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Augmented reality, manufacturing systems, tracking, data collection

Ján BAJANA*, Martin KRAJČOVIČ**, Kinga BYRSKA***

AUGMENTED REALITY AND TRACKING SYSTEMS FOR PRESENTING INFORMATION IN AN INDUSTRIAL FACTORY

Abstract

We introduce and describe one of the most advance tracking technologies for augmented reality application. Presented tracking technology will be used for create own augmented reality applications focused on information systems in industrial environment. Very important part of interest is how to collect data. For it we can use online database and real time data from production lines.

1. INTRODUCTION AND STATE OF ART

Modern solutions for present information via AR can be provided by means of 3D digital models, short videos, images and information in the form of text, maps, drawings, which will give us better opportunities to present our intentions. If we want to give people new and real ideas, we must help them see information in a real environment. There is very important how to take and track this information.

The challenge of this paper is describe the most suitable tracking technology which we use to create own software solution for presentation information using AR. It is important to understand in which area of interest our system will work. It can be internal environment of buildings, industrial halls, local large areas or we want to focus on a geographically large area. Each of the presented technology has different characteristics and different area of use.

In our solution we want to focus on information systems presented via AR. Very important part of interest is how to collect data. For it we can use online database. Our implementation will focused and work in industrial environment. For collect information in real time we want to use OPC implementation, similar system for OPC communication has been present [1].

Over the past years, many positioning and tracking systems have been proposed. Depending on the features and methods we can divide these systems into the two categories. In the first category there are optical tracking systems based on image recognition with camera systems [2]. We can recognize object like doors, buildings, markers and then compute client position. In the second category there are navigation systems as the Global Positioning System (GPS), gyroscope and accelerometer [3].

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2. OPTICAL TRACKING SYSTEM

2.2. Marker-less Systems

Object recognition and tracking using a visual marker is not a new concept in Augmented Reality. Visual markers have been widely used in existing AR applications many times in last years. In most of these applications, the performance of an AR system depends highly on the tracking method for visual marker detection. A standard visual marker represents a two-dimensional image border consisting from information inside for unique identification. But the use of these visual markers limits the interactivity and is constrained to a range of objects encapsulated within a border to create the marker. We present another technology: marker-less systems where any part of the real environment may be used as a target that can be tracked in order to place virtual objects.

In marker-less systems comes augmented reality tracking of known objects based on natural features without kept any artificial markers, not only allowing to use real objects as a target instead of these old and ugly markers, but also overcome some of their limitations. However, among the disadvantages we can consider for marker-less augmented reality systems is that tracking and registration techniques become more complex [2].

2.3. Vuforia system

Vuforia is the software platform that enables the best and most creative branded augmented reality experiences across the most real world environments, giving mobile apps the power.

A Vuforia AR application uses the display of the mobile device as a "magic lens" or looking glass into an augmented world where the real and virtual worlds appear to coexist. You can see example in “Fig.1.” where we developed own sample application base on the Vuforia extensions for Unity3D engine. The application renders the live camera preview image on the display to represent a view of the physical world. Virtual 3D objects are then superimposed on the live camera preview and they appear to be tightly coupled in the real world.

Fig.1. Example of Markerless AR application using Vuforia libraries.

3. NAVIGATION SYSTEMS

3.1. GPS Tracking

The Global Positioning System (GPS) is a space-based satellite system that can provide location information anywhere where there is an unobstructed line of sight to more than three satellites. While GPS system is widely used to aid navigation, however, many applications

demand more accurate locations and more detailed sensor information for better environment-interaction capabilities. The GPS technology doesn't have sufficient precision for augmented reality applications because we can't compute exact position. For more stable and robust solutions we need to use combination of more tracking systems like gyroscope, accelerometer or optical tracking approach. Similar system has been presented in [3].

3.2. Gyroscope and Accelerometer

A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. Unlike an accelerometer, which measures the linear acceleration of the device, a gyroscope measures the orientation directly. The gyroscope inside a mobile device is a MEMS based gyroscope.

An accelerometer is a sensor that measures acceleration relative to a free-falling frame of reference. Mobile devices use 3-axis MEMS based accelerometers.

Many augmented reality applications use gyroscope or accelerometer in combination with other tracking systems. Junaio present augmented reality browser for camera equipped smartphones or other mobile devices presenting users with interactive web-based information and experiences wherever they are.

4. INFORMATION SYSTEMS

During the presentation through augmented reality we can see information of different nature for example meteorological data, cultural monuments, multifunctional building and shopping centrum or industrial factory. In our solution we want to focus on industrial environment and manufacturing. Depending on user device we must make a decision about suitable tracking system. But there is also another question. How can we provide the right information at the right time and show the correct results about manufacturing system in field of view? The solution is load static data from databases and real-time information about manufacturing system load data using the industry standard for floor connectivity OPC.

The OPC UA Specification defines a binary TCP based protocol which provides fast performance with minimal overhead. For the enterprise environments SOAP/XML is normally the preferred communication protocol. OPC UA offers the ability to pre-encode message which improves performance by as much as ten times when compared to the same massage sent using XML [1].

5. DISCUSION

We have seen a several positive and negative aspect in compare to all tracking technologies. In this section we summarize our experiences of working with the most interested tracking systems for our work focused on AR. Our idea is make information system which use AR for visual presentation of information in an industrial environment.

There we must solve two main problems: How to exact track data for AR and how to provide exact information about object in field of view and save them. In AR application we need very stable tracking system for the best visual effect. It is important to understand in which area our system will work. It can be internal environment of buildings, industrial halls, local large areas or we want to focus on a geographically large area. Each of the presented technology has different characteristics and different area of use. It is also important if we use mobile device or static device placed on the ground as kiosk.

The main asset of traditional marker system is based on two-dimensional black image border consisting from the information inside. Utilization of these markers is limited. The use of these visual markers limits the interactivity and it is constrained to a range of objects encapsulated within a border to create the marker. More useful technology is marker-less system. Based on this system any part of the real environment can be used as a target for recognition and tracking. In marker-less system comes about augmented reality tracking known objects based on natural features without kept any artificial markers. This system is universal and successful as in the internal as well as external environment where we can recognize different types of objects form different distances.

We describe the navigation systems. The GPS is very useful mainly if we want to make AR application for global geographical large areas. With the GPS information, the system can selects the nearest cluster and then loads the corresponding database about environment where we are. We need compute position of client device and position of virtual objects around us. For it is better to use combination of more technologies like camera recognition, gyroscope or accelerometer.

6. CONCLUSION

In this paper we describe modern tracking systems that can be used for AR applications. We focus on information systems and how to present information to end client using AR technology in an industrial environment. We explain more tracking technologies useful in all areas of use like buildings or external areas usable for geographical large areas. We present marker and marker-less detection techniques, technologies based on GPS, gyroscope and accelerometer. The challenge is used some presented tracking technology to create own software solution for presentation information using augmented reality. Information will be collected from the database and production lines in real time for we use OPC AU. We can focus on static devices like kiosk placed on the ground or mobile devices where we need more sophisticate tracking technology than in the first case because device is still in dynamic move and we need compute exact position in real-time. In this way we can use image detection techniques.

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Lean manufacturing, preventive maintenance, TPM, 5S

Monika BANACH*

HUMAN MENTALITY – (UN)NECESSARY TPM?

Abstract

Present-day economy put pressure on the modern enterprises to quick react to competitors in the game called "be or not be" in the competitive market. Because of this competition, enterprises implement improving methodologies, among other things: TPM (Total Preventive Maintenance) reducing wastes. The aims of the TPM are zero accidents, zero defects and zero failures.

1. TPM PHILOSOPHY

"TPM is the abbreviation of Total Productive Maintenance. It is a comprehensive strategy that supports the purpose of equipment improvement to maximize its efficiency and product quality" [1].

This tool belongs to management philosophy which eliminate wastes. Waste means all activities, investments and processes which do not add values to manufactured product or service from customer point of view. It does not mean to fire employees. TPM increase work efficiency to rival in present economy.

Preventive activities have been used for fifties of XIX century.

TPM is based on 7 pillars and methodology 5S. 5S is the methodology of creation and maintain well organized, clean, highly efficient and high quality work station [2]. 5S tool has 5 steps: 1S (sort), 2S (simplify), 3S (Shine), 4S (Standardize), 5S (Self-Discipline).

There are 7 pillars [3]:

1) Health and safety
2) Education and training
3) Autonomous maintenance
4) Planned maintenance
5) Quality maintenance
6) Focus improvement
7) Support systems

There are defined 6 main wastes in enterprises. These wastes are called 6 huge wastes [4]:

1) Breakdowns – failed devices cause stopped production, it needs to be quickly repaired
2) Changeovers and setup – changeovers, adjustments
3) Idling and minor stoppages – blockades, lack of materials, problems with sensors
4) Reduced speed – unknown optimal speed, machine's limits

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5) Quality defects and rework
6) Stirtup (yield) loss – preparation to start-up of production

2. TPM IMPLEMENTATION

Implementation of TPM tool is carried out immediately in whole plant. It is implemented step by step on some machines, some group of machines. Due to customer orders it should be fully used machine performance. Therefore, we should first carefully analyze the production process and indicate where the loss arises the most.

On the basis of quality, technology and the availability of the machine should be indicated a group of machines, where the TPM will be implemented. Implementation of TPM should be started for critical machines in the process.

Implementation of TPM starts with 5S workshops and then TPM workshops. The participants of workshop are representatives of different departments and different levels in order to best identify anomalies and together find the best solutions.

The workshop is divided into two parts: theoretical and practical. At the beginning there described 5 steps of 5S methodology and then it is implemented on indicated machine. All things (necessary and unnecessary) are collected in some prepared big box. During cleaning machines everyone pays attention to faults on the machine. All faults are indicated by yellow card, but especially dangerous (connected to health and safety) are indicated by red cards.

After 5S workshop we know the status of machine. The number of yellow and red cards say information about anomalies and faults on this machine. These subjects are written into action plan. The lecture of TPM mainly is focused on changing the approach to TPM philosophy of team members. The base to achieve success from TPM implementation is convince the senior stuff that it is needed to change and get their full support during implementation of new manage tools, and lower stuff that TPM is not punishment and brings results.

Next step is to create causes of anomalies analyzes. The cause and effects diagram (Ishikawa diagram) which helps to find sources of faults. We start the analysis from defining result (e.g. breakdown, defect). Next, this analysis identifies all possible reasons, which it caused: manpower, methods, machinery, materials and management. These causes are called 5M.

The main point of TPM workshop is to collect as many data as it is possible such as breakdowns, indicators (MTTR, MTBF, OEE, OCE), TPM 1st and 2nd level, etc. These data allows to make good analysis and identify what should be done to reduce breakdowns and improve indicators. The situation analysis of before and after TPM implementation is showed in following part of article.

After analysis the TPM team verify points of autonomous maintenance (AM) and preventive maintenance (PM). It is necessary to update AM and PM to achieve TPM aims by machine documentation and acquired knowledge.

It is created action plan and write down people responsible for each point. The important point is to collect data and their analysis to take appropriate decisions, when the process will be deviated.

3. OBTAINED BENEFITS

The benefits are counted by compared present situation on the machine to that met during workshop (counted number and length of breakdowns, number of defects, etc.). We can easly count savings by monitoring indicators.

If number of breakdowns or defects are reduced, we have savings otherwise wastes. The method of calculating the savings is to calculate the profit by reducing losses.

Example of effect of TPM implementation on one machine is illustrated on Fig.1., where achieved savings are 1455,90 PLN after 15 weeks. Taking -292,50 PLN of losses the total savings are 1163,40 PLN. This value can be seemed low, but when we implement TPM on another similar machines (in accordance to schedule), we can receive high savings.

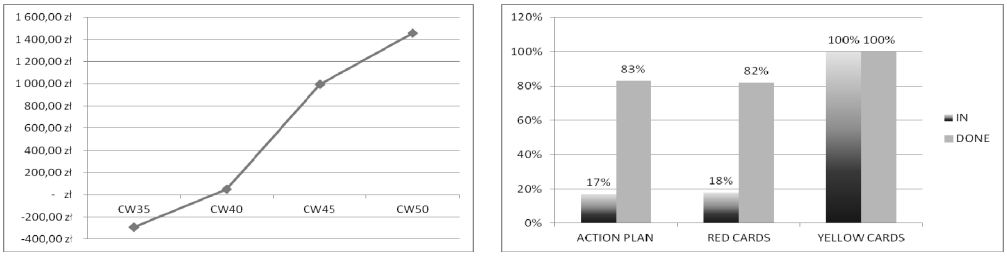

Fig.1. Effects of TPM implementation after 15 weeks

The main aspect is to get savings from TPM methodology. At the beginning it can be hardly noticeable, because we should invest in improvements that would later bring us profits.

We define when anomalies from yellow cards will be made, while these from red once should be realized as soon as possible. As we can see, activities from yellow cards were done in 82%. The remaining 18% are long term activities, which will be implemented step by step. Realization of action plan is only 83%, due to long term activities.

The Fig.2. shows the structure of typical losses occurring on the machine. As we can see 84,6% of lost time is awaiting. Awaiting is defined as awaiting for material, operator or to start production. This point was reduced to 71.3%.

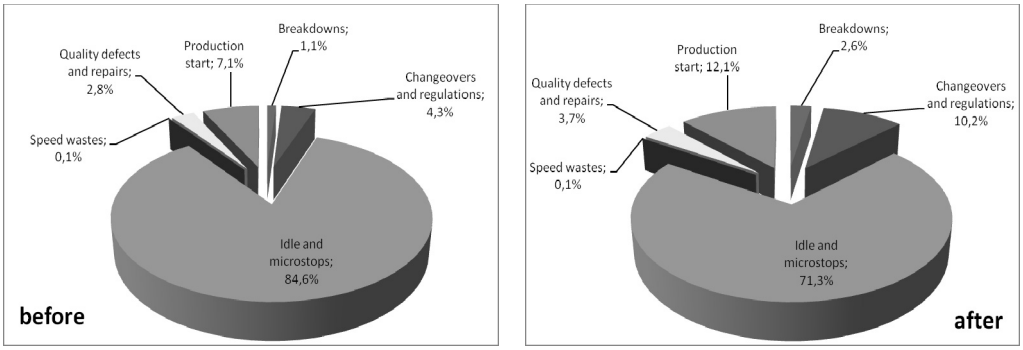

Fig.2. Losses before and after TPM implementation

The second problem are activities connected with preparation of production and operator breaks. Each employee must have break and nobody can replace them. Therefore, it is necessary to focus on preparation time by for example SMED implementation (methodology of changeover time reduction and preparation for production).

4. SUMMARY

The Fig.3. shows the most important changes which occurred during TPM implementation on analyzed machine. The production was only 49,2% of time before TPM workshop. The efficiency of the machined increased by 7% by the implemented activities.

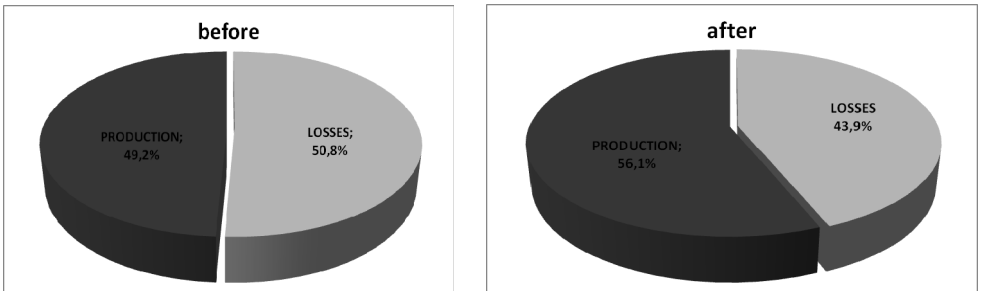

Fig.3. Production vs. losses before and after TPM workshop

The implementation of TPM philosophy does not mean one-time change, but the start of continuous activities progressively increase efficiency of machine. These are long term, costly activities bringing effectiveness.

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APPLICATION OF ERGONOMIC PREVENTION PROGRAMS

Abstract

On the basis of practical experience, it is possible to point out the fact that the solution to the issues in the field of ergonomics, humanizing the work helps to optimize the working conditions, thereby contributing to the growth of productivity and quality of work. Addressing the issues is based on the comprehensive studies of specialized scientific disciplines. With the use of ergonomic knowledge is impossible to ensure the effectiveness of the various elements of the work process.

1. PROBLEMS IN THE CURRENT ERGONOMICS

The working conditions of people working in companies are adjusted only in exceptional cases. Currently, against improving workplace conditions prevent employees themselves. This is due to their fear of taking of extra fee for hazardous work and for fear of losing their job. From a practical perspective we considered ergonomics as the science that seeks to ensure human comfort while benefits for the enterprise. By increasing the efficiency of the human labor is increasing the competitiveness of enterprises and they can easily adapt to the conditions of supply and demand in the market. Slovakia will be able to achieve long-term economic stability and competitiveness, by the use of ergonomic approaches in the prevention of work-related diseases. The basic role of ergonomics should therefore be to create appropriate ergonomic prevention programs, which will be based on the scientific approach to solve problems in the workplace.

1.1. Ergonomic prevention programs in the context of legislation in Slovakia

If companies want to implement measures that are formulated in the Law no. 124/2006 Z.z. Safety and health at work and on amendments to certain laws, ergonomic prevention programs are the first step. Very important is the regular risk assessment, risk announcement and risk management.

Insights on issues related to humans and the work carried out can be different. On the one hand, companies seek to increase productivity at the expense of the health of workers. On the other hand, experts and health services put the emphasis on the safety and health of employees. If there is more emphasis on economic aspects and not health, this leads to increasing pressure

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on the health sector and increase in the cost of insurance. On the other hand, if greater emphasis on health aspects is put more pressure on the Ministry of Labour and Social Affairs. Most prosperous enterprises in developed countries has reached its successes thanks to the introduction of the ergonomic prevention programs. Their application should be to achieve a synthesis between issues relating to the health of workers and economic issues. The best way is to make ergonomics as the part of the ergonomics programs that are focused on health and safety at work. By applying ergonomic programs increases the safety and quality of the work, which is one of the characters of a thriving business.

The basic conditions to ensure the safety and health at work are laid down in the laws and regulations governing safety and health at work (www.employment.gov.sk).

Of great importance are the Slovak versions of European standards, which are marking STN EN 1005-1 to 4-5, 1005 STN EN A1, which deal with the machine safety and human physical performance.

1.2. Occupational diseases and statistics

Important indicator of the level of working conditions is the incidence of occupational diseases and other injuries to health caused by work being carried out. Disease from long-term excessive unilateral exposure include not only in Slovakia but also abroad, the most commonly reported occupational diseases. National Health Information Center has published a statistical publication titled Occupational diseases or threats from occupational diseases in 2012. The publication is recorded the development of occupational diseases from the year 2001 to the year 2012. Overall, there were in the year 2012 reported 344 cases of occupational diseases and professional poisonings (141 women and 203 men), compared to 2011 a decrease of 29 cases, a decrease of 9%. This decrease, however, in my personal opinion it is influenced by many factors such as the decrease in employment in some sectors, the increase in the number of business, employees have often fear of loss of employment, but also the ignorance of employees about occupational diseases.

Tab. 1. Percentage of occupational diseases in the years 2008-2012 (Statistical publication: Occupational diseases or threats from occupational diseases in 2012)

The proportion of the total number of occupational diseases					
	2008	**2009**	**2010**	**2011**	**2012**
1. Industrial production	32,5 %	50,9 %	52,6 %	48,7 %	51,2 %
2. Mining	41,9 %	21,3 %	19,3 %	14,7 %	16,3 %
3. Agriculture and forestry	13,6 %	12,2 %	12,6 %	10,7 %	12,5 %
4. Healthcare	3,6 %	6,1 %	6,2 %	10,1 %	6,1 %
5. Construction industry	2,4 %	2,9 %	2,3 %	4,8 %	5,5 %

The most common occupational disease in 2012 was a disease of bones, joints, tendons and nerves of the extremities of the long-term excessive unilateral exposure, a total of 168 cases, representing 48.8% of the total number of reported occupational diseases. The highest incidence of occupational diseases and the risk of an occupational disease in the total number of 64 has been reported in workers in metallurgy and engineering. It was also reported 54 cases of occupational disease, most commonly been reported in Zilina (22) and Kosice (18) region.

