, i.e. control measure. Due to the larger number of operations, as well as the slowness of the process control, on the control measure it is not possible to produce more than 1250 pieces per working shift. After implementation of the first working step, where can produce 2250 units per working shift, is cable harnesses accumulated in the buffer stores. After the realization of the second step, the pieces are again temporarily stored in buffer stores in order to build up a sufficient quantity of units for visual inspection. Visual inspection allows for to test up to 4500 pieces of cable harnesses per working shift.

Considering the spatial characteristics of the room where is this production process performed, lot of buffer stores restricts the movement of workers, as well as container handling in the production process. Containers on the workplace are not colour coded, which leads to the formation of wasters. In this production process is frequent that the buffer stores with work in progress are in the workplace more days due to the transfer of staff to other production, because of the need to accumulate a sufficient amount of units for visual inspection.

Based on the conditions described in the production process can be therefore summarized as the following deficiencies:

- bottleneck in the production process causing the formation of large number of buffer stores,
- long persistence of work in progress in the buffer stores,
- limiting the workers mobility as a result of buffer stores,
- creating chaos in the workplace because of the wrong container location.

5 Proposal of optimization solution for spatial characteristics of the production process in Process Designer

In terms of spatial organization of the production process it seems to be an appropriate proposal to install a production line that would eliminate the bottleneck in production and thus prevent accumulation of work in progress in the buffer stores. Installation of this production line could also enable to increase the number of produced cable harnesses per working shift.

Structural line design was implemented in a software program Solid Works. It was made because of the need of saving production line in the format stp, which can then be converted using Autodesk Inventor software to JT. format needed to work in the Process Designer. Structural line design together with a description of the individual components is shown in figure 5.

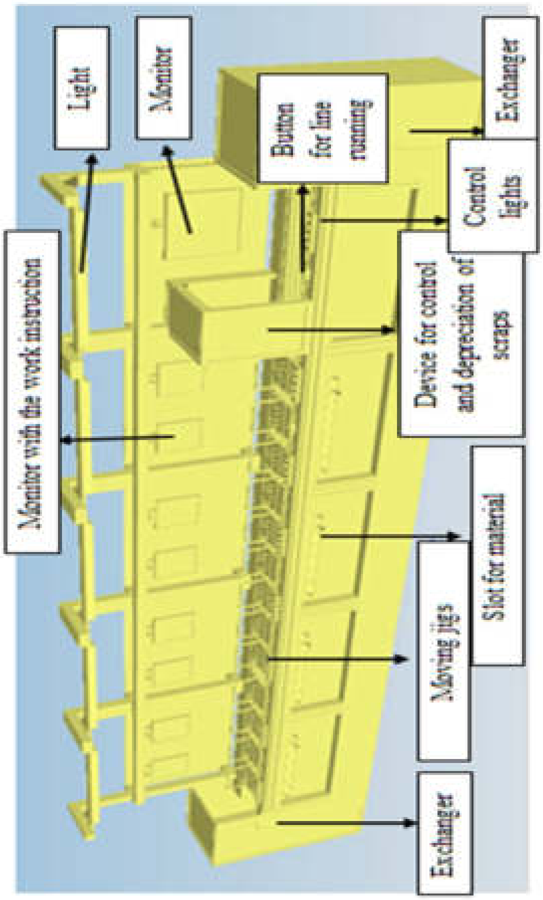

Figure 5 Proposed production line

The proposed production line consists of nine basic components:

1. Exchanger – there are two exchangers on the production line. One exchanger is located at the beginning of the line, second is at the end of the line. In the exchanger there is a change of the position of moving products. Jigs located at the top of the line after the withdrawal of cable harnesses by workers fall down in the exchanger. With the bottom of the line, which is not visible, the jigs will return to the exchanger at the beginning of the line, where they get back up for the next assembly.
2. Jigs – they serve to attach "house" and the gradual installation of cables. At one moving jig it is possible to assembly four cable harnesses. The speed of jig movement from station to station is indicated by worker using the button for line running.
3. Slot – it is used to store material that represents "houses", cables and tubing. Worker selects material from the container and put it in the slot. Consequently, when assembling, select the necessary material from the slot and assembles it on incoming semi-finished product.
4. Monitor with the work instruction – on these monitors is correct assembly scheme. Each workstation requires two monitors, considering the sequence of operations carried out. These monitors are necessary, because workers on the line can´t use jigs with blind holes and thus may occur more frequently mistakes.
5. Monitor – at the end of the production line is monitor that provides information to workers about the current state of standards achievement. On the monitor there are four lines that provide information about:
    - standards that must be achieved per working shift in terms of number of pieces,
    - number of pieces produced until now,
    - number of pieces produced until now as a percentage,
    - number of scraps.
6. Control lights – these lights are located on each of five stations. Each station has four lights, corresponding to the number of cable harnesses contained in one jig.
7. Device for control and depreciation of scraps – this device is the part of the last station of the production line, which is focused on control. In this device, there is a push – back test and test realized by compressed air. Based on the outcome of the control, cable harness either forwards where the worker released it from the lines for visual inspection, or discarded it automatically with cutting the cables.
8. Button for line running – this button provides the moving of the line.
9. Light – it is used to improve the visibility of workers at assembly.

As can be seen in figure 6, proposed production line consists of five stations. In each station is carried out some assembly operation.

In table 2 is sequence of operations as well as their duration.

Table 2 Sequence of operations and the proposed duration of the production line

	Operation name	Duration [s]
Station 1	Fixing „house" in the jig	2
Station 2	Assembly of red cable	2
	Assembly of black cable	2
Station 3	Assembly of green cable	2
	Assembly of brown cable	2
Station 4	Assembly of insulation tube	2
Station 5	Control	2
Sum		14

Control in Station 5 is realized through Push-back test and test realized by compressed air. This inspection is aimed at detecting lightness of cable harness, because cable harness must be water-resistant. The principle lies in the compressing of air into the cable harness and then the sensor records and evaluates air leakage from the cable harness.

From the production line cable harness proceeds for visual inspection, where are detected various mechanical damage. Visual inspection of one cable harness takes 7 seconds. Total production time of one cable harness for the proposed production line is therefore 21 seconds.

The part of the new workplace organization is the use of different coloured boxes. In the original organization of the production process were used boxes of the same colour.

Each material as well as work in progress contained in boxes, had designated place in the space reserved for the realization of the production process, but often occurred errors in the placement of boxes by workers. Subsequently, there was a chaos in material, respectively work in progress searching.

Using different coloured boxes will increase transparency and therefore the efficiency of the production process.

In Fig. 6 we can see the final proposal of production process layout with production line in Process Designer.

Figure 6 Proposal of production process layout with production line in Process Designer

Proposed production line provides the following benefits:

1. removal of buffer stores,
2. reduction of staff,
3. increase the number of produced pieces.

Conclusion

Optimization of spatial organization of production is verz important and will ultimately lead to the increase of production efficiency. This optimization can influence material flows, mobility of workers, as well as vehicles and other units of production, production time characteristics, workplace safety and many others.

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