1.3 Application of ergonomic preventive programs

Injuries and diseases of the musculoskeletal system (MSDs) are currently not only in Slovakia, but globally serious problem. Currently the diseases of the musculoskeletal system are among the most commonly diagnosed diseases and their prevalence can be in all sectors of employment (European Foundation for the Improvement of Living and Working Conditions, 2005). These diseases can be classified as a long-term and their treatment and subsequent compensation are expensive.

The emergence of MSDs has results in addition to health impacts also reduce employee work performance, overall productivity and quality of products and services. reintegration into the workforce. Therefore, the purpose of ergonomic prevention program is the prevention of these diseases and injuries. By the early identification of symptoms of diseases of the musculoskeletal system for employees in the company, we can assist in improving the effectiveness of prevention of diseases which are associated with the work, improving work efficiency and quality of life. Diseases of the musculoskeletal system (MSDS) can call in Slovakia as well as long-term excessive unilateral exposure and they have affect bones, joints, tendons, muscles, nerves and blood vessels. They can create in the various work activities that are associated with long-term excessive unilateral overload limbs with insufficient time to rest and regenerate areas that are stressed.

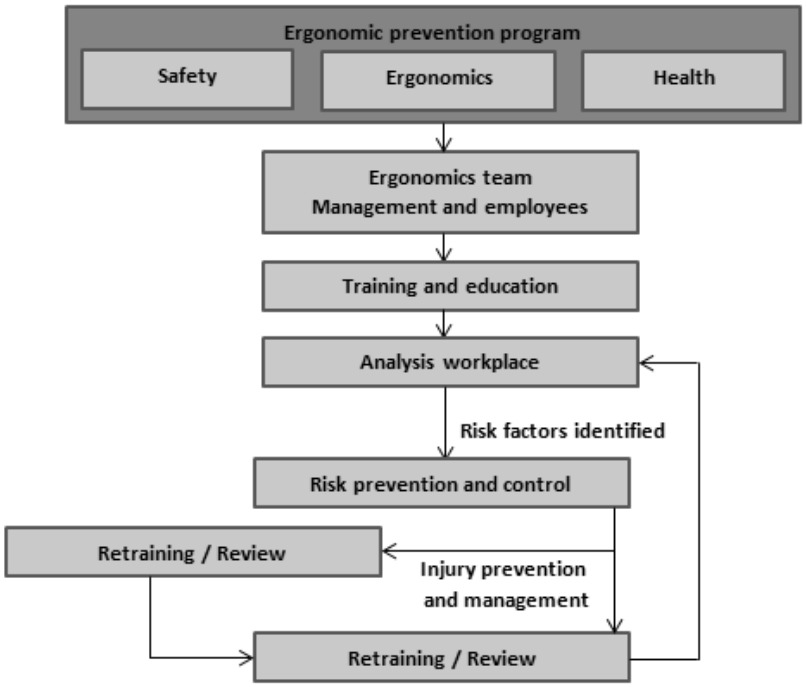

Fig. 1. Elements of ergonomic prevention program

In order to be ergonomic prevention program successful, it should be formed by the following elements:

1. Analysis workplace - identification of jobs and workstations that may contain hazards causing MSDs, identification of risk factors that representing a danger and causes of risk factors.
2. Risk prevention and control - removal or minimize hazards defined during the analysis work through change jobs, workstations, tools or modifying environmental factors so as to be adapted to the employee.
3. Medical care (medical reports) - efficient use of available medical devices in order to prevent work-related MSDs, or try to manage them.
4. Training and education - the method by which employees and managers can understand the potential risk of injury, its cause, symptoms, prevention and treatment.

2. CONCLUSION

By means of preventive ergonomic programs can be at specified intervals to review the consequences of the implemented solutions to improve the health of employees and so achieve the benefits of costs incurred. Until it has been improving the health of employees as well as economic benefits for the enterprise to carry out further analysis and based on them more ergonomic solutions.

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Ergonomic aspects, Workplaces design, Modular production system

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ERGONOMIC ASPECTS OF THE DESIGN OF PRODUCTION SYSTEMS

Abstract

Workplaces design with regard to the use of ergonomic principles is currently very important. In addition to efforts to adapt the shapes of objects so that their faces were best fitted to the shape of the human body, it is also necessary to study the cumulative impact of risk factors and proposes measures that would reduce the physical, psychological and mental burden on the human body. This article describes the best practices to improve the shortcomings that often appear in the workplace with respect to current legislation.

1. WORKPLACES DESIGN WITH THE APPLICATION OF ERGONOMIC PRINCIPLES

Workplace and the worker himself represents a separate part of the production design department. It deals mainly ergonomics, occupational safety and other requirements imposed on the proposed production system. When designing it is necessary to pay attention to itself workspace worker especially when designing assemblies or dismantling workplaces. When designing it is necessary to be based on the following characteristics:

- anthropometric and physiological characteristics of the worker,
- analysis of the different movements in the implementation of the activities (movements of the hands, the frequency, etc.).

Production systems with respect to ergonomic principles can bring increased productivity, shorten production time and especially reduce or eliminate negative impacts on the health of workers. Properly designed workstation is a major factor in ensuring operational efficiency and quality in production. Musculoskeletal system of worker is during performed the work of strenuous. Unilateral load of musculoskeletal system or inappropriate position may cause serious health problems and, ultimately, even the negative impacts for the company. Therefore, it is important to address when designing workplace the area of ergonomics also.

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1.1. Ergonomic workstations

Ergonomic workstations allow you to achieve maximum performance and productivity of workers, their safety and your motivation. Designing ergonomically appropriate workplace is based on fundamental principles that try to adapt the workplace for each employee and for each work task. Through the ergonomic workstations can facilitate the work and to preserve the health of the workers, through increased motivation and satisfaction. It also ensures better performance, increase efficiency and quality, and reduce the risk of disease.

Fig. 1 Ergonomic workstation

1.2. Taking account of the anthropometric data

The height of the desktop in the workplace should comply with the physical dimensions of the different workers. Modular workstations allow variable height adjustment of the desktop, which takes into account 95% dimensions of adult men and women. When selecting the working table height is necessary to take a few points:

- the worker must have sufficient space for movement,
- the height of the table depends on the posture of the worker,
- the different position of the worker in the sitting position depend on the activities of the employee:
  - bending forward (assembly with effort, when the hull of worker is tilted slightly forward)
  - upright position (control activities, the assembly of smaller pieces of components),
  - backward bend (monitoring activities when the hull is bent slightly to the rear of the worker).

The height of the table can be determined as the optimum working height minus the height of the object to processing or loading height. Similarly, when designing rack systems. When you place a component in the containers, it is therefore necessary to take into account their height, weight and the type of activity (Fig. 2).

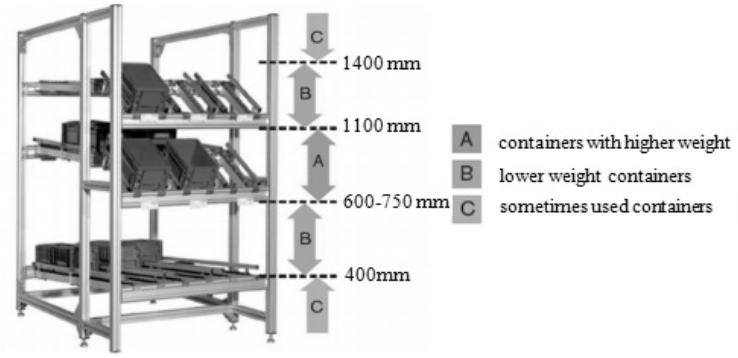

Fig. 2 Rack system

When designing ergonomic workstations for the assembly or dismantling it is important to take into account some basic rules, which I present below:

- appropriately to define working conditions work standing up/sitting position, in order to avoid an increase in stressful situations.
- the worker should not perform work above the level of the heart. As a result there may be a reduction in blood flow and, consequently, a reduction in the performance of the worker.
- to limit the implementation of static work, which causes a reduction in blood supply to the muscles and this leads to decreased coordination and thus the quality of work.

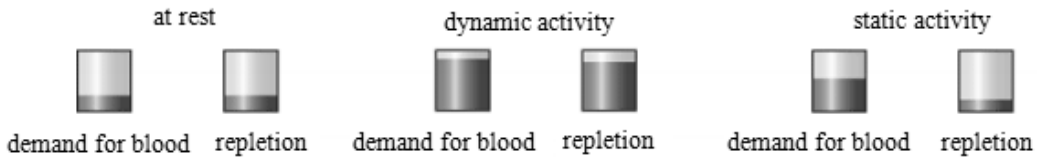

Fig.3. The effect of static and dynamic activity of the worker

1.3 Setting the modular production system for manual work

The correct setting of modular production system for manual work leads to a reduction in stress, downtime and at the same time leads to increased efficiency and productivity. Therefore, in order to facilitate this, it is necessary to modify the table, chairs, containers, availability of tools, materials and equipment to suit the needs of a particular employee and requirements of the work, which is carried out. These components should form the harmonized system. Ergonomic positioning and prevention of mental and physical fatigue can be achieved through (Fig. 4):

- setup chairs and platforms so that your thighs and calves formed a right angle,
- ensure the correct height and distance for the components and tools,
- use of the mobile carts for the material in hand, of the eventual adjustment the inclination of the plane for easier grip,
- use containers which can be positioned for easier access of heavy components.

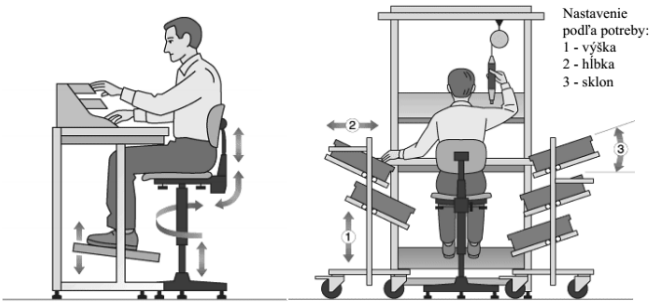

Fig. 4 The application of ergonomic principles for manual work

2. CONCLUSION

Production systems with respect to ergonomic principles can result in an increase in productivity, shorten production time and especially reduce or eliminate negative impacts on the health of workers. Properly designed workstation is a main factor in ensuring operational efficiency and quality in production.

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ergonomics, ISO standards, work systems improvement

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STANDARDS IMPORTANCE IN THE ERGONOMIC DEVELOPMENT OF WORKPLACES

Abstract

Nowadays machine design is very complicated. Creators of machines have many demands that must be met, so often ergonomic requirements are not very important for them. Every company should create a base set of requirements associated with their machines. The paper collects the data resulting from the requirements of a few selected norms: PN-EN ISO 6385:2005; PN-EN ISO 26800:2011; PN-EN 13861:2012; PN-EN 1005-4 A1:2009. The analysis was performed for thermoforming machines.

1. INTRODUCTION

During searching the standards available on the website of the Polish Committee for Standardization use ICS code - this is the number of international standards for classifying groups. International Classification of Standards (ICS) developed by the International Organization for Standardization (ISO) is the basis for the development of international, European and national catalogs of standards and other standardization documents, as well as the basis for subscriptions standards. It is also used to classify standards and standardization documents in databases and libraries. ICS is a three-level hierarchical classification. Level 1 consists of 40 fields of standardization activities, such as, for example road vehicles, agriculture, metallurgy. Each area is marked with a double-digit differentiator. Areas are divided into 392 groups of lower level (level 2). Marking the group consists of the discriminant field and three-digit discriminant groups, separated by a dot. 144 of 392 groups is divided into subgroups lower 909 (level 3). Determination of subgroups of this level is composed of a group and the two-digit number separated by a dot. Standards relating to general issues are identified subgroup number 01, while the standard theme that does not fit into any of the sub- 99. If the content of the standard is not clear field of application, indexing can take into account the topics relevant technical committee, subcommittee or working group responsible for drafting the standard. Among other things, you can find classifiers: 01.040.13 Environment.Health care. Safety (Vocabularies) 01.040.25 Industry (Vocabularies) 01.040.83 Rubber and plastics (vocabulary), 13 environment. Health care. Security; 13.100 Safety in the workplace. Industrial hygiene, clothing and protective equipment, 13.340; lighting of workstations, 91.160.10; 13.110 Safety of

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machinery (This group includes standards for general use) ;Ergonomics 13.180 , 83.080 Plastics; 83.080.01 Plastics. General; 83.080.10 Thermosets including hard rubber, silicones, see 71.100.55 , 83.080.20 Thermoplastics ; 83140 Rubber and plastics; 83.140.01 Rubber and plastics. General; 83.140.99 Other rubber and plastics.[4][5]

During designing the machine have to be considered the requirements of many norms. With ergonomics especially important for thermoforming machines are: PN-EN 1005-1+A1:2010P, PN-EN 1005-3+A1:2009E, PN-EN 13921:2007E, PN-EN 547-1+A1:2010P, PN-EN 547-2+A1:2010P, PN-EN ISO 10551:2002E, PN-EN ISO 20685:2010E, PN-EN ISO 7731:2009E, PN-EN ISO 9241-110:2006E, PN-EN ISO 9241-304:2009E, PN-EN ISO 9241-910:2011E, PN-EN ISO 9921:2005E, PN-EN ISO 7726:2002E, PN-Z-08052:1980P, PN-EN 12464-1:2012P, PN-EN 27243:2005P, PN-EN 60447:2005E, PN-EN 614-1+A1:2009E, PN-EN 894-1+A1:2010P, PN-EN 894-2+A1:2010P.[4][5]

2. EXAMPLES OF THE STANDARDS REQUIREMENTS

2.1. PN-EN ISO 6385:2005 Ergonomic principles in the design of work systems requirements

The load of an employee or stress at work does not have a negative overtone. The standard provides during workstation design takes into account the stages: formulation of objectives of the system, determine the possibility of spatial localization and functions to be performed, sequence and subsequences analysis of their work, the concept of work process, detailed design, implementation, workstation deployment validation and evaluation.[1] At each stage must be evaluated proposes solutions. This action aims is not to create restrictions but made creative solutions to ergonomic issues. The standard emphasizes that project should take into account conditions such as maintenance and repair of equipment. The system should have organization characteristics and should be intended for appropriate employee work tasks. Tasks must be clear to the operators. It is advisable that workers are not forced to work on the machine speed. During process planning must be defined the experience and qualifications that are required from operators. Tasks should be defined to perform only the operations required by the process and avoid activities that do not add value to the product.[1]

The project however includes a proposal of work, working environment, workplace equipment, computer hardware and software, if is applicable. During the concept, you can specify how workers' skills will be developed which exercises are most appropriate for them. Standard emphasizes training as a way to improve relations between man and a technical means. Norm reiterated that guard against both overload and underload in employee work in necessary. If it is not possible to make improvements in machine construction to improve the quality of work must be introduced extra breaks, organizational changes such as job rotation or job enrichment content. Standard drew attention to the used tools and work items. Items frequently used should be closest to or in sight. Norm require that visual and audible signals should minimize the risk of errors and faulty workmanship. The standard states should determine the stress with which are affected person in the work process.[1] The norm emphasizes that the ergonomic assessment should be carried out taking into account at least three types of criteria:[1]

- the health and well-being, where can be used medical research methods,
- physiological, psychological,
- subjective assessment of safety - the reliability of the system, faults, dangerous behavior, events, near misses, accidents, performance – quality.

2.2. 13861:2012 Safety of machinery - Guidelines for the application of ergonomics standards in the design of machines - requirements

It indicates the need to identify occupational hazard at every step in machine desin. It is recommended to evaluate the risk for the selected ergonomic criteria. If any identified risk is unavoidable, must be carefully determine work method, manual specifying how hazardous work must to be performed. Stages of design worksation include: verification of the work; verification of the risks to the employee, standard hazardous lists examples: heat, noise, poor posture, the failure of human anatomy, lighting, psychological stress, human behavior, fall, incorrect seat, the location of controls and control panel. Must be specified the population of workers - age, gender, anthropometry, qualities, skills will benefit from the machine, what is the lateralization of workers and if present identify degree of disability. Is indicated as part of the ergonomic work space tactile contact with the machine and tools, compatible kinematics of the machine movements and the employee and simply visual instructions.[3]

The standard clearly pointing to the need to identify personal protective equipment, which specifically apply to the present case. It is important to determine to what may be unintentional use, and how its effects will be minimized. Possible situations to consider are: the use by other employees, the lack of skills, the wrong order, wrong conditions, without the required training job position.[3]

2.3. ISO 26800:2011 Ergonomics - General approach, principles and concepts requirements

Artefacts are designed and should be used for many users. Therefore, appeal principles of universal design. The dimensions of the machine are taken into account as the largest range of the anatomical characteristics of employees. The standard emphasizes that fatigue is a non-pathological state and concerns when manifested externally the internal load. Internal loading is defined on a par with the concept of arduousness work. The standard in the introduction emphasizes that while work to optimize the system should take into account the physiological aspect, biomechanics work, anthropometry, cognitive aspect, the characteristics of the work process, the complexity of the job and work environment - physical and social, such as interpersonal relationships. Internal loading affects the way how the employee achieve the goal, what kind of method he selects during manufacture so in result affects in quantity and quality of generated during operation. This is the premise that in addition to the analysis of work instructions designer must focus at in detail how the work is actually performed. The purpose ergonomic design is to increase the efficiency of the whole production system. Design new or changes in old workstations demand the performance evaluation and appropriate criteria for the evaluation of ergonomic state. Users or potential users should evaluate the design of the system.[2]

Must be taken into account that in the future the target group of employees may change in terms of anthropometric characteristics . Designing should take into account the 95 and 5 percentile values of anthropometric characteristics. Designing safety features take into account the 1 and 99 percentile. Important is also the nature of human movements. Design work tasks must take into account possible differences between the project and the scope of operator actions actually performed. The reasons for these differences is a change of equipment types or characteristics of materials between the planned originally. Well-defined work tasks can be performed safely during a long period. They should make appropriate use of the capacities, forces and skills of operators. Tasks for the manufacturing system are divided into subtasks for

which are examined the various tasks of work. In simple systems is good to use one operator but for complex systems better is team work. Tasks can be performed individually but linked each other.[2]

Should take into account the impact of environment, legal requirements and cultural sphere of the organization. Currently, these conditions are often treated as a state of stable. When results are analyzing in a neutral environment is often achieved lower performance as expected by work system. Each designed system should be evaluated according to certain criteria, regardless of whether it was designed taking the human being as the most important element of the system working or not. According to such criteria could be: human performance, health and safety, employee satisfaction. Repeated evaluation of the system is an integral element of the workstation design. The load must cause the same effect for the employee both in a short and long period time. Workload internal and external influences unevenly and will depend on personality traits operator. Factor contributing to the subjectively perceived difficulty of the work is also the structure of the rest. A human in a work process is unaffected by short-term internal processes, which on one hand can worsen the conditions of work subjectively felt fatigue, weariness or improve worker wellbeing. Poorly chosen pace of work can destroy the end result of this work and result in poor quality or poor performance. Heavy physical work is generally associated only with negative phenomena such pain but it also has a positive aspect in the form of adaptation, improve the overall human condition. Usability in ergonomic means that all the states of the work station have been included to design therefore the process of maintenance, repair and other like phasing out, the ability of the transport, etc. The project must be of sufficient quality and value for money. Corporate social responsibility is related to the health of users, lack work and environment hazards generation, use appropriate first aid or chemicals.[2]

3. SUMMARY

Improvement of the production system is not an easy task. One area reorganization is no certainty that work system will be improving. Improving the one area can cause problems in another area. Further modifications allow eliminate time, material and activity waste. These waste makes it difficult to manage the entire value chain of the company. To complete design a safe workplace must be analyzed other selected standards as discussed five norms. The analysis of the norm requirements allows define type of the static and dynamic analysis which must be considered when company made workstation ergonomics and safety assessing. If the constructor has experience in machines designing he already knows some good solutions. Their idea are adopted by him intuitively. Less experienced designers should taking into account the best available technologies and standards that are reflected in the norms.

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Key words: Knowledge Management, Implementation, Innovation.

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KNOWLEDGE MANAGEMENT

Abstract

The article deals with the knowledge management and its importance in society. It describes the procedures for its implementation and the factors affecting it. The article represents the concept of transformation knowledge society to innovative society, as a shift of knowledge-based to a higher level.

INTRODUCTION

Nowadays it is not uncommon for companies to diversify, change their strategic position, core business, the country in which they operate, or the people they employ. They try to adapt to market conditions and at the same time, to be efficient, to maintain their market position. Despite the rapid development of information technology and all means for achieving this aim, the potential for their development still remains on the people, because the work, thoughts and knowledge of workers form a substantial part of the system based on knowledge.

1. FUNDAMENTALS OF KNOWLEDGE MANAGEMENT

Knowledge management is not a new concept. It is associated with the work of various disciplines such as philosophy, document management, computer science, artificial intelligence, human resources management, expert systems and knowledge-based systems. Knowledge-based systems, often confused for expert systems attempt to solve the kinds of problems that normally require human experts.

Its establishment is particularly important for the development of the company in the field of usage of the whole intellectual property in the main business processes generating value and their future needs. The company is thus more resistant to change and responds faster. The role of knowledge management is to make knowledge in the required form within the enterprise available to employees who need this knowledge to increase their job performance and business

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performance. It combines information technology and staff to create information that are collected, gathered, sorted, stored and presented.

1. 1. Factors affecting the implementation of the knowledge-based system

Implementing knowledge system is a long and difficult process, which is influenced by many factors. The actual view on the knowledge management affects the initiation of its building. It differs in the approaches applied. If an organization considers that there is only one best approach to knowledge management, called the universalistic view on knowledge management, which counts on this assumption, it would suffice to apply this one as the best approach to knowledge management. For a small business, however, this approach is expensive and a better way is an appropriate leadership. Contingent view on the knowledge management on the contrary assumes, that none of the existing approaches of knowledge management are the best at all times, and notes that there are several alternatives to the success of knowledge management, depending on the particular company.

The company itself affects the suitability of individual knowledge processes. Size and the strategy of the organization influence mainly the choice between a pair of processes supporting the application and knowledge sharing. Companies with more employees will benefit more from the knowledge application on the principle of routines, because they use more standardized procedures than smaller, non-bureaucratic companies, independent of standardization and rules. For a small business, the more appropriate is the management in the application of knowledge. Company size also has an impact on knowledge sharing. Socialization of knowledge is recommended for small business, while for large, this method would be extremely expensive and much more favorable would be the distribution of knowledge. Other conditioning characteristics that affect the knowledge management are characteristics of the solved tasks and used knowledge, the external environment and the already mentioned characteristics of the organization (Paralič, 2008).

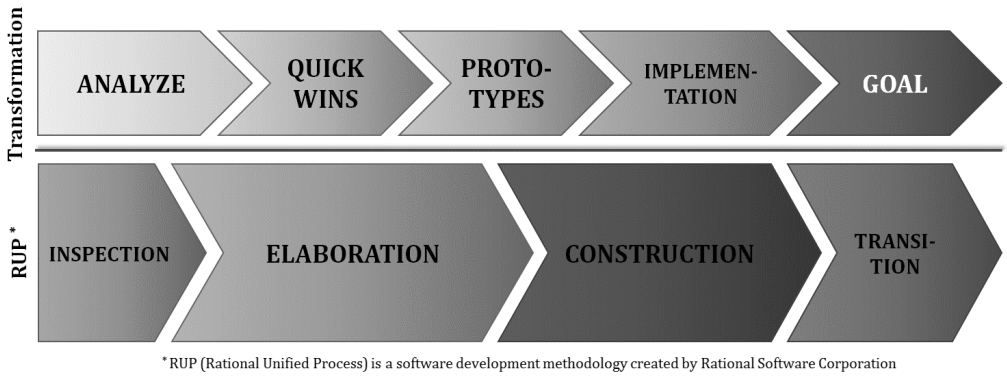

Fig.1. Process of transforming knowledge society into innovative society (Oravec, 2008).

Main philosophy and approach to the implementation of knowledge management is chosen independently by the company, in the interests of the company's management. The process of the implementation itself can be divided into preparation phase, design phase, implementation phase and the phase of transformation to an innovative society. The main emphasis is on the

stage of implementation, which represents the most complex part of the system, consisting of all the activities leading to the establishment of knowledge management, the development of the information itself, knowledge, human resources, organizational structure, culture, communication and information technology.

1. 2. Impact of knowledge management

Knowledge management has an impact on the organization mainly in four basic levels. The first is the impact on people in the organization, which can lead to teaching staff, whether among themselves or from external sources, helping employees become more flexible and thereby increase their satisfaction with the work they are carrying out. With the work being carried out are closely related processes in an organization (usually marketing, production, accounting, public relations, and others). Processes are being improved in terms of efficiency, performance and innovation. The innovativeness is associated with the impact on the organization's products, as they can lead to stimulating the creation of new and innovative products with significant added value, or products that are in their nature based on knowledge, for example software companies and their products. All these impacts on individual basic levels form directly and indirectly overall performance of the organization (Závarská, 2005).

2. DEVELOPMENT OF ORGANIZATION THROUGH INNOVATION

Through innovation, businesses develop new ideas and create new products. Management can effectively support the innovation process in terms of cooperation between workers who take part in it. This form of support is efficient because it saves time and money while ensuring continuity of business development. In the innovation process, which is supported by knowledge management, knowledge is automatically created, stored and shared. Knowledge management is not concentrated in one process of the company, but is distributed to all cooperating processes. At the same time, employees are interactively involved in the creation of knowledge. This causes significant reduction of the financial cost on creating the knowledge base. Employee participation on innovation is often very strong motivation. Transformation of enterprises into innovative societies requires also focus on the development of the organization in the processes and procedures, human resources management and technology.

Improvements of processes and workflows enable the company development of knowledge, its sharing and re-use, particularly in areas such as company strategy making, culture and customs of company, work procedures, staff leadership, return on investment, productivity, laws, risk management, etc.

The result of development of an organization is the introduction of new and effective elements for collaboration and support of innovative processes that automatically collect knowledge. The effective elements include: communities of interest or proffesion, specialized knowledge networks or matrix organizations. These elements can be effectively integrated into the existing organization.

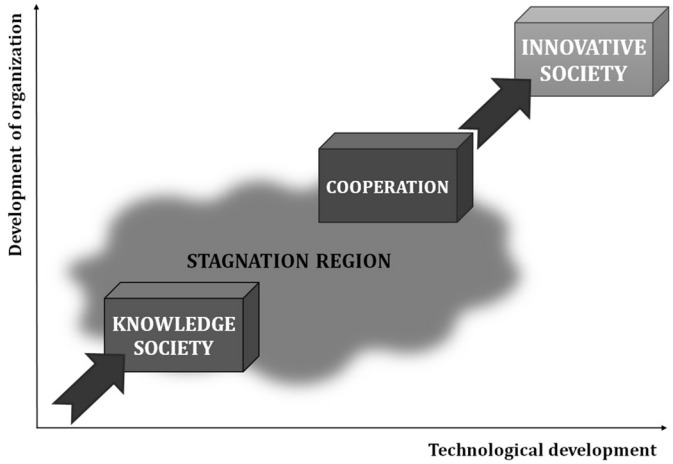

Fig.2. The impact of organizational and technological developments on development knowledge management in the enterprise (Oravec, 2008).

3. CONCLUSION

Building a knowledge-based system not only in the maintenance area has great importance, becoming a key economic resource and the dominant, or even the only source of competitive advantage. It is building a new generation of employees, which reflect the firm knowledge into financial indicators. So far, this trend has caught on just as the concept of multinational companies (e.g. software companies) and audit firms, however more and more popularity is gained among the smaller companies as well.

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planning and optimization, computer simulation, logistics

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PLANNING AND OPTIMIZATION MODULES OF INTERACTIVE LOGISTIC PLANNING SYSTEM

Abstract

Published article deals with description of planning and optimization modules, which are part of proposal of design of interactive system for logistic planning. This article approaches functioning of these modules and describe advantages and disadvantages of using computer simulation as a basis for planning system.

1. PLANNING MODULE

Planning module forms core of planning system and it consists of simulation model of warehouse and simplified model production hall. To ensure as real representation of company as possible simulation model have to be created for every company separately. While designing of simulation model it is possible to use software library for warehousing. These libraries can accelerate creation of simulation up to half time compared to creation using basic elements. Module can be used as communication medium. Module in addition to planning function can also serve as communication medium connecting all external modules for the purpose of data collection and transmission of results. Advantage of this solution is that there is a reduction in the expenses of installing the system as a whole

Working with system depends largely on degree of automation of collection and evaluation of input data as well as intended use of system. System can work on long term simulation, which can help with testing various procedural options in warehouse and logistics or on short term simulation which can help with setting number of manipulation resources according to daily requirements on logistic system. To work with proposed scheduling system is necessary to observe sequence of steps for import of actual input data, run planning tool, optimization obtained results, generate statistics and determine appropriateness of solution generated in sequence as shown in figure below.

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Main working activities with module are:

- Launch application
- Load store inventory
- Define incoming supplier/customers
- Define consumption/stock out materials to/from production.
- Set material handling resources.
- Start simulation and optimization.
- Selection of most suitable alternative.

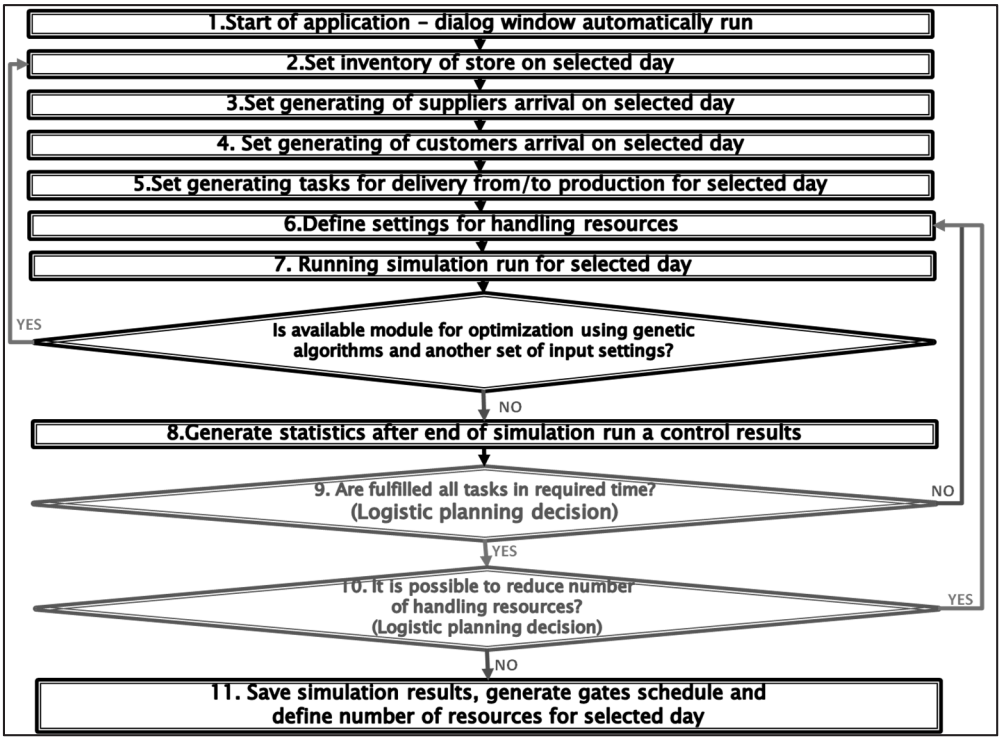

Fig.1. Work with planned module

Tasks that should be covered by planning and optimization module include:

- Import materials in warehouse – set of tasks associated with unloading trucks, performing system income of material and stocking material into warehouse.
- Delivering to/from manufacturing – tasks connected with delivering materials for production, removal finished products from production and stocking into warehouse.
- Delivery of output products – set of services that are needed to picking finished products from warehouse, system outcome and loading products to customer's trucks.
- Specialised tasks – services that are not preformed periodically and arise in random intervals. These tasks arising during repacking packaging, nonstandard supplies to production, handling transfer inside warehouse etc.

2. OPTIMIZATION MODULE

For optimization in planning system genetic algorithms are used. Any commercial simulation software now includes module of optimization using genetic algorithms – examples of used optimization modules for several software's: AutoMod = AutoStat, OptQuest =Arena Quest, Optimizer = Witness, GA Wizard = Plant Simulation. Each of optimization module works as standalone application or additional modules for simulation tool. Therefore it is standalone application, used algorithm is "black box" and it is not freely accessible. Functioning of algorithm is based on fact that simulation also takes as black box to calculate parameters of modelled system. To use optimization in simulation program is necessary to define following parameters:

- Coding – for optimization it is not possible to vary all input values, which are necessary to fulfil of planning system. Input data for suppliers/customers arrival are immutable for each variant, therefore optimization should affect factors related to handling resources For using optimization it suitable to change setting for manipulation resources like:
  - Number of manipulation resources – at beginning of optimization is necessary to define limits of manipulation resources that can be changed during optimization.
  - Shifts model for manipulation resources – for each group of handling resources we can define various types of shift plan or for every manipulation device would have which shift plan.
  - Distribution/merging tasks relating to warehousing and production – significant input parameter is ability to combine respectively divide tasks to store or production services, according this assign individual tasks to different manipulation devices.
  - Used algorithm of work allocation to individual handling devices – there are several types of algorithms for allocation tasks to resources (cyclic, random, finding first free device, etc..) This parameter can be altered and has affected to compliance of tasks and cost of manipulation.
- Restrictions – restrictions significantly reduce search space and allow faster running optimization. Restrictions shall be constraints of input data, where before optimization it can define limits of each input data that can be used to define maximum number of manipulation devices, define which algorithm of allocating tasks are permissible etc. Second view on constraints is to exclude solution that does not satisfy main conditions – for store it can be: do not unload every planned truck, do not manipulate every pallet into store, do not satisfy requirement of production etc. Method used to achieve this state is penalization method, which can excluded from optimization system settings that does not meet basic requirements on logistic system that company defines (some of them are mentioned above).
- Fitness function – to solve simulation optimization it is necessary replace fitness function by simulation model. Fitness function is equal to objective function calculated at the end of simulation run from output parameters based on input data, which optimized variant includes. Assessment of individual variant is thus formed on basis of objective function. The most common parameters for evaluation of assembly, manufacturing and logistics systems are cost and effort to minimize them.

For proposed system I decided to design the objective function f (x), which will be used to evaluate the costs to implement all handling activities (C_{HA}) and on the basis of the total number of loads per day to choose the most appropriate solution. Proposal of objective

function to optimize daily schedule is given in equation (1). Elements of the objective function for evaluating individual simulated variants, these costs Equation (2):

- Cost of handling resources manpower (C_{MP}).
- Cost of handling resources on return to dispatching centre and waiting (C_{RW}).
- Cost of non-compliance performed tasks (C_{NCPT}).

$$f(opt)=\min(C_{HA}) \quad (1)$$

$$C_{HA}=C_{MP}+C_{RW}+C_{NCPT} \quad (2)$$

3. ADVANTAGES AND DISADVANTAGES OF IMPLEMENTING MODULES

Final point of modules description is description of advantages and disadvantages of proposed modules for planning and optimization..

Advantages include:

- Working with actual data of supplier/customers arrival.
- Automatic creation of loading/unloading schedules.
- Possibility of testing different variants of manipulation resources number and their shift plan.
- Accuracy of planning.

Disadvantages include:

- Higher acquisition costs.
- For incorporation of strategic changes in processes of storing and logistics is needed certain qualifications or it can cost financial resources to implement changes.
- Longer time of implementation.
- Stricter requirements for accuracy exchanged data.

Preparation of proposed modules for planning and optimization of logistic processes has disadvantages. However provided benefits outweigh disadvantages and after finalization individual modules for automated creation of model stores these modules will be advanced planning for future conditions in logistics.

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planning system, computer simulation, logistics

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DESIGN OF INTERACTIVE LOGISTIC PLANNING SYSTEM

Abstract

This article shows necessity of information linking between internal and external logistic flow into single coherent system that will be able to exchange data between suppliers, customers and logistics providers System should also be management decision support system that can analyze number of possible solutions and choose one with the best with results. Research and development of such system will speed up process of logistic planning, which will increase quality, accuracy, time to adopt logistical decisions and great potential cost savings.

1. DESIGN OF MODULAR SYSTEM SOLUTION

Each of companies that produce products, which are used as assembly of sub-assembly parts or final product, respectively stored and dispatched types of products is forced to bring input material, store it and ship it to customer. In each company has own system of processing input material, storage and shipping. Each system may vary depends on space limitations of company, manipulation equipment and human constrain. For the greatest versatility of system is necessary to define modules of proposed system. Depending on system used in company it can be defined several modules that can be used for company specification. Result is modular system that would give companies options for automation for data collection, conducting experiments and making decisions in addressing situation. Between modules included in system solution for internal and supply logistic processes we can define:

- Planning and optimization module of logistics.
- Module of external logistics.
- Module of internal logistics and production.
- Database module.
- Communication module.
- Knowledge module.

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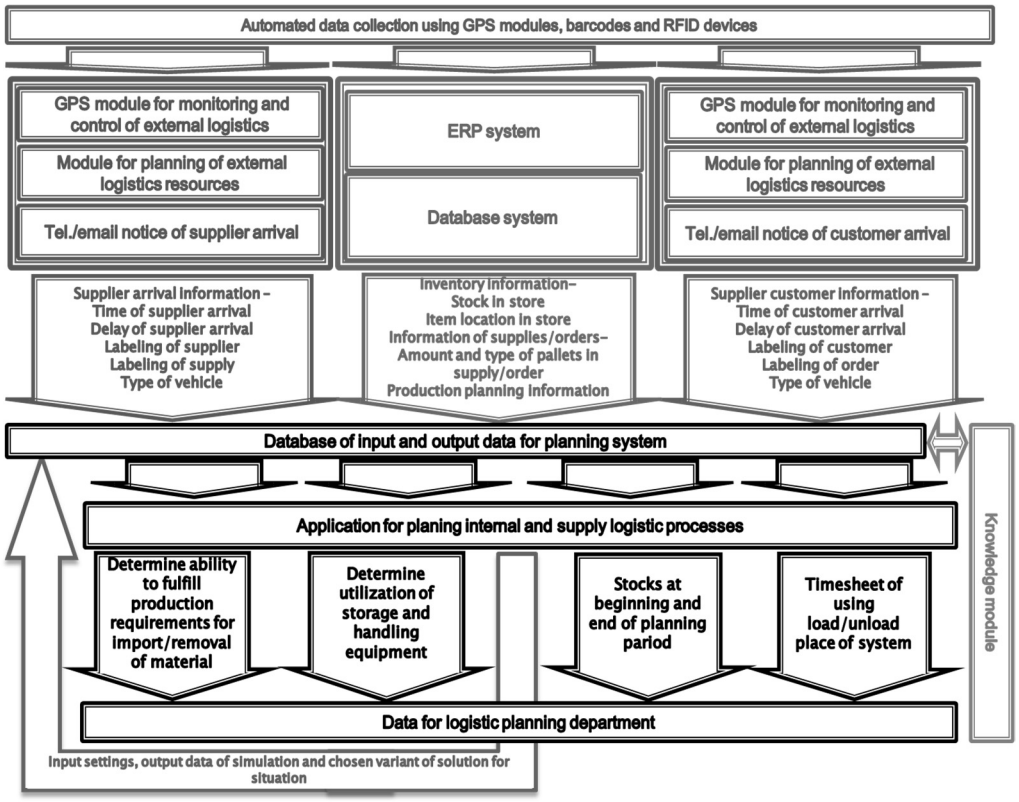

Fig.1. Information flow of planned system

2. DESCRIPTION OF INDIVIDUAL SYSTEM MODULES

Following section will describe briefly different parts of system:

2.1. Planning and optimization module

This module forms core of system. Module will consist of built warehouse simulation model and simplified model of production. To ensure as truly view of reality in store as it is necessary to built simulation model for every company separately. In developing simulation model it is possible to use program libraries for warehousing that enables us to accelerate creation of simulation model in some cases up to half time required when using basic elements of simulation software. Module is used to plan internal logistic processes according to information from external suppliers/customers.

Module in addition to planning function can also serve as database and communication medium connecting planning application to external software for purpose of data collection and transmission of results. Advantage of this solution is that there is possibility of cost, for installing whole system reduction.

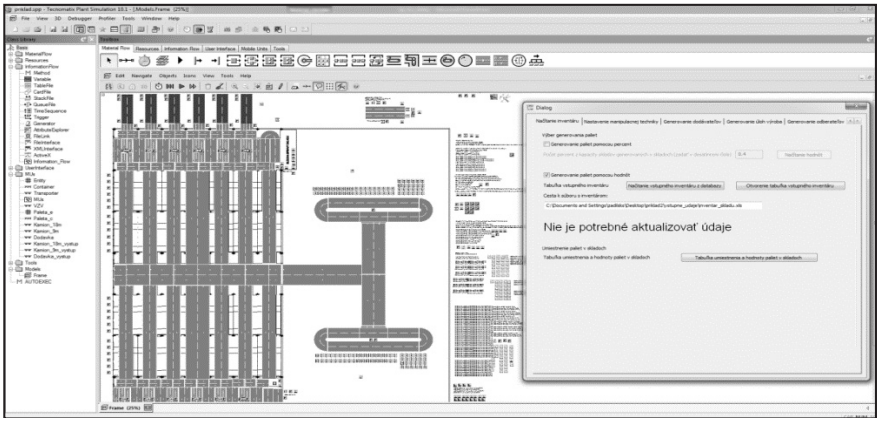

Fig.2. Sample of planning system based on simulation model

2.2. External logistics module

Module of external logistics will serve in system to gather data from supplier and customers incoming to company. Information about incoming can be divided into primary, resulting from planning process of supplier/customer vehicle route. Secondary types are actualization of planned arrival time according to delays etc.. Further breakdown of information is way of creating and delivering information to company. Module of external logistics should be able to process data:

- Information from planning application of external logistics.
- Information from GPS monitoring and controlling vehicles.
- Information from telephone and e-mail communication about suppliers/customers means of transport arrivals to company.

2.3. Module of internal logistics and production.

Module of internal logistics consists of two main parts, namely:

- Information of handling devices used in internal logistics – module serves primarily to online data collection of equipment availability, technical specification and impact of human resource needs for possibility to ensure requirements that are connected to these handling vehicles. Information of handling tool are used to define assignment of handling equipment to each process while process of positioning work tasks to individual logistic resources based on technological limitation and limitation of human operator (employee absence for various reasons).
- Information relating to manufacturing of company – data affecting production plan, current production power of production facilities. Module serves also to define information about, which products are planned to produce at which production capacity and defining constraints on side of machining, statistics collection about machine failures, setups etc.. Part of information that have to be included in this module should be information about orders/deliveries relating to stock of company to determine precise volume of handling operation. Data relating to production shall include collection data from real situation after scheduled daily capacity so that it can be compared projected

state using planning system with real state of system. This is particularly important in view of knowledge module.

2.4. Database module

Database module will primarily serve as repository of primary data base for planning and knowledge module. Therefore this module is important storage for whole system and module will store data as input data for planning process, as well output data from planning process for various variants and selected variant of solution for particularly situation to create knowledge data base for knowledge module. For possibility of finding dependencies that are not apparent using knowledge module it is required to store whole types of data – input/output data, decisions and comparison plan and actual situation.

2.5. Communication module

Communication module will form connection medium for connecting external sources of information, database and planning module. Module will be linked to all modules and sub-modules of system, which may vary from customer to customer. Module will be able to automatic collect necessary data, their updates for needs of planning application as well as export information of different test variants that application performs. Planned applications included to communication and connected to this module include supplier/customers planning and monitoring applications, enterprise information system, knowledge module and planning system itself.

2.6. Knowledge module

Module will be used to represent knowledge of logistic flows planners in company. Knowledge in form of decisions in choosing alternative daily schedule and number of vehicles according to planned situation of company. Use of this knowledge can help in planning various of states, that can occur in system, by finding solutions based on comparison historical data and success of selected solutions in past. Module will serve on automatically first defining number of necessary manipulation resources, or shift model of resources work.

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Ergonomics, Prevention, Ergonomic programs, Effects of work factors, Risks

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ERGONOMICS IN SLOVAK ENTERPRISES CONDITIONS

Abstract

The authors present the current state of ergonomics in companies in Slovakia in the context of EU legislation. They point to the lack of evaluation of the impact of work and lack of ergonomics programs in Slovakia. The article also compares European and American model approach to ergonomics work. The authors highlight the importance of primary, secondary and tertiary prevention as an essential tool to eliminate musculoskeletal disorder (MSDs) at work. The findings are supported by the results of research on the incidence of MSDs and work-related diseases.

1. INTRODUCTION

The aim of ergonomics is health care, specifically physical, mental and social well-being of man, the creation of conditions for optimal human activity, as well as creates a sense of comfort in the workplace. The use of ergonomic principles in practice contributes to creating well-being, the humanization of work and at the same time it also brings economic effect. In addition to these factors, the use of ergonomic principles has a positive impact on economic indicators. These are directly affected by reducing the cost for absence of work, accident, increasing performance and hence productivity growth. This is confirmed by the official definition of ergonomics formulated IEA in San Diego (2000).

Generally, Slovakia, despite the arrival of foreign investors largely unchanged view of ergonomics and optimization of human labor. Currently staring at the man as cheap labor, which you need only to take advantage of. Especially in industrial plants is does not place such emphasis on working comfort of their employees. They do not use ergonomic prevention programs, which should be focused on the effectiveness of human labor and reduce the negative effects on the health of employees. Work-related illness, injury and in the worst case death have resulted resulted in increased costs for the company. In particular, it has an impact on the employee, but it also a burden on society and the state. In case if the companies more focused on ergonomics, would they not only benefits for the enterprise as a whole, but also have a positive impact on the health of workers.

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2. ERGONOMICS AND PREVENTIVE MEDICINE IN SLOVAK ENTERPRISES

In the period after 1989 in ergonomics and preventive medicine made some mistakes in Slovakia. The biggest mistake was the abolition of doctors working under the guise of free choice of doctor in companies in Slovakia. This change has many problems passed on specialists of safety and health management who were not and are not professionally trained for it. Currently, some companies are starting to set up in-house clinic. [1]

Another mistake is that ergonomics is disappearing from legislative materials. Policy decisions create a great amount of revisions that complicate the situation to ensure the prevention of work-related illnesses. [1, 2]

A major drawback of the European legislation is that there is no emphasis on the fact that the work and working conditions must not damage the health of the employee. For example, in the U.S. this is true, that if the employee confirms the injury or occupational disease under the Disability Act, company must adequately compensate the employee. The company must then learn what harm his health. Shall rectify the negative factors and to create conditions so that the employee can return to their workplace and the collective to which he was accustomed. [1, 3]

Based on research conducted by the anthropologist prof. Hatiar with his team has been partially mapped and compared the incidence of Musculoskeletal System (MSD) and their intensity in selected EU countries and Slovakia. It turned out that there is no significant difference by employees without difficulty MSD between Slovakia and European samples of employees. Samples are statistically significantly different in the incidence of milder difficulties MSD. Most employees in the sample of European companies have a doctor if they feel easy difficulty localized in MSD. Conversely employees of Slovakia samples courage to see a doctor only when the intensity reaches a degree of difficulty that do not take counter medicines painkillers. [2]

The reason is that in Slovakia, we focus primarily on the protection of business, businessmen and employers who are willing to accept only valid legislation and exploit high unemployment in Slovakia. A system of rewards motivates employees to the less visited a doctor. Employee released because it is not enough to meet the performance standards, the reason is not that got ill at work. Demanding performance standards meet the health employees after job training. Health problems but do not allow it. Ill employee gets into so called social networks.

This situation is consequence of that the company not focus on preventive ergonomic programs. Businessmen focus on profits and are willing to accept ergonomics programs only after verifying that they really bring profit. [6]

3. IMPACT OF WORK AND WORKING CONDITIONS FOR HEALTH EMPLOYEES

Impact of factors of work and working conditions for man at work is often underestimated. It is often claimed that the pains can make people feel at work not only because of the impact factors of work and working conditions, but also for other reasons. [1]

Tab. 1: Evidence of a causal relationship between factors of physical work and diseases MSD (Source Hatiar, 2012)

BODY PART (syndrome) *Risk factor*	Strong evidences	Evidences	Insufficient evidences	Evidences of inaction
Neck				
Repetition		√		
Power		√		
Location	√			
Vibration			√	
Shoulder girdle				
Repetition		√		
Power			√	
Location		√		
Vibration			√	
Elbow				
Repetition			√	
Power		√		
Location			√	
Combination of factors	√			
Wrist and hand				
Carpal tunnel syndrome				
Repetition		√		
Power		√		
Location			√	
Vibration		√		
Combination of factors	√			
Tendovaginitis				
Repetition		√		
Power		√		
Location		√		
Combination of factors	√			
Hand-arm vibration syndrome				
Vibration	√			
Lumbosacral region of the spine				
Lifting and sudden movements	√			
Unsuitable working position		√		
Heavy physical work		√		
Whole body vibration	√			
Static working position			√	

Table 1 shows the results of an epidemiological assessment of 25 years of research carried out at the workplace, which focused on the incidence of difficulties and work-related diseases that have a negative impact on the efficiency and quality of labor. It would be good if those facts applied in European legislation in the field of ergonomics, safety and health at work. [1, 5]

Strong evidences. The evidences are strong when considered on the basis of epidemiological criteria of causality appears to be a causal relationship between intense or prolonged exposure to a specific risk factor or factors and disease MSS as very likely. The positive relationship between exposure to a specific risk factor and disease MSS there could be observed at least in some studies where randomness, bias and confounders factors could be excluded with reasonable certainty

Evidences. The evidence can be said, when some favorable epidemiological evidences show a causal relationship between intense or prolonged exposure to a specific risk factor or factors and disease MSS. There was observed a positive relationship between exposure to a specific risk factor and disease MSS in studies in which, randomness, bias and confounding factors are not a likely explanation. [1, 2]

Insufficient evidences. The evidences are called insufficient, when there are too little available, not consistent and statistically significant studies not in sufficient quality that would allow conclusions on the presence or absence of causal relationships. Some studies suggest a relationship to specific risk factors, which may be explained by randomness, bias or confounding factors (confounders).

Evidences of inaction. We can talk about the evidences of inaction when the studies consistently show that a specific risk factor (or factors) in the workplace is not related to the occurrence of disease MSS. [1, 2]

The risk of work-related diseases can be reduced, respectively, eliminated only when the all aspects of primary, secondary and tertiary prevention are consistently and systematically applied in the practice. Suitable ergonomic intervention of against risk factors is considered to be effective in the prevention of these diseases. [1, 3]

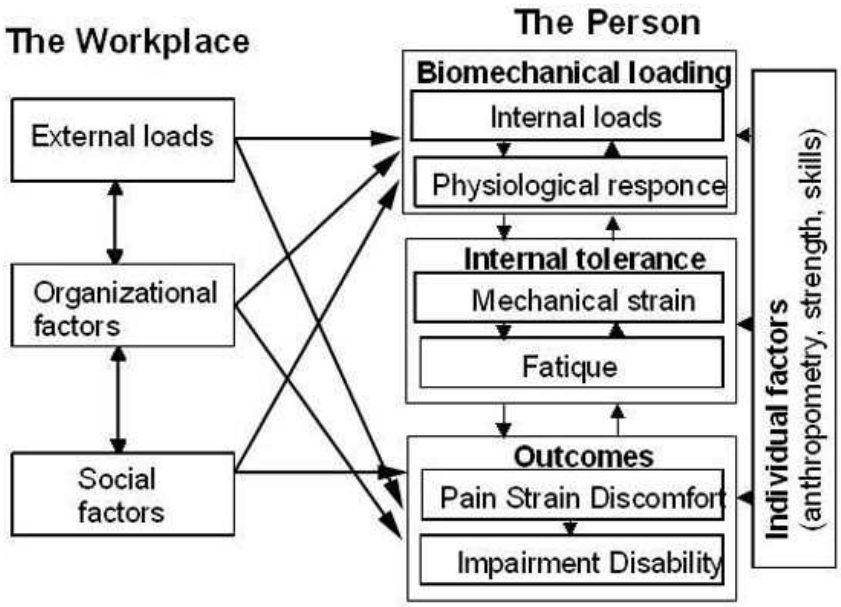

Fig.1. A model of hazards affecting risk of work-related musculoskeletal disorders.

Primary prevention characterize risks to health of workers through technical measures ensures their elimination. Tertiary prevention ensures eliminating of the risk of further damage to the body after adequate rehabilitation, job modification and interference in the work process. This creates the opportunity for the employee's return to work and do the same team, which was accustomed to. Primary prevention measures create conditions for preventing microtrauma, injuries and other disabilities, particularly musculoskeletal system. Secondary prevention measures eliminate risks outside their own working process during the absence of work of man. Tertiary prevention measures to restore the function of the affected workload and congestion and recovered the man as a worker. Means of primary and tertiary prevention have the same goal. Ensuring the health of the individual in the work process in terms of complexity it is necessary to talk about the secondary prevention that is essential, not least because the methodology and techniques of tertiary prevention are linked to an organic phase of secondary prevention. Primary prevention characterizes risks to health of workers and through technical measures and ensures for their elimination.

4. CONCLUSION

Slovak Republic has processed legislation that is harmonized with the EU legislation. This legislation provides the basis for designing department in companies and solution of machinery and equipment. There are not enough provisions for the application of systematic approaches. The guidelines ensure efficiency of human labor through ergonomics programs for long term maintenance of ergonomics, safety and health of employees. Our research is focused on the production practices that systematically aid in the creation of new ergonomic work systems. We place emphasis on ensuring employee health and increase productivity for companies. Maintaining good human health, increasing humanization of work and labor productivity can only be achieved with complex solutions in the field of ergonomics. [6]

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Management Model, Condition-Oriented Prevention, Musculoskeletal Disorders

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INTEGRATION OF ERGONOMICS INTO PRODUCTION SYSTEMS

Abstract

In recent years, efforts in health promotion programs have increased. Not with standing, work-related musculoskeletal disorders (wMSDs) remain a widespread and growing issue of concern in the manufacturing industry in european countries. In this paper a comprehensive management model is introduced that enables companies to identify and control physical stress at work.

1. INTRODUCTION

The prevention of wMSDs is achieved through improvements in the design of working conditions and tasks as well as through influencing the health promoting behaviour of individuals. So far, many workplace health promotion and prevention programs focus on behaviour – oriented prevention such as fitness programs, control of alcohol and tobacco use and diet programs (Kramer et al., 2009). In general, these programs, however, affect only certain risk – groups and yield only effects on individual behaviour. In addition, consequences and lasting success of these behavioural changes are seldom evaluated.

Actions of condition – oriented prevention, however, affect all individuals working in given respectively changed conditions and do not depend solely on sustaining behavioural changes of individuals and can thus be better controlled and sustained. Nevertheless, isolated condition – improvements always risk achieving only locally optimized conditions by shifting hazards to a different part within the production system. Condition – oriented approaches which are based on single solutions, therefore, cannot be effective in systematically reducing wMSDs. What is needed, therefore, is a systematic approach, that enables companies is identify and control physical stress at work that leads to wMSDs in a comprehensive manner. Such a comprehensive integration of ergonomics as condition – oriented prevention is described in the following.

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2. THE MODULAR ERGONOMICS CONCEPT

The concept comprises four modules which describe different levels of the integration of ergonomics and a controlling module (see Figure 1). Each module defines process and method – requirements that should be realized within the production system to integrate ergonomics. The modular structure allows to define necessary actions for each module based on the situation at hand in a given company.

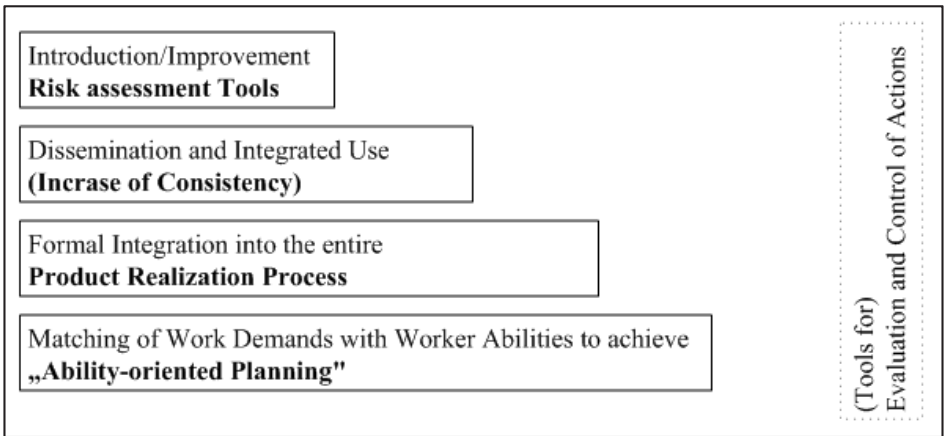

Fig.1. Modular ergonomics concept. (Adapted from Bruder et al., 2009)

2.1. Module 1: Introduction of appropriate risk assessment tools

Basis for the improvement of working – conditions is the analysis of the existing conditions and the identification of work system deficits and risks. For that purpose structured risk assessment methods are needed. Introduced risk assessment methods have to fit the existing load patterns and working conditions and should allow an assessment of all types of jobs in the production system. A two – stepped method – approach with so – called "screening tools" for a quick identification of possible risks and 2nd – level (expert) tools for detailed analyses of contributing factors and the workstations as well as to conduct detailed analyses. Training in these methods for selected staff members is needed to enable the company to conduct analyses without the involvement of external resources.

Without such assessment methods, potential risk and deficits cannot be detected and analysed systematically. Likewise, contributing factors for existing risks may not be properly determined and consequently actions taken may not solve the effective problem. With appropriate assessment methods changes in the work system can easily be evaluated under ergonomic aspects. Standardized methods also help to communicate ergonomic issues in an objective and comprehensible way. Thereby, their application also raises the ergonomic awareness within a company.

Prerequisites for the introduction of risk assessment methods are a scientific foundation of all introduced methods and the acknowledgement of the assessment results within the company.

2.2. Module 2: Dissemination and integrated use of introduced tools

Risk assessment methods provide information about risks, contributing risk factors and indications for improvements. The second module concerns the use of these tools and the findings they generate with the aim of a comprehensive optimization of working condition. The methods and the resulting indications should be used and considered whenever working conditions are to be changed or at question.

After a risk has been identified, improvements are achieved only if changes in the work system are realized and a re – evaluation confirms the effectiveness of the actions taken. For this purpose, a problem – solving process such as a PDCA – Cycle with defined responsibilities and allocated resources should be established each time a risk has been identified (Deming, 1986). To avoid inconsistencies all introduced screening and 2nd – level tools need to be aligned so that they do not produce contradicting results. Moreover, it should be defined which method is to be used in which context.

To disseminate the introduced methods and to gain acceptance, managers of various levels and departments should be enabled to understand the methods structure and their results. Furthermore, more staff members with different functions should be trained in conducting analyses. Analysis – findings and derived improvements should be evaluated and documented in terms of knowledge management (lessons – learned, best – practice) and used in future improvement cases.

Through the integrated use of assessment tools and their indications wherever ergonomics aspects are affected, an optimization of the work system in a comprehensive manner can be achieved. Within "Kaizen" – activities and for the definition of job rotation patterns, the systematic consideration of ergonomic aspect can contribute significantly to risk reduction.

The increasing use of assessment tools also facilitates the transparency of the ergonomic quality of the work systems. This also avoids the shifting of hazards from one work system to another. A structured and standardized form of the assessment results helps to include ergonomics aspects in decision making and benchmarking activities. The combination of the findings with other data can also help to optimize other issues, such as quality and productivity performance.

Prerequisite for the implementation of module 2 is the introduction of at least one appropriate and well – founded risk assessment method and the commitment of the management to support improvement activities with adequate resources.

3. SUMMARY

In general, the described concept finds a high acceptance among the involved companies. Nevertheless, our experiences show that high efforts by different stakeholders are needed to achieve a total integration of ergonomics into the production system

Often, ergonomics activities are not connected or remain isolated on – demand activities, as for example the introduction of risk assessment tools. Our experiences suggest that the introduction of new methods should be based on a formulated need which arises from specified situations in the work systems or which the future users of the tools have already encountered.

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Automated guided vehicle, OEE, availability, speed, quality, Six Big Losses.

Lukáš ĎURICA*, Peter BUBENIK**

OVERALL EQUIPMENT EFFECTIVENESS OF AUTOMATED GUIDED VEHICLE

Abstract

This paper describes possible abnormal states, which may occur to automated guided vehicles, and which can be categorized into the Six Big Losses*. Those losses form the three main factors – availability, performance, and quality. OEE ratio is a product of those factors. The proposed categorization can be used to analyze abnormal states, which can be signaled by automated guided vehicles, or used for data acquisition and visualization in modeled 3D manufacture.*

1. INTRODUCTION

Among indicators, which describe the effectiveness of manufacture, there also belongs OEE – Overall Equipment Effectiveness that is one of the key indicators for enterprises that are actively involved in improving and optimizing operations.

In the following lines, abnormal states of the automated guided vehicle are described, and categorized into the Six Big Losses. A proposal concerning how to signal them from auto guided vehicle and then analyze and visualize them.

2. OVERALL EQUIPMENT EFFECTIVENESS

This indicator represents the overall efficiency of the equipment (or manufacturing cell), that are involved in the production. It also reveals the hidden capacity of manufacturing systems and therefore it reveals the field for increasing profits from the production plant. It is also used in programs such as Downtime Management (DTM), Lean Manufacturing, Six Sigma or Kaizen [2].

OEE has an impact on production costs and profits of the whole enterprise. It belongs among the most important indicators for direct management as well as individual operators of the manufacturing equipment. OEE indicator is expressed as a percentage. If the enterprise achieves a value of OEE greater than 85%, then it is rated as a world-class enterprise [3].

The indicator consists of losses caused by malfunction, downtime, unscheduled maintenance, failure of subsystems, as well as material or operator shortage, start-up of

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manufacturing equipment, smaller stops or slowdowns and damaged goods, that need to be reworked.

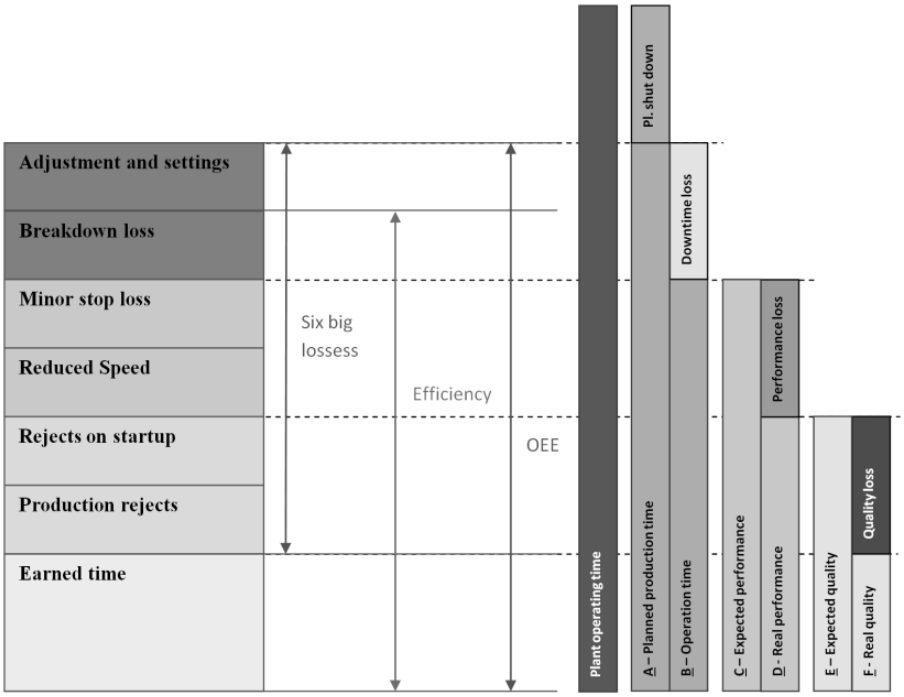

Fig. 1. The relationship between the Six Big Losses and OEE factors

These losses can be categorized into the Six Big Losses: planning down time, breakdowns, short breaks, slowdowns, and during startup, or during the process. These losses can be further categorized into three types – namely losses of availability, performance and quality.

These losses are determined by the difference between actual and expected values (time and pieces). Ratios of these actual and expected values define the three factors – availability, performance and quality. OEE is defined as the product of these three factors (Fig. 1).

Therefore factors are determined by planned production time A and operation time B (availability); expected performance C and the real performance D (performance); expected quality E and the real quality F (quality) [3].

And thus OEE can be expressed as follows:

$$OEE = \left(\frac{B}{A}\right) * \left(\frac{D}{C}\right) * \left(\frac{F}{E}\right),$$

wherein the ratio of B / A is the availability, D / C is the performance and F / E is the quality factor.

Table 1: Classification of abnormal events into the Six Big Losses

Category of OEE losses	Category of Six Big Losses [1]	Abnormal event	Status indication that the device sends / expected status
Availability losses	Failures caused by faulty equipment and lasting more than 5 minutes	- All failures lasting more than about 5 minutes (failure of the main parts of the automated vehicle - engine, electronics, control unit, communication unit, guidance system, etc.); - Unscheduled maintenance;	No received signal / Any other state is expected
	Adjustment and settings	- Adjustment / reprogramming equipment; - Downtime; - Lack of material;	Received signal of preparedness
Performance losses	Inactivity and small breaks (abnormal activity sensors, blocking, etc.).	- All the reasons that cause the device to stop for less than 5 minutes; - Minor malfunction of guidance system (failure of one or more of its subcomponents - sensors, controller, path); - Static or dynamic obstacles in the path; - Small corrections tracks (or static part of guidance system); - Failure / poorly received radio command from headquarters; - Poorly designed path; - Disconnecting of pulling carts, etc.	Received signal of waiting
	Speed reduction (difference between the demanded and actual equipment speed)	- All cause that reduce speed - Temporary obstacle in the way; - Temporary malfunction of guidance system; - Improperly designed track; - Improperly designed logistics; - Overloading of the vehicle (goods); - Start-up of equipment;	Received signal of reduced speed
Quality losses	Reduction of goods quality during stable operation of the equipment	- Any damage to goods during transport	It is difficult to assess if the goods was damaged - deal with operator of the maintenance with to report it (sending information from device built-into the equipment)
	between start and stable operation of the equipment	- Any damage when unloading / loading goods	

3. CLASSIFICATION OF ABNORMAL STATES OF AGV

In this case, the OEE indicator is not calculated for the manufacturing machine, but for material handling equipment -– the automated guided vehicle, which is used to transport goods. Losses of quality should therefore be minimal, but need not be zero, because during the transfer goods can be damaged.

Automated guided vehicle systems are fully automatic transport systems using unmanned vehicles. AGVs are able to safely transport all kinds of products without human intervention

within production, logistic, warehouse and distribution environments. They represent the obvious way to reduce costs and to increase efficiency and profitability [5]. These days the number of AGVs is significant increasing, because they facilitate automatic handling of material and thus reduce the cost of human operators in logistics [4].

There is great diversity in guidance systems of AGVs: for example, a guidance system may be based on following markers or wires in the floor, or it may use vision, magnets, or lasers for navigation. This diversity can cause a variety of fault events, but by quantifying the OEE these can be categorized by losses they incur. Tab. 1 contains a summarized table of abnormal events of the AGV, categorized by the Six Big Losses that are part of the OEE indicator.

4. CONCLUSION

OEE indicator belongs to one of the most important indicators for the manufacture, which is participation in improving, optimizing and downsizing of the manufacturing process. One of the production systems to which this indicator can be applied, are automated guided vehicles.

Possible abnormal states of this equipment were evaluated and categorized into the Six Big Losses – losses of planning downtime, breakdowns, short breaks, slowdowns and quality loss in starting up the process or during runtime. Methods that were proposed for signaling various states of automated guided vehicles could be used for monitoring or visualization operations.

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Computer vision, measure system

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OPTICAL MEASURE SYSTEMS IN AMZ02

Abstract

The article deals with application of the optical measure systems on automated measuring equipment (AMZ02). Measuring system allows measure of plane or spatially components with dimensions 2000x1000x100m. According to the requirements can be deployed 2D or 3D camera system with accessories.

1. OPTICAL MEASURE SYSTEM AMZ02

AMZ02 system is designed to automatically check the quality of components with a choice a parameters of the output protocol. Operator has the option to add new components to the system via the HMI interface. Is necessary to define all details which should be checked/measured on the components, when learning of the system. Their dimensions, the tolerance fields for the dimensions and so on.

The measuring system is configurable with respect to the desired final measurement accuracy and type of measured components. The measuring device can be assembled in several versions. The maximum dimensions of measured components: 2000x1000x100 mm. The system is primarily designed to measure and check components from the 5-sides.

The options are:

- two versions of the positioning subsystem:
  - portal manipulator (X, Y, Z)
  - robot with additional axis
- three variants of the measurement subsystem:
  - 2D camera system with a laser distance sensor
  - 3D camera system
  - configurable 3D camera system with the option of line scanning.

From the available positioning and measurement subsystems can be assembled inspection / measuring equipment suitable for the specific components.

1.1. Module of 2D camera system with a laser distance sensor

The module contains a 2D camera system with 1024x 768pixels, telecentric lens with a field of view of 48 mm x 36 mm with a circular lighting and laser displacement sensor (Fig. 1). In this configuration, it is possible to achieve accuracy of 0.05 mm in the X-axis, Y-, and 0.02 mm in the Z-axis, this module is suitable for checking and measuring of known components,

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their dimensions, details. It's not suitable for complete scan of components because of time-consuming full scan.

Process of check / measure

In measurement process handling subsystem positioning sensor subsystem over of detail on the component that needs to be check / measure. Using the camera system is desired detail evaluated and localized. If it is necessary to measure the position / size of detail in the Z-axis, handling subsystem re-position the laser to a specific position on the base of information provided by the camera system. The process is repeated for all objects on that component.

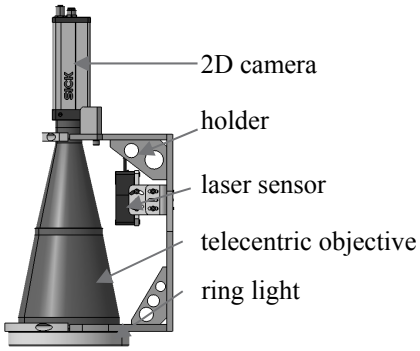

Fig.1. Module of 2D camera system with laser sensor (source: authors)

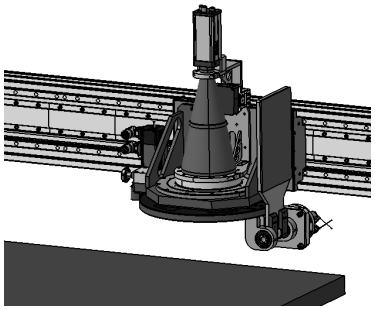

Fig.2. Checking and measuring of component (source: authors)

If it is necessary to measure the components from the 5-sides and 2D camera module is about 400 mm high and the prescribed distance from the telecentric lens to component is approximately 300 mm, it was necessary to design a construction of portal manipulator which not add too much error into the results. Serial rotary construction would require to gain height by approximately 400 mm and errors in the positioning of the rotary axes should be transferred to the long arm of approximately 700 mm therefore was chose a static camera and additional mirror. If necessary, the mirror is tilted into the working position (45 °) and can rotate about a vertical axis.

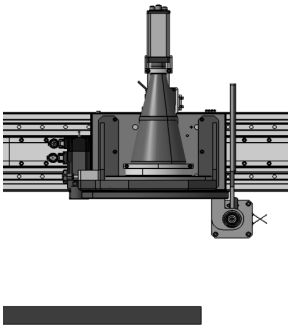

Fig.3. Checking and measuring of part from TOP (source: authors)

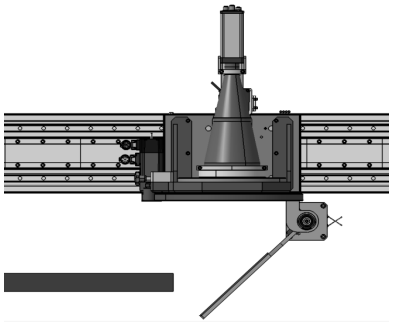

Fig.4. Checking and measuring of part from SIDES (source: authors)

1.4. 3D Camera Module

Accuracy in X, Y-axis is 0.1 mm and 0.03 mm in the Z-axis. The maximum height of the measured component is 100 mm, the width of the one scan max. 50 mm. 3D camera system consists of a line laser and camera system, which are located in one housing with a fixed geometry. As a whole is then calibrated by the manufacturer.

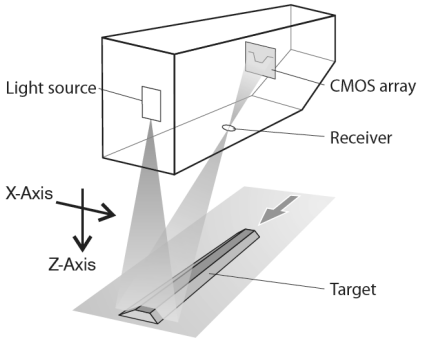

Fig.5. 3D Camera system (source:http://www.micro-epsilon.com/)

1.3. Module of configurable 3D camera system

The advantage of this system is its openness. Geometry line lasers and 3D camera system can be set to a specific range of components, thus we can reduce the unused portions of the field of view of the camera system and thus can increase the accuracy of the entire measurement subsystem. After resetting the system must be calibrated. Accuracy in X and Y-axis is 0.05 mm and the Z-axis is 0.03 mm. That system offers the possibility of line scan and 2D shooting with an accuracy of 0,025 mm in the X-axis.

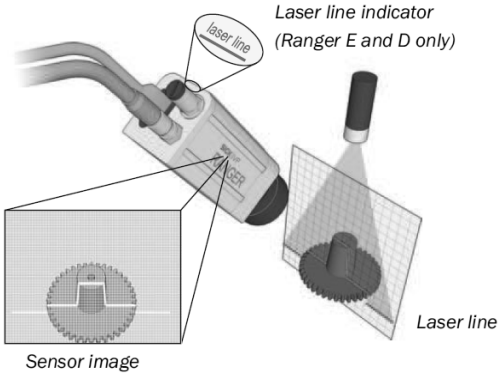

Fig.6. 3D camera system [1]

Process of check / measure

In measurement process handling subsystem positioning sensor subsystem continuous over component in the X-axis, then moved 100 mm in Y direction and the process is repeated until it

scan the entire component. The result scan can be processed and stored as a whole. In addition to the 3D information provide 3D camera 2D information in 8-bit color depth.

2. CONCLUSION

Camera systems are an integral part in designing automated measuring devices. The machining process is highly automated and therefore different types of camera systems largely contribute to the analysis and identify the required parameters of the components in the process control / measure / inspection. Using information and communication technologies can be adapted to automated measurement equipment conditions in practice.

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Ergonomics of workplace, light conditions, economic efficiency,

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IMPROVEMENT OF WORKING ENVIRONMENT OF COMPANY HESSEL SLOVAKIA

Abstract

The paper deals with improvement of working environment of Hessel Slovakia in terms of ergonomics with respect to light conditions. Based on assessment of illumination new lighting concept using LED was designed. Project on implementation consisted of preparation, approval processes and realization phase is described. Beside the esthetical aspect, better illumination parameters, positive effect on workers as well as energy saving was achieved.

1. INTRODUCTIOM

Lean production, standardization, best practice and customer satisfaction are current trends and tending of most of the companies. Here, worker is considered to be in the centre of attention for driving of lean processes. Companies use several methods focusing on lean principles; however, there is equal important feedback of workers which as a best practice method shows the weaknesses and opportunities for improvement.

Company Hessel Slovakia, s.r.o. decided to conduct a survey aimed to areas of ergonomics, working environment and subjective motivation factors. It was found out that 75% of workers were not satisfied with level of light conditions. They pointed out possible negative influence on quality of work or effect on exhaustion at work.

Lighting conditions and illumination are discussed topics of ergonomics research for a long time. For example, Yagi et al. (1998) examined variations of eye fixation related potentials (EFRPs)for two tasks under three lighting conditions for assessment of lighting environments. More recently, Juslen et al. (2007) reported on effect of illuminance on the speed and the quality (percentage of errors) with which workers assemble electronic devices. As the company considered this to be a wide problem, project with the aim to evaluate the lighting conditions was carried out. Submitted paper describes the preparation, approval as well as realisation phase of the project.

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2. METHODOLOGY

In preparation phase, evaluation of the level of lighting conditions was conducted. Illumination was measured for daylight conditions, artificial conditions as well as mixed conditions. Standard methodology was used (Rybar, 1996; Schwarz, 2009). Measurements were done in measuring grid across the production hall; conditions were measured at selected workplaces as well. For visualization, interpolation methods using GIS (ESRI ArcView) were used. Obtained data were compared with legal standards (no. 541/2007; STN EN 12464-1; STN EN 12464-1:2004. Details can be found in Szakallosova (2011). For approving process following analyses were applied: Swot analyses, Critical Chain Method, labor requirements, planning of technical sources, econmical effect calculation (return of investment). At the end, new lighting system was implemented and the benefits for emploeeys and company were summarized.

3. RESULTS

3.1. Preparation phase: Assessment of illuminance of the workplace and suggested solutions

Results of illumination measurement are given in Figure 1. (A –values of illuminance during daylight – morning shift (11 a.m.,), B - values of illuminance during artificial conditions – during night shift (8:30 p.m.), C - values of illuminance during mixed conditions (10 a.m., 12a.m.). Also, the illuminance of selected workplaces was measured. It was found that the conditions were not with requirements of Ministry of health and STN EN 12464-1. Following areas were insufficient: values of illuminance, uniformity of illuminance, sun blindness at the workplaces near windows, visually demanding operations were under- lighted.

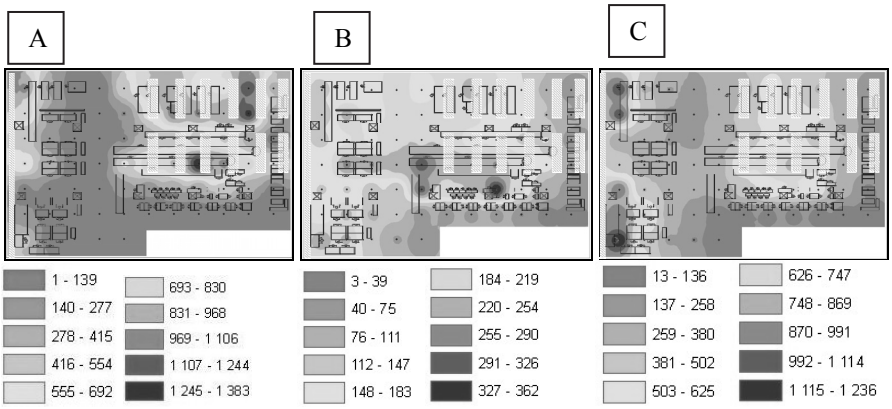

Fig.1. Illuminance (in lux) alues for the three lighting conditions (Szakallosova, 2011)

3.2. Approval phase

After determination the failing in terms of lighting conditions, several technical solutions for improvements were considered. Company selected the LED technology for replacement of existing lighting system. This was because of economic efficiency of the operation as well as

ergonomics benefits as colour temperature and CRI index. Next, project team and its responsibilities were named. Following steps were conducted in order to implement the project.
1. Gantt chart

All activities were divided into three main groups: Preparation and approval processes and realization phase. Their controlling was ensured by planning in Gantt chart.
2. Theory of constrains

Constrain:	Origin:	Action:
Pilot analysis is out of goal	Ineffective ROI index	Review of financial inputs: financial service provider, technology chosen, supplier, installation process
Unsatisfactory results of the validation phase	Parameters does not comply prescribed/requirements vs. declared	redefinition for the supplier, possible postpone of implementation accepted
Finance	loan disapproval	Selection of other lender(bank, leasing company) with worse conditions , considering the ROI
Shipment damage, incomplete, non working		conditions of shipment should be agreed before purchase, payment conditions - after delivery and checking the shipment
Problems with installation	supplier/implementer	if supplier - conditions in agreement, acceptable extra time 14 days, acceptable extra costs 2.000eur

3. SWOT analysis

Strengths Cost saving for lighting of prodcution Possitive effect on workers Possitive effect on non direct factors which influence production quality Possitive effect on environment Possitive visual effect Technical solution which enables unlimited number of swithing on and off Cost saving on maintainanvce and repairs of lighting system	**Weaknesses** Own assessment (not contractor based) – not considering all aspects Limited life cycle of lighting system Price of spare parts (if not MOQ)
Opportunities Possibilities of use of movement sensor Productiong of supplementary in own organisation – offer to market Extension of own production offer with complet solution (methodoloy, sourcing, lighting system of halls and building)	**Threats** When purchase outside EU possible non compatibility with NN network Sudden dropout of functionality after 2 years warranty Work safety while instalation in own responsibility Incorrect instalation - damage

4. Critical chain method

Critical chain elemets	reason	Buffering
Members of project team	Work load with operative tasks	Regurral meating ones to twice per week
Problemms with	Possible purchase	Early verification of commodity from

supplier/commodity	outside EU	selected countries
Legal restrictions	Possible purchase outside EU	Early verification of legal restrictions when purchase outside EU
Internal environment of company	Installation in own overhead	Preparation of cost offers, selection of supplier(contractor) in case of need

5. Capa planning

Capacity planning was done for the alternative of realisation under own supervision. It was calculated, that labour requirements were estimated for 1 worker for 11 weeks and 7 people for 2 weeks for the final installation.

2.3 Realisation phase and benefits

After all analyses, management decided for realization under own supervision. After the installation of new LED lighting system, there were several benefits for workers as well as company. From the ergonomic point of view, the LED lighting enabled better illumination, good colour rendering index and colour temperature. In terms of economic efficiency, the energy costs were reduced by approximately 66% with return of investment of 2.6 years.

3. CONCLUSION

Ergonomics and effect of lighting conditions is important aspect of lean implementation. Survey showed that workers perceive their work environment and consider it to be linked to the production quality and work efficiency. Company Hessel Slovakia decided to aim at lighting conditions. Implementation of new LED lighting technology delivered all benefits expected. Beside the esthetical aspect, better illumination parameters, decrease of energy costs by 66% was achieved. From ergonomic point of view, new system had good impact on works. It is necessary to mention the CRI and colour temperature of the system could be considered as the biggest improvements for working environment. The project received positive respond not only from employees but also from customers and authorities.

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Stereoscopy, viewing angle, stereoscopic base

Martin GAŠO[*], Martina SMUTNÁ[**]

CREATING OF CORRECT STEREOSCOPIC RECORD WITH PARALLEL AXES FOR CAMERAS

Abstract

The article deals the issue of creating a stereoscopic video using two independent cameras in parallel set of axes. When is creating stereoscopic record, is important that the resulting image was correct in terms of biological needs of the human eye. Tracking error of the record could be annoying for the observer even harmful. The aim of the article is to present the impact of individual input parameters on the resulting stereoscopic correctness of the record.

INTRODUCITION

To understand the impact of various input parameters on the resulting stereoscopic correctness is necessary to determine the importance of individual input parameters. This importance is the development of values of output parameters, the continuous change in the values of individual input parameters. The mathematical model on which the individual relations processed is described in doctoral thesis of one of the authors of this article [1]. In creating stereoscopic it is necessary know how the various input parameters influence, and ultimately change, resulting stereoscopic parameters. The correctness of the resulting stereoscopic hardest decisions two output parameters, which are:

1. The absolute value of the mutual shift points between the left and right images, the value of which should not exceed 63,5 mm.
2. Observation (paralactic) angle, that is the angle which grips observer with selected elements of the left and right image, the value of which should not exceed 1,5°.

1. EFFECT OF INPUT PARAMETERS FOR CORRECTNESS OF STEREOSCOPIC RECORD

Effect of input parameters described in the article is valid only for variant parallel axes cameras. Variant converging axes of cameras requires a different approach due to the different geometry of the camera system and different mathematical relationships between variables.

When examining the impact of input parameters on the resulting stereoscopic correctness we will focus mainly on the following input parameters: 1) Distance of the nearest point. 2)

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The distance cameras. 3) The distance of the observer. Graphs will show the values of output parameters at two different stereoscopic display devices, which are among the technical equipment of the Department of Industrial Engineering. Specifically:

1. Monitor Samsung SyncMaster 2233RZ *(http://www.samsung.com),*
2. Projector DepthQ *(http://www.depthq.com)*.

1.1. Distance to the nearest point and cameras distance

Affect the distance the nearest point on the scanned output parameters is shown in figure (Fig.1.).

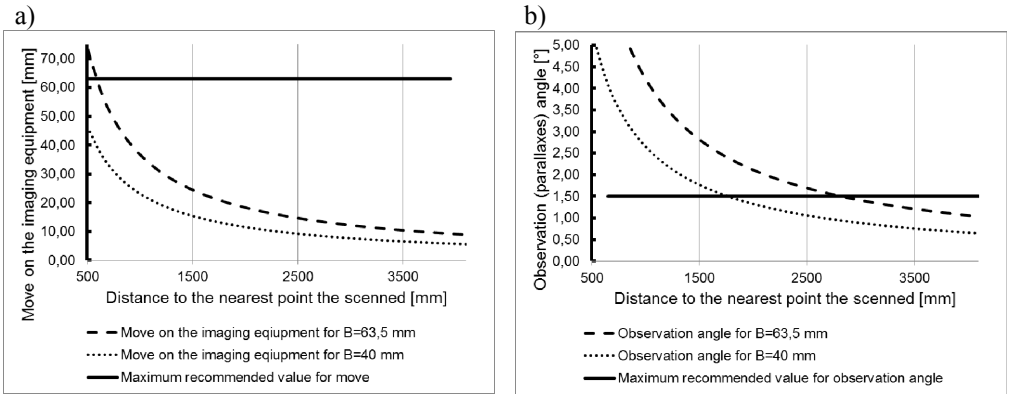

Fig.1. Shooting distance of the point if the display device is monitor
a) Evaluation of mutual shift image, b) Rating viewing angle

On the principal axis x - wall distance values are plotted nearest point. On the y- axis are in the chart "and" plotted the resulting values of mutual displacement of images on a display medium. On the y- axis in the graph "b" values are plotted resulting viewing angle provided a standard viewing distance from the monitor, which was set to 0.5 m. For both output parameters are plotted maximum recommended values.

Graph illustrates changes in these output parameters when changing the distance of the nearest point. All curves have a concave shape, converge to zero. The mutual comparison of the two output parameters, it is clear that the value of the maximum recommended viewing angle is much stricter than the recommended maximum mutual displacement images. This fact is due to the relatively small size of the observation device. With increasing dimension of the display device, proportionally increasing the absolute value of the mutual displacement of images, the same record. In this case it is necessary to take into account the maximum permissible parameter viewing angle , which is not only more stringent criterion , but also more accurate because better represents the biological nature of human spatial vision.

The chart also seen that varying the distance between the cameras can be achieved eligibility for output parameters. When changing the camera distance from 63.5 mm to 40 mm, it is possible to reduce the minimum distance from the nearest point of about 2500 mm to 1500 mm, while maintaining the same final viewing angle to 1.5 °. In practical terms, this means that you can change your camera correctly to extend the scope of recordable space.

A similar case is when surveillance equipment for select projector (Fig.2). Graph is to a certain extent that of the previous graph. The difference is, however, observables, which in this case is a diagonal image projector 4.6 m. For calculating the viewing angle of the observer standard length set to 4 m. These individual curves are comparable with the previous graph. Resulting value of output parameters can also be affected by mutual zoom camera as before.

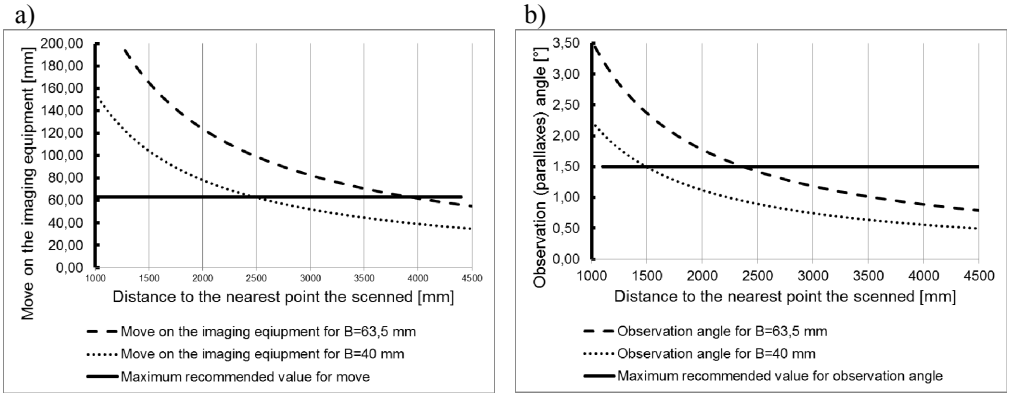

Fig.2. Shooting distance of the point if display device is a projector,
a) Mutual evaluation of image shift, b) Rating viewing angle

Significant difference when comparing the values of the two output parameters. In this case, the parameter recommended maximum absolute value of the mutual shift parameter is stricter than the final viewing angle. This is caused by expansion of the display device. When you create a stereoscopic recording on storage media created a mutual shift images. The absolute value of this shift is directly tied to the size of display media and therefore will increase the size of these media, grow its value. The absolute value of the shift, we can say that the change occurs if and only if we change the dimensions of the display device.

Therefore, we cannot in creating stereoscopic , which will be designed for large-scale screening consider only the resulting value of viewing angle , but we must also check the resulting absolute value of the mutual shift images.

The resulting viewing angle is a parameter which can be influenced by the change of the viewing distance. Thanks to this parameter becomes very important and it is necessary to accurately quantify its evolution when changing the viewing distance.

1.2. Distance of the observer from imaging media

Distance of the observer from the imaging medium is an indication that you need to know before by the execution of stereoscopic recording. It is necessary to lay out the presentation room, whether it is a large screen projection or only a relatively small monitor.

Graph (Fig.3.a) shows the evolution of viewing angle (axis "x") when changing the viewing distance (axis "y"). The chart "and" Monitor was display device in graph "b" projector. As a basic setting was chosen distance 63.5 mm cameras and the recording nearest point distance of 1.5 m.

As the chart shows that the 22 "monitor and the default setting of cameras, a minimum distance of 1 meter observer. If desired, a shorter distance the observer is necessary to change

the distance cameras, resp. reducing it to the level of 40 cm. Of the movie can be seen from a distance of 60 cm, while maintaining its correctness.

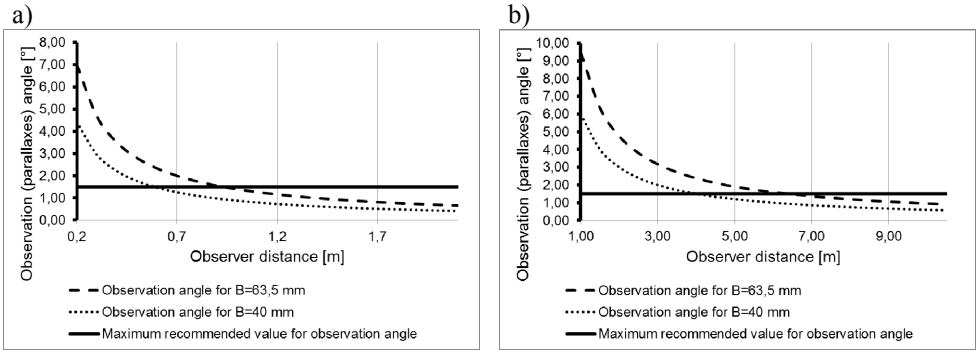

Fig.3. Distance of the observer from imaging device
a) Imaging device is monitor, b) Imaging device is projector

Another advantage of changes in the viewing distance is the ability to achieve fair presentation of stereoscopic created under restricted conditions. For example, if the layout of the space does not permit to create three-dimensional recording of a distance, it is possible in spite of stereoscopic create a record for which the correct turn determines the minimum viewing distance.

Graph (Fig.3.b) also shows the evolution of viewing angle (axis " x ") when changing the viewing distance (axis "y "), but in this case, the display device is a projector with a diagonal image 4.6 m . These individual curves are similar to curves is in the previous chart. The only difference is in the range of distances observer. Even in this case, all rules apply as above. However, in this case it is necessary to control the parameter of absolute mutual image shift.

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expert system, eco-efficiency, optimization

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EXPERT SYSTEM CONCEPT FOR EVALUATION AND IMPROVEMENT OF MINES ECO-EFFICIENCY

Abstract

The paper presents the concept of building an expert system used for complex evaluation and optimization of coal mines, referring to eco-efficiency. The complexity and diversity of technological processes for particular mines makes it difficult to build the expert system because the system has to be suitable for any Polish mine. The considered system is not a classical expert system, but rather an information system which, using a variety of tools, acts as an advisory for a mining company executives.

1. INTRODUCTION

The doctrine of sustainable development requires taking into account during the design process its impact on the environment. Various measures of the impact are used. One of the most popular techniques are eco-indices those are determined basing on analysis of the product life cycle (called LCA method - Life Cycle Assessment) and based on the eco-indices, a new index called eco-efficiency that expresses a benefit in comparison with the influence of the process on the environment [1,2]. The purpose of the designed expert system is to enable the evaluation of the technological process carried out at the mine in terms of its impact on the environment. The system will serve for the management as a decision support system in case of either new investments or coal mining technology modifications.

Comparing these technological processes, with the process we can state that the coal mining process is much more complex. It takes several steps. Sequence of particular stages strongly depends on the local conditions of a mine, the availability of deposits and market conditions. Information systems in mining enterprises are not as clearly defined as in the case of industries based on the classical technological lines. This makes it difficult to create expert systems supporting the management of a mine. In the scientific literature there are few publications in this field. Among the described in the literature expert systems there are strongly represented systems from the area of security [3, 4]. There also are expert systems covering a wider range of issues, including optimization of the mining company [5,6], however, often focusing on the economics of the mine, or on some fragmentary processes and not on the overall coal mining process itself. The designed system shall allow both to assess the

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current state of the mine and support decision-making. The two main tasks of the designed expert system are reflected in its main elements: evaluating part of the expert system and advisory part of the expert system. The complexity of the system, its unusual, heterogeneous structure makes it difficult to be applied to the construction of the system some standard tools available on the market (such as skeletal expert systems). For this reason, a dedicated expert system will be built based on the software platform .NET, which provides a wide range of tools for working with data stored in relational databases and XML files, presentation frameworks and a wide range of libraries useful in the creation of expert systems.

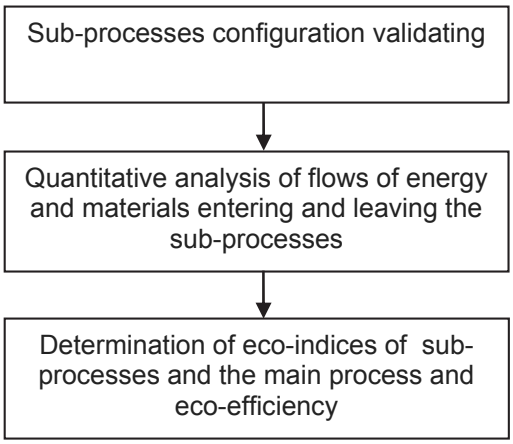

Fig.1. Layers of the evaluating part of the expert system.

2. EVALUATING PART OF THE EXPERT SYSTEM

Evaluating part of the proposed expert system must have a multilayer structure shown in Fig. 1. Output of previous layer enables the implementation of the functionality of the next layer. The functionality implemented in this layer will be made on the basis of a classical expert system that uses a knowledge base stored in the form of rules. Because at different mines there are run very different technological processes, the only way for knowledge acquisition is the method of interviews with experts.

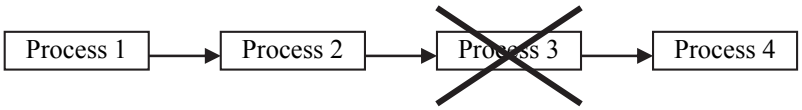

Fig.2. A chain of sub-processes.

The first part of the knowledge base will contain rules describing the presence or lack of presence, within the chain of coal mining process, various variants of sub-processes (Fig. 2). E.g. it could be rules in the following form:

IF "local conditions" AND "neighboring sub-processes" THEN "a sub-process exists/does not exist"

Each process can be described in the knowledge base as a separate decision-making module [7], in which all rules have the same attribute in the conclusion part, taking the value of the process acceptance or rejection in a determined place of the processes chain. Such a module would contain only the rules directly connecting the inputs of the decision unit with its outputs. The role of the inference engine boils down to finding a matching rule for the process and its environment. The second part of the knowledge base includes rules regarding the selection of models for the determination of parameters of sub-processes involved. E.g. it could be rules in the following form:

IF "local conditions" AND "preceding sub-processes" THEN "parameter_model(local conditions)

Also here, each process can be described in the knowledge base for a separate decision-making module that output attribute indicates a mathematical model allowing to determine quantitative parameters of a sub-process. Models used for determination of the process parameters of the models forming the base, will be coded either in the form of logical functions or mathematical formulas encoded in the form of modules. NET (called. NET assembles). On the basis of accumulated knowledge expert system assesses whether entered by a user process chain partial structure and processes parameters are consistent with the technological knowledge acquired from the experts. In addition, this layer of the system can support the user in the design process of coal mining technology, indicating that processes must or cannot be added to the chain of sub-processes, and may advise the most suitable quantitative parameters of these processes. This functionality goes beyond the main objectives of the proposed expert system, but it can be a very useful feature for the user of the system.

After setting process chain describing the technology of coal mining one can proceed to the quantitative analysis of flows of energy and materials processed by the various sub-processes. The models are built based on artificial intelligence algorithms (starting from a linear regression on the number of variants ending neural networks) . The choice of a particular method will depend on the availability of data and the complexity of dependences binding the input and output fluxes. However, the specifics of mining processes, expressed in both: their low reproducibility and incomplete monitoring, indicates that for most sub- processes one will require the construction of models based on both: an interview with an expert and writing dependences in the form of formulas . An indirect way may be to create a part of the rules on the basis of data [8, 9], and then complement and correction on the basis of interviews. Models created using both techniques will be stored in the database in the form of compiled modules .NET (called assemblies).

3. ADVISORY PART OF THE EXPERT SYSTEM.

The advisory part of the expert system, supporting managing staff in improving the eco-efficiency at the mine, is a development of the evaluation part with algorithms for numerical optimization, which used, as a optimization criterion, the value of eco-efficiency, that is determined in the evaluation part of the system. Optimization of the system will be implemented in two nested cycles associated with the corresponding layers of the evaluation part. External cycle will perform combinatorial optimization of the sub-processes chain that creates the global technological process of the mine. This cycle will be implemented based on an evolutionary algorithm as a low cost computing designate the criterion function, allows one to apply algorithms that perform well in combinatorial tasks (present in the cycle), and significantly increase the probability of finding the global optimum.

4. SUMMARY

The paper presents the concept of being built expert system used for a comprehensive assessment of a coal mine in Polish circumstances. This comprehensive assessment, taking into account technical, economic, social and environmental issues, is called eco-efficiency. At this stage of the study, a preliminary selection and aggregation of relevant processes occurring in coal mines have been done. Takes into account the current structure of coal production processes, basing on the knowledge and experience of mining experts and existing models of mine (that have been updated taking into account the conditions of operation of the national coal mines). The process of coal production is defined as a system of sub-processes, activities, and technological operations carried out in a specific time and space, performed by human teams using specific technical measures in place to produce commercial coal of specified quality parameters.

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Product, Prototyp, Reconfiguration

Michal HALUŠKA*, Róbert SASIK**, Milan GREGOR***, Patrik GRZNÁR****

RECONFIGURABLE ASSEMBLY SET OF THE LOGISTIC TRANSPORT SOLUTION

Abstract

Reconfigurability has become as a new engineering technology which has a significantly impact on the changes in design. Reconfigurable manufacturing systems should be designed so that they can effectively respond to changes in the product requirements. Currently reconfigurable products will be a great benefit for customers and also a big challenge for designers of the manufacturing systems.

1. INTRODUCTION

The aim of today's enterprises is to produce a different variants of the products that ensure their profitability. Due to the fact the enterprises must to focus on the customer requirements and low cost production. An acceptable alternative is the production of modular product components that can be easily and quickly mounted on the basis of the actual requirements of customer (personalized product). However the customers will much more prefer a product that can be easily reconfigured. Each configuration is represented by the specific product. But it is necessary to take into account the modular architecture of the product, which allows us to propose a reconfigurable product. Modularity of the product is a sufficient but not necessary condition for creating reconfigurable product. Reconfigurable product must be convertible from one shape to another or scalable.

According to the Koren (2010) the basic characteristics of reconfigurable product can include:

- **Modularity** – Product modularity enables the change of product shape to fit the various customers and utilizations.
- **Integrability** – Integrability refers to defined module interfaces (mechanical, electrical, and information) for ease of product reconfiguration and customization.
- **Customization** – Customization provides customers with just the product functions they need, and not features that they will not use.

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- **Convertibility** – Convertibility enables products to be changed to fulfil various utilizations of the same product.
- **Scalability** – Scalability allows a product to be scaled up or down to fit to the user's body or applications.
- **Diagnosibility** – Diagnosibility means that a product is designed with embedded diagnostic functions, for easy service and maintenance.

Due to the rapidly changes customer requirements, manufacturers must have manufacturing system that will offer different levels of response to changing the customer demand but also reckon with new practices in the field of design.

2. ASSEMBLY SET OF THE PROTOTYPE

In laboratory ZIMS was designed and subsequently produced the first mounting assembly prototype of the logistic transport solution. The mission of the prototype is to integrate the advanced technologies and workplaces in the laboratory. It should be also noted that the product will be used to developing of different variants, which include production of product with different features. From the point of view, the product must be modular and should suggest also other modules, which will be easy integrable and implementable. Replacing of the components can affect the added value, which can product created.

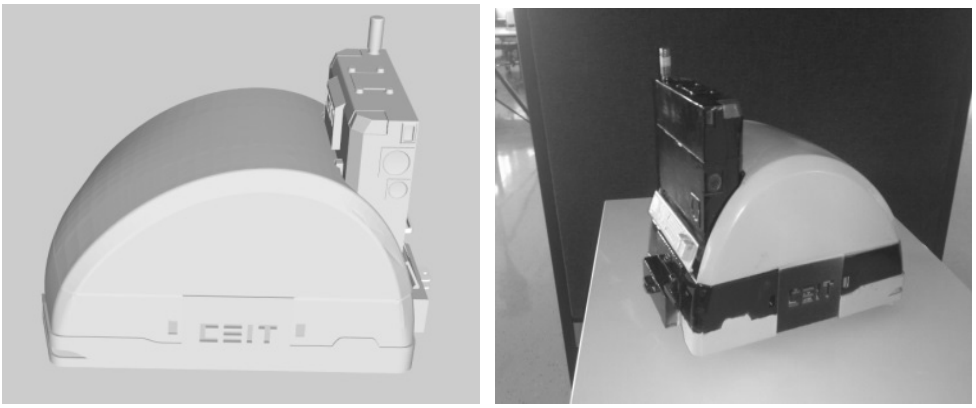

Fig.1. Prototype of the assembly set

Basic components of the assembly set include front axle, rear axle, shell, I. part of the logical box, II. part of the logical box and screws. In the mounting assemblies is also possible to incorporate chassis that is navigated through bluetooth chip and also chassis which is navigated through infrared communication interface.

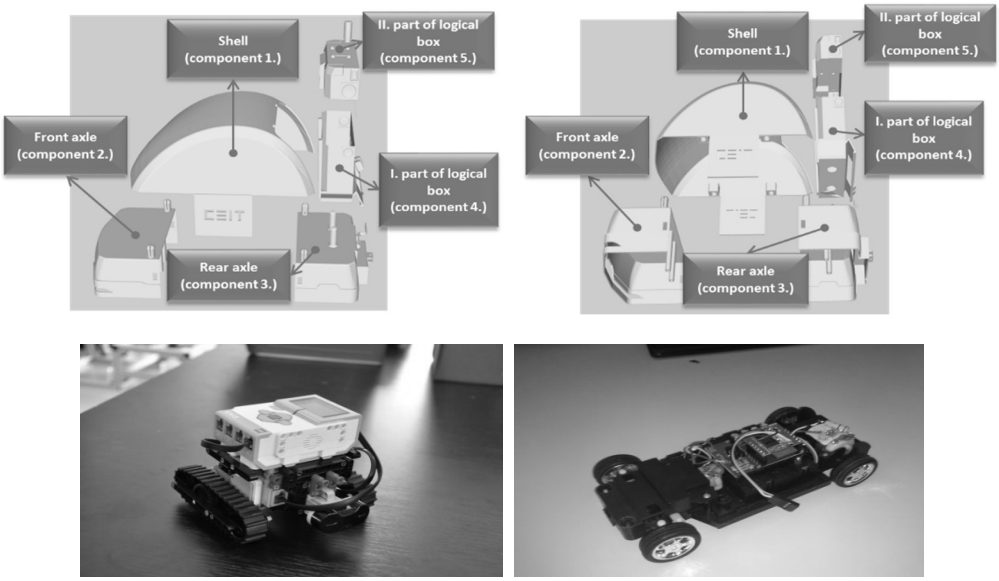

Fig.2. Components of the assembly set

Assembly set was designed in Google SketchUp and virtual models of the individual components were used for prototyping in 3D printer Dimension. After printing was carried out surface modification of each component which included cementing, sanding of outer surfaces and spattering with colour spray.

Fig.3. 3D printer Dimension and components of the assembly set

Assembly set is represented by the reconfigurable product which possesses of essential characteristics of the reconfigurability as modularity, integrability of new functions and convertibility. It is also possible to easy change and integrate individual components.

3. FUNCTIONAL ANALYSIS

There was also performed functional significance analysis of the individual system components from which is evidently clear that the most important link in the functional set is chassis that consists of logical components.

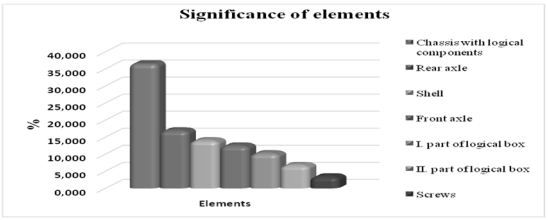

Fig.4. Graphic representation of the significance of individual elements

Simultaneously was also identified satisfaction fulfilment rate for each function which shows the direction of the further improving. Among the critical functions of the product can be assign control of movement direction, protection against external environment, reusability and quality of image recognition.

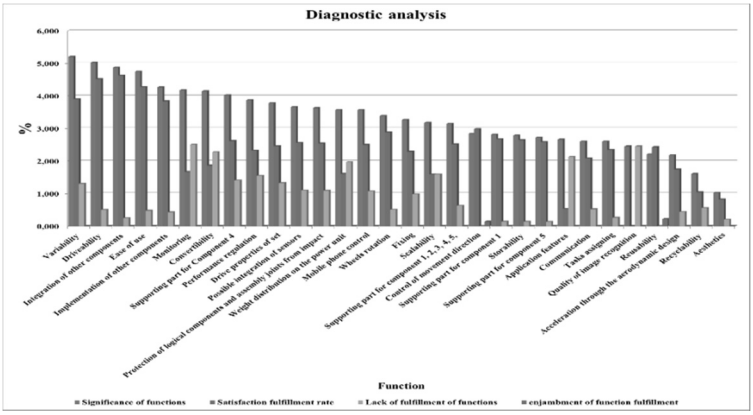

Fig.5. Diagnostic analysis of functions

4. CONCLUSION

From the functional analysis is evident that product has still deficiencies in control but also in the level of possible reconfiguration. The product will be used not only for the integration of technologies in laboratory ZIMS but also for the direct development of the own logical platform and product variants.

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operations management, manual, education, multimedia.

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MULTIMEDIA MANUAL FOR THE PURPOSE OF MODERNIZATION OF EDUCATIONAL PROCESS

Abstract

The article discusses the results of a project focused on electronic education and the development of an algorithm for creating a multimedia manual, which has been verified during the development of a manual for the subject Operations Management, taught at the Department of Industrial Engineering of the Faculty of Mechanical Engineering at the University of Žilina. Multimedia manual is intended to improve he knowledge of the operational management and simulation. The emphasis is put on a modern and attractive form of presentation of its content.

1. INTRODUCTION

Nowadays, it the times of rapid development of information and communication technology, the mankind is being many new, progressive ways of presenting information. One of these forms is sharing information on the internet

Mass expansion of the Internet, increasing transmission speeds and the exponential increase in supply of goods and services, which enable quick and uninterrupted access to the web have revolutionized not only the presentation of information, but also access to them. Any user connected to the Internet can search, view and listen to almost anything in a constantly expanding mass of data.

At the same time, however, it allows the user to create these data, place and share them with other users. It is a growing trend that must be respected in the field of education and training, as it is as a part of the system that must be innovated and improved through technical advances.

This growing tendency leads schools from around the world to create multimedia educational courses that are trying to meet the needs of students, and thus create a modern access to the information that can be accessed anytime, anywhere.

2. ADDRESING THE ISSUE

An algorithm for creating such a course was created at the Department of Industrial Engineering of Faculty of Mechanical Engineering at the University of Žilina. This algorithm consists of the following steps:

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1. Formulation of requirements and goals,
2. Analysis of the requirements and selection of a feasible technical solution,
3. Purchase of a domain,
4. Installation of a content management system,
5. Division of the content,
6. Creation of the graphical design,
7. Creation of a pilot version of the manual,
8. Installing modules and GUI,
9. Optimization,
10. Processing the content,
11. Uploading the content,
12. Debugging,
13. Documentation.

This algorithm was verified during the development of a manual for the subject Operations Management, taught at the Department of Industrial Engineering of the Faculty of Mechanical Engineering at the University of Žilina.

2. 1. A closer look at the algorithm

The first step was to define the characteristics, which the multimedia manual must meet and what is its purpose. They were determined as follows:

- interactivity,
- can be accessed at any time,
- responsive design (automatic adjustment of the page content to screen resolution of the device on which the page is being viewed),
- examples of exercises,
- glossary,
- clarity and legibility of the text,
- content corresponding with Operations Management,
- modern and for students attractive form,
- option to edit or update the content without programming knowledge,
- and others.

The main objective of the manual is the option to deepen, complement and recap the knowledge gained during the course of Operations Management subject.

The second step consisted of an analysis of these requirements and subsequent selection of a feasible technical solution. We decided to develop the manual as an interactive and responsive web site, with CMS WordPress used for management. The advantage of content management systems is the ability of site administrator, or other contributor (e.g. teacher) to upload and manage learning materials in a simple way, without programming knowledge. These materials have a form of articles, and it is possible to define the type of article (lecture, exercise, etc.), which is used to organize the content on the site. Student or other person obtains access to the site after entering a username and password provided by the administrator.

In order to be able to access the web page, it was necessary to purchase a domain. Domain serves in URL as a unique string identifier of a particular web page. We have registered domain "www.operacnymanazment.sk".

In the next step, content management system was installed on the server, together with database, where CMS data are stored.

The fifth step consisted of the division of multimedia manual into four main parts – lectures, exercises, collection of assignments, and glossary. Each of these parts may contain unlimited number of sub-headings (e.g. Lecture 1, Lecture 2, …, Lecture N).

The creation of the algorithm was for the purpose of creation of e-learning system. The user does not perceive this system – he "sees" only a webpage. For this very reason, we have focused within the design of the website to maximize simplicity and clarity. We chose a single main menu for the whole website, which will serve as navigation by content type. The main menu links to:

- Home page,
- Lectures,
- Exercises (video tutorials),
- Glossary,
- Collection of assignments,
- Contact.

Subsequently, a basic graphic design of the page layout was created, along with background and logo. Within graphics, we used modern, minimalist design, focused mainly on the clarity and readability of the text on various types of devices.

In the next step the graphics and plugins were installed. These plugins were used to replace the native text editor as well as creating custom fields. In the replacing text editor we can find, unlike the original one some advanced features that significantly increase the ease of adding and formatting text.

Custom fields can be used to create more complex structures of a web page. In our case, this module was used to create three switchable alternate page layouts – one for sections with video, one for solved assignments, and one for the rest of the sections.

3. PROCESSING THE CONTENT

The content was processed depending on whether it was a lecture, exercise, an assignment or glossary. Processing was carried out parallel with the processing of technical requisites of the website. Content was divided into individual units, in accordance with the schedule of the subject and adapted to format suitable for presentation on a website. The terms from each unit were also processed and added with their explanation to the Glossary section. Within the exercise category, we used presentation in the form of narrated video tutorials, which had also text descriptions and explanations. Assignment collection category contains practice assignments, along with their results and procedure of solving.

After processing lecturing materials and video tutorials, these materials were uploaded on the website. After the upload, visual inspection and additional editing was carried out, for achieving the best possible clarity.

In addition to the creation of the multimedia manual itself, also a complete documentation for its administration and creation of additional lessons was made. Since the multimedia manual was developed as an open system, further editing, development and expansion is possible.

Possible extensions can be divided into content extensions (e.g. adding news about modern trends in operational management), the extension of the target group (e.g. viewing of content not only by students of the Department of Industrial Engineering) and technical extensions (e.g. the inclusion of electronic testing).

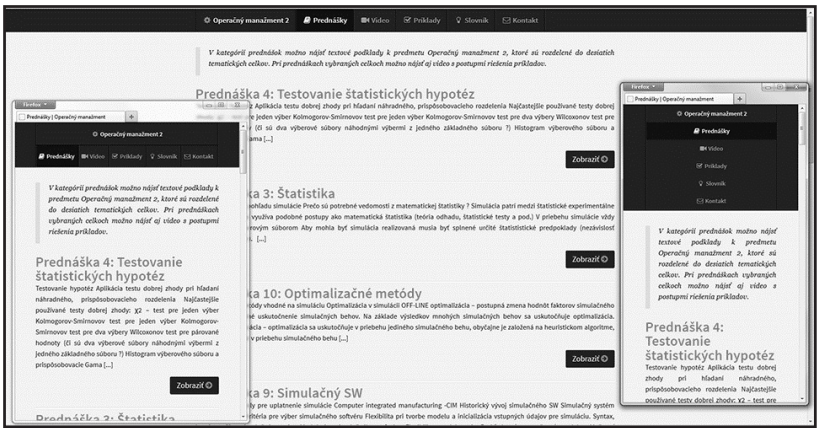

Fig. 1. Example of the developed multimedia manual

4. CONCLUSION

The development of the multimedia manual was conducted in accordance with the formulated algorithm, witch verified its functionality. The creation process itself can be divided into four main parts: processing of the technical functionalities, content processing, filling the manual with processed content, and documentation. The main contributions can be summarized as follows:

- Creation of a new, modern and interactive form of presentation of the contents of the Operations Management subject,
- optimization of the multimedia manual for modern multimedia devices (PCs, tablets, smartphones),
- creation of narrated video tutorials in HD quality for deepening knowledge needed to work in the software Tecnomatix PlantSimulation,
- creation of a collection of assignments for the students' possibility of practice,
- development of an algorithm for creating multimedia manuals,
- creation of a manual for administration of the manual and for creation of video lessons.

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Plant layout design, genetic algorithm

Viktor HANČINSKÝ*, Martin KRAJČOVIČ**, Józef MATUSZEK***

GENETIC ALGORITHMS WITHIN PLANT DESIGN

Abstract

The article is focused on the presentation of genetic algorithms, and their use for the design of plant layout. Within the article, the basic operation of genetic algorithm is discussed, its history, operators and advantages along with examples of their usage for solving the facility layout problem.

1. INTRODUCTION

In today's rapidly evolving industry, designing an effective plant layout has become one of the most important parts of industrial engineering. Effective plant layout is essential in a constant struggle for customer. Short transport routes, high throughput, flexible response to change, all these aspects lead to a competitive advantage by reducing production costs and increasing production capacity. In general, the facility layout problem can be defined as the search for the best arrangement of physical objects, which ensures the most effective operation of these facilities. Therefore, we can say, that the main objective of plant layout design is a more effective work flow at the facility, allowing workers and equipment being more productive.

Through time, methods for designing plant layout were improved. One of relatively new method is the design using genetic algorithms. In the following sections, we will discuss their principles and application for facility design problem.

2. INTRODUCTION TO GENETIC ALGORITHMS

Genetic algorithms are based on the Darwinian principle of natural evolution that he described in his book "On the Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life"(1859). The idea of life, which is evolving in time – new forms of life replacing the old existed even before Darwin, but it was this publication that brought a revolution of the perception of life on Earth. Together with other disciples they gradually formulated the laws of classical genetics and the basic principles of reproduction. In the twentieth century these principles extended into other, than biological fields.

In the seventies of the twentieth century, genetic algorithm was proposed by J.H.Holland as an abstraction of appropriate genetic processes. A decade later, genetic algorithms became one of

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major rapidly developing fields of informatics and artificial intelligence. The basic procedure of genetic algorithm can be seen in Figure 1.

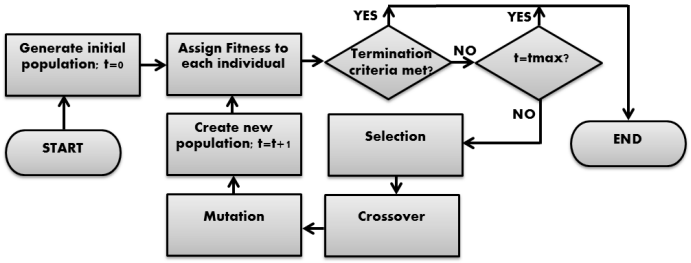

Fig.1. Basic genetic algorithm

2.1. Selection

Within selection of parents, we can choose between multiple selection rules including:

Roulette mechanism (fitness-proportionate selection) – In roulette mechanism, all individuals have a chance of being selected at any given point. The probability that a given individual will be selected is proportional to its fitness value. For creating this „roulette" it is necessary to sum fitness values of all individuals and then assign circular sectors to each of them. The size of a circular sector given to individual „j" is then adequate to the proportion of the fitness of individual „j" and this sum. This is the most common type of selection (Hynek, 2008).

After studying various modifications of this mechanism, J. E. Baker designed an improvement – instead of the cycle of k-fold use of roulette and gradual selection of k-individuals, roulette mechanism will be carried out only once and all k-individuals will be selected at once. Mechanism does not work with only one „roulette ball," but k-balls, which are equally spaced around the circumference of roulette. This method can be found in literature as stochastic universal sampling.

Roulette mechanism (rank selection) – to suppress the effect of above-average individuals (reducing the selection pressure) J.E. Baker designed a modified version of the mechanism, in which individuals are ranked in ascending order according to their fitness value. This type of selection offers a better chance of maintaining diversity of the population, but can also lead to slower convergence, because the difference between the individuals is not so considerable.

-	Individual 1	Individual 2	Individual 3	Individual 4
Fitness	25	5	3	10
p_{fps}	58%	12%	7%	23%
Rank	1	3	4	2
p_{rs}	40%	20%	10%	30%

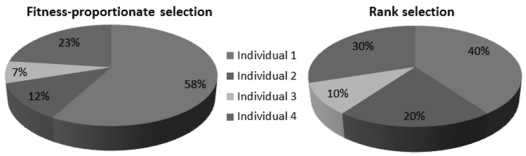

Fig.2. Selection probability distribution of individuals by roulette mechanism

Elitism – This method avoids losing so far the best solution found by copying this solution to the new generation before applying genetic operators. The rest of the selection continues by one of the other methods.

Steady-State Selection – The main purpose of this method is the survival of a large portion of individuals to the next generation. A specified number of the best and worst chromosomes are selected. The best chromosomes will then reproduce and their offspring replaces the weakest individuals. The remaining individuals proceed to the next generation unchanged.

Tournament mechanism – for each iteration, the mechanism chooses k-individuals (k-determines tournament size) and then selects the best of these individuals and moves it to the next generation. This process is repeated i-tims, where i is the size of the population.

To find the right balance between the selection of the finest individuals and the search of solution space (finding the right selection pressure) is one of the key aspects of effective search for a solution. Higher selection pressure leads to faster convergence, but increases the probability that the algorithm gets stuck in local minima. On the contrary, lower pressure prolongs the time needed to find a solution.

2.2. Crossover

In genetic algorithms, crossover is an analogy to chromosomal crossover and reproduction in biology on which they are based. It is a genetic operator, which is responsible for mutual exchange of parts of chromosomes.

In general, we can speak of a j-point crossover, where $n>j\geq 1$ (n = chromosome length). J–crossover points are generated, which divides the individual into j+1 strings, which are then exchanged between individuals. After further generalization we can speak of uniform crossover. During the creation of the first descendant, for every gene there will be a decision with probability p=0,5; from which parent it will inherit corresponding allele. The second descendant then inherits alleles from the second parent.

In case of representation of possible solution by real numbers, we can mention another types of crossover such as arithmetic (descendant allele is the arithmetic average of parental alleles) or geometric (descendant allele is the square root of the sum of the squares of parental alleles).

2.3. Mutation

Mutation is a genetic operator used to maintain genetic diversity of the population. Within mutation, one or more alleles in the chromosome are altered from their initial state. The main goal of mutation is to prevent algorithm from being stuck in local extreme by preventing excessive similarity of individuals. It is also important to determine the mutation rate within the genetic algorithm. If the probability is set too high, the algorithm can turn into a random search.

2.4. Evaluation

Formulation of the function whose output will be the information how good the solution encoded in given individual is, is one of the most important tasks when applying a genetic algorithm to solve a problem. Solution quality evaluation is usually based on fitness function, which returns real value for each possible solution. The higher the value (or lower, depending on the problem formulation), the better the potential solution is.

After applying a fitness function to each individual we obtain a set of points in n-dimensional space (hyper surface), which allows measuring problem solution quality. To effectively optimize defined problem, the fitness function must be clearly defined and individuals with higher score must be unambiguously favored.

3. EXAMPLES OF USAGE

In publication Genetic Algorithms for Optimizing Manufacturing Facility Layout (Nur Fadhillah Binti Saleh, et al., 2008), twelve papers dealing with different variations of this problem are mentioned, wherein for obtaining a solution they use genetic algorithms.

S. Gupta and S. and J. Kyparisis in 1996 used genetic algorithm to create product families and also to design a layout for individual manufacturing cells. The developed algorithm is focused more on the arrangement of cells or production facility areas, rather than creating layout inside the cells. The arrangement of machines in individual cells was not taken into account (Nur Fadhillah Binti Saleh, et al., 2008).

G. Suresh, V.V. Vinod and S. Sahu in 1995 used a genetic approach to solve a facility layout problem, where the aim was to minimize the cost of interaction between departments. Unlike the problem of organization of the production layout, facility layout problem focuses on finding the best layout of departments rather than actual machinery (Suresh, et al., 1995).

4. CONCLUSION

The aim of this paper was to present the possibility to use genetic algorithms for designing plant or a facility layout. This method can be classified as mathematical exchange method, with heuristic approach. As there are many examples of usage of evolutionary algorithms in modern industrial engineering, we can state, that further research of the various possibilities of combinations of the parameters and operators within genetic algorithms can produce significant results.

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Assembly line, line balancing

Jozef HNÁT[*], František KALL[**], Dariusz PLINTA[***]

ASSEMBLY LINE BALLANCING METHODS

Abstract

One of the greatest problems of assembly line design and optimization is balancing problem. This article is focused on different approaches for solution of presented problem. Three chosen methods are described and used for solutions of simple case study. Results of these solutions are then compared.

1. LINE BALLANCING

A line balancing problem is defined by a line along which products (vehicles) go through and are progressively assembled. The assembly operations are performed by workstations spread along the line. The objective is to assign operations to workstations in order to minimize, for instance the number of required workstations (workers), or we can say that objective is to balance the line. This is called a simple assembly line balancing problem (SALBP). If the line is not well balanced the idle times on workstations rise. The basic constraints are cycle time and precedence constraints.

Line balancing problem is considered as GALBP (General Assembly Line Balancing Problem) in case if it takes into account not only precedence constraints but also other attributes and limitations. Thus widespread problem includes solution of lines with mix-model production, lines with parallel workstations, U-shaped lines, lines with differently equipped workstations and the so on. A common feature of most line balancing problems is that one predefined precedence graph represents all possible precedence constraints between the operations. However, in real industry problems, there may be some parts of the manufacturing process replaced with alternatives, so there may be more variants of manufacturing process procedures. This is possible in many cases either assembly or disassembly of products for which there are multiple variations of production. So there is large space with possible solutions to the problem and it is needed to have effective tool for finding solution close to the optimum.

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1.1. Method of the shortest path in the network

One method that can solve the problem of balancing lines, is a procedure of optima search with the use of shortest path in the network. In order to solve task by this procedure it is necessary in particular to define and construct the corresponding network, i.e. define nodes and edges of such networks and their evaluation.

Let *Dr (r = 1, 2, ..., z)* is a complete set of all states, where *D1 = 0* and *Dz = A*, i.e. the state *D1* is an empty set and state *Dz* is a set of all operations.

By the state we mean a subset *D* of an ordered set *A* with given priorities *p* that could represent assignment of operations at first place, in conformity with the order *p* and irrespective of the tact time *c*. The set of all states is composed by all possible subsets *D* that can be carried out without previous completing of any operation and in any order that meets priority *p*.

Assign to each state a number equal to the sum of the operating times of individual operations, namely:

$$t(D_1) = 0, t(D_z) = 0, t(D_r) = \sum_{i \in D_r} t_i \,, (r = 2,3, \dots, z-1) \qquad (1)$$

Network *G* is defined by nodes corresponding to states D_r (node u_r responds to the state D_r) with the nodes values $t(D_r)$. Within the network *G* there will be oriented edge *(r, s)* from node *r* to node *s* if and only if $D_r \subset D_s \; and \; t(D_s) - t(D_r) \leq c$.

And each such oriented edge has assigned rating (distance) $c - \big(t(D_s) - t(D_r)\big)$.

Length of any network path from the node u_1 to the node u_z with *m* edges is $c - t(D_z)$, and thus for a given *c* is sufficient to find the path with the minimum number of edges.

For finding the shortest path the network *G* can be designed with all edges and it is possible to specified condition for edges selection to the form $c - (mc - T) \leq t(D_s) - t(D_r) \leq c$.

It is similar with nodes selection that would be crossed by the shortest path from input to output. But it is not necessary to consider all the nodes, we can choose just subset of that nodes that can theoretically occurred in a coordinating network in order to solve the task for given *c* and *m*.

Nodes´ rating (t(Dr)) is a sum of operating times of the set Dr. Therefore in the network with given m and c there can occur just nodes with rating equal to the tact size *c*, or equal to integer multiple of tact size *c*, or lower than previous numbers but maximum in variable *mc–T*, i.e.:$T - c(m - j) \leq t(D_r) \leq jc(j = 2,3, \dots, m-1)$ for groups of internal nodes of the shortest path (but not for input and output).

1.2. Region approach

This method involves jobs interchanging after initial balancing execution. The method leads to the optimal solution so jobs combinations dedicated to interchange can be inconvenient and impractical for large systems.

This method is governed by the following rules:

1. Operations with a strong dependent responsibility (operations on which other operations are dependent) should be arranged as soon as possible.
2. Disadvantage is that operations with a long operating times should be preferred to the operation with very dependent responsibility (in the case that more dependent operations have a short operating time).

Region approach includes these steps:

1. Precedence graph is prepared in conventional manner.
2. Priority regions are assigned from left to right. The graph is redrawn, mapping all transactions to the latest possible regional priorities. This ensures that operations with a small number of successions to be considered in assessing later.
3. Within each priority region there are operations arranged from the maximum to minimum time. It ensures that the largest operation will be considered as the first, giving the chance for later better combination of smaller tasks.
4. Taking into account zoning restrictions, operations are assigned according to the following procedure:
    a) at first leftmost region,
    b) at first the greatest operation within the region.

After operations assignment to each workstation we have to decide whether time utilization is acceptable. If not, it is necessary to check all the operations which meet precedence constraints and to determine if utilization is increased when exchanging assigned operations by operations whose predecessor regions are the same or are before considered operations. If so, then the change can be performed. This assignment of workstation is final.

1.3. Genetic algorithm (GA)

Genetic algorithms are used for solving optimization problems, thanks to its functionality and relatively simple applicability. They are also usable for solving lines balancing problem. Restrictions in GALBP given in the form of certain rules, dependencies between variables, or algebraic expressions should be properly grasped and included into the genetic algorithm.

In the genetic algorithm for solving line balancing problem it is needed to use the technology of decoder. Its use leads to the fact that the chromosome is not seen as a coded solution, but rather as information, which makes it possible to construct a feasible solution. Chromosome represents a sequence of operations in which they will be assigned to workstations. So instead of searching space S and its subsets it is possible, by using an appropriate representation, to create a completely different searching space D.

Decoder d serves as a transition between individuals of space S and their images in the set of feasible solutions $F(c_1,...,c_m) \subseteq S$.

For solving specific tasks by using genetic algorithms it is required:

1. To encode combinations of parameters (individual) into a string (vector) called chromosome. Each characters of string (vector elements) are called genes. The most commonly used is binary encoding. However for the line balancing problem it is more appropriate to use permutation encoding.
2. To determine size of the population (20 is suitable in our case). Too large population usually does not increase GA performance, in terms of speed of finding solutions.
3. To determine the fitness function and the method of quantification of individual chromosome. In the lines balancing we try to ensure maximum efficiency and minimum idle time units.
4. To identify technique for individuals selection for further reproduction. Very good and easy to understand is a random selection technique using the roulette wheel. However, in the case of very large differences in fitness function values, it is better to use the method of rank selection.

5. To determine operators for reproduction, crossover and mutation. For the balancing problem traditional forms are inappropriate and therefore it is necessary to use special "ordered two point crossover". Probability of crossover should be quite high and move somewhere in the range of 80% - 95%. Probability of mutation should be very low. In general, it is between 0.5% - 1%. For our problem it is appropriate that the mutation does not occur at all in the process of reproduction, since it is a random change of some genes, which could lead to the formation of undesirable individuals.

2. CONCLUSION

We have solved line balancing problem on production system with 37 operations by using of these three methods - shortest path in the network, region approach and genetic algorithms. Results are shown in the final table below. As it can be seen genetic algorithm seems to be powerful tool for solution of presented line balancing problem.

Tab. 1. Final table with results

Indicators	Method used		
	Shortest path in the network	Region approach	Genetic approach
Efficiency E [%]	76,19	85,75	85,75
Root mean square of imbalance [min]	0,0315	0,0144	0,0065
Number of workstations	9	8	8
Number of workers	9	8	8

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Cellular manufacturing, Clustering binary data, Matlab

Filip HORÁK[*], Libor KUBINEC[**], Jana HALČINOVÁ[***]

BINARY DATA CLUSTERING APPLICATION FOR CELLULAR MANUFACTURING

Abstract

The article describes MATLAB application that has been designed to aid cell creation in cellular manufacturing with use of basic and widely used clustering algorithms such as ROC and ECIA. Application is also equipped with possibility of user interaction consisting of manual rearrangement of rows and columns of incidence matrix.

1. INTRODUCTION

The main motivation for adopting cellular manufacturing is the globalization and intense competition in the current marketplace. The first step in the design of a cellular manufacturing system is the identification of part families and machine groups and forming manufacturing cells so as to process each part family within a machine group with minimum intercellular movements of parts. Clustering is the problem of identifying the distribution of patterns and intrinsic correlation in large data sets by partitioning data points into similarity classes. Since the clustering is NP-complete, to solve large scale problems, heuristic algorithms are likely to be used, but these also require substantial computational effort. In this paper we describe a MATLAB application, which has been created to implement some of the most common clustering algorithms such as King's Rank Order Clustering (ROC) and Kusiak's Efficient Cluster Identification Algorithm (ECIA). Moreover, the user can interact with the part-machine matrix by rearranging columns and rows using arrow keys.

2. PROBLEM FORMULATION

As it was said earlier, clustering is NP-complete problem, and thus can sometimes be very hard to solve even with an extensive computational power. Computational complexity of some of the most used algorithms is usually $O(nm^2 + n^2m)$. where m denotes number of rows and n number columns in binary matrix A. This is also the case for King's ROC algorithm mentioned earlier. The ECIA algorithm uses binary machine-part incidence matrix to verify the existence of

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mutually separable clusters. This algorithm has a drawback of only being able to identify perfect clusters if they exist in a matrix. However, it has a great advantage of relatively low computational time complexity of *O(2mn)*, and can always at least partially solve the solution, if the perfect clusters exist. In order to assist the solving process, which is always assessed by the end user of the algorithm applied, we proposed to integrate the capability of user interaction alongside the usage of clustering algorithms.

3. APPLICATION

Final application was decided to be created in MATLAB with graphical user interface in GUIDE environment, because of the MATLABs' flexibility in regard to working with matrices and vectors. The main requirement was the ability to load incidence matrix along with machine and part identification numbers from remote .xls or .xlsx file, provide user the ability to apply ROC and ECIA clustering algorithms to loaded incidence matrix, along with possibility to manually rearrange individual rows and columns, and finally export the matrix into another excel file as an output solution. Input and output format of excel table that is required for the application to correctly process can be seen on Tab. 1.

Tab.1. Required input format of incidence matrix stored in excel file

Arbitrary	1	2	3	...
1	0 or 1	0 or 1	0 or 1	...
2	0 or 1	0 or 1	0 or 1	..
...	...	...	...	...

Row and column headers, which correspond to part and machine identification numbers respectively doesn't have to be ordered, but they have to be of numeric integer type. Incidence matrix have no fixed size limit and doesn't have to be square.

Fig.1. on the left shows the final application with loaded 30x30 matrix from excel file and on the right there can be seen the same incidence matrix with ECIA algorithm applied.

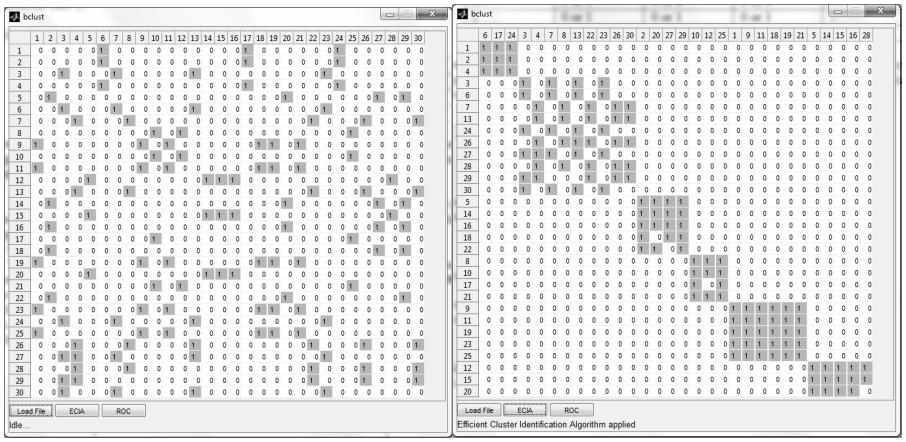

Fig.1. Incidence matrix loaded from excel (left) with partially identified clusters via ECIS (right)

Fig.2. on the left shows the same matrix from Fig. 1 (right) with ROC algorithm applied, which has the longer computational time, that is, however, significantly reduced by applying ECIA algorithm. On the right, there is the same matrix with rearranged rows and columns, specifically corresponding to machine 4 and part 29 in order to create more compact cluster, which was not accurately computed by using ROC algorithm due to intercellular movements.

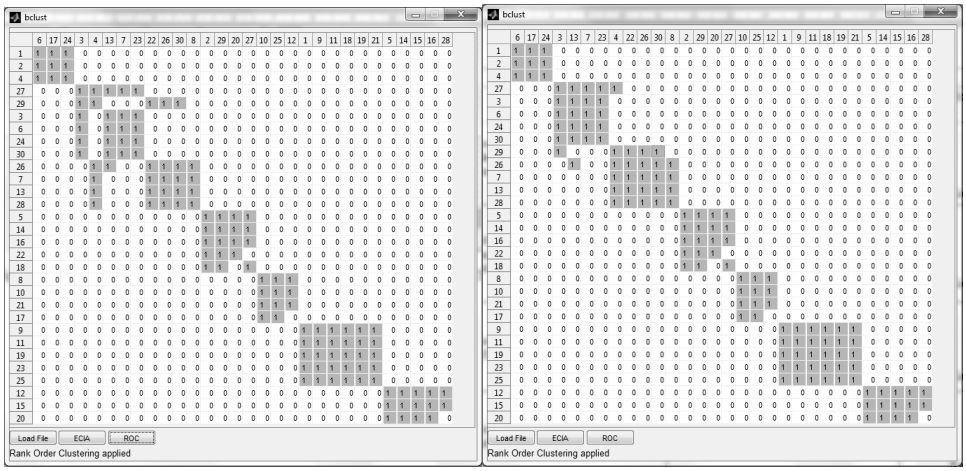

Fig.2. Incidence matrix from Fig. 1 clustered with ROC (left) and rearranged rows (right)

As can be seen, the application in this case can create a final block diagonal matrix, which can then be exported into another excel file as a final solution. Rearranging of rows and columns is done by clicking the cell and using arrow keys. By hitting up or down arrow, the application switches row with selected cell with the upper, or the lower row respectively. The same applies to left and right arrows with respect to columns of incidence matrix.

4. ROC ALGORITHM MODIFICATION

The ROC algorithm is usually defined by computing r_i ranks for rows and c_p for columns as in (1), where b_{ip} is matrix element in row i and column p.

$$r_i = \sum_{p=1}^{m} b_{ip}.2^{m-p}; c_p = \sum_{i=1}^{n} b_{ip}.2^{n-i} \tag{1}$$

This way of computing ranks is feasible when working with small matrices, but will result in exponential growth of ranks with increasing size of the incidence matrix. These large ranks would be from computational point of view at some point very hard to store and eventually impossible to work with. In order to overcome this innate theoretical drawback of ROC algorithm, many developers solve this by switching rows based on comparing individual ones and zeros of adjacent rows or columns. This feature is also implemented in our application. Comparing values produces more iterations, but on the long run conserves memory, and enables the computation of very large matrices without overflowing maximum values of data types that store values of ranks.

This iterative approach scans adjacent rows and compare their values, if it finds value of zero in upper row and value of one in lower row, the function to switch rows is called and algorithm moves to the next row. in case of equal values in both rows, it proceeds to the next column. The same approach is used when sorting columns of the matrix.

5. CONCLUSION

Created application described in this article can be used in cell creation within cellular manufacturing by supporting two widely used clustering algorithms, namely Rank Order Clustering and Efficient Cluster Identification Algorithm. Moreover it supports user interaction along with import and export from and into excel .xls and .xlsx formats. There is no doubt about other possible implementations, as it tries to solve problem of clustering binary data, which can arise in many domains of industrial data analysis.

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3D, HTML5, XML, DWG, VRML

Peter HRUBANÍK*, Branislav MIČIETA**, Martin LEHOCKÝ***

PRESENTATION POSSIBILITIES OF 3D DATA ON THE INTERNET

Abstract

This article deal with possibility representation 3D graphic models over the internet. Representation over internet into web browser is most actually for multiplatform support, faster response from side customer. Big advantage this solution isn't necessary install licensed software on client device.

1. INTRODUCTION

Nowadays is a trend using 3D applications in the widest range and the entertainment industry to analytical or production area. This is the reason why the engineering branch will move in this direction. Since it became increasingly demanding for quality products and promote them more attractive to customers. The presentation of data on the internet is very effective tool which can be used in communication with customer , supervisor or co-worker with a very quick response . An example can be internal communication or contact with customer . The more customers, partners and colleagues , to access the 3D model, which they have imagined , the greater the chance that they just this product will enjoy most of all .This may result , for example, distributed model (parts, tools , machines etc.) that can be designed using different programs into a 3D environment . This fact enables fast and multiplatform representation and subsequent presentation to a better idea. When combinations of 3D modeling software and Internet network environment can thus be far wider use. For us this brand new technology and are also high demands , which may be as accessible to the public or model only authorized persons of supported platforms , user demands on hardware , services and price . 3D visualization of the internet is used relatively short time, but its use is still growing , and day by day enjoying greater popularity .

2. TECHNOLOGY USED FOR 3D VIEWING ON THE INTERNET

Displaying 3D objects began in the late eighties when incurred language VRML. SiliconGraphics and proposed library for working with spatial objects called Inventor. It was a

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extension graphics library GL (Graphic Library). In the early 90s, a new graphics library OpenGL and with it a new application OpenInventor library, which formed the basis of the VRML language. SiliconGraphics defined in the 1995 format VRML 1.0, which extends OpenInventor the possibility of use of spatial data from the internet. In 1997 there is a version 2.0, now known as VRML97. At the end of the year was formally adopted as an ISO standard bearing the ISO / IEC 14772-1:1997. Now replaces VRML X3D format (ISO / IEC 19775-1).

2.1. Differences VRML and X3D language using XML syntax

Creating spatial scenes in files saved in X3D can do in two variants. In such cases it is supported as well as original syntax of VRML 97 format based on the Open Inventor, as well as XML syntax, with all the requirements for well-formed documents and validity. For X3D files stored in the XML variant of course there are the relevant XSLT, so check the accuracy of the registration is simple and for ability to use many tools, including smart extension to the text editor. The difference between the two methods of entry is significant, in practical terms, however, both syntax equivalent, at least as to the ability to save representation of the same scene. Same tree in which all nodes are stored scene file size containing the same scene is not much different, although the XML format is considered too "chatty".

2.2. WebGL

WebGL (abbreviated Web-based Graphics Library) is a software library that extends the scripting-language programming JavaScript. Allows to create interactive 3D graphics on any compatible web browser. WebGL(Fig. 1) code runs on a computer graphics card (GPU), which must support calculation program for rendering graphics (shader rendering).

Fig.1. Official logo WebGL

The WebGL is content of the HTML element "canvas" that lets you work with 3D computer graphics without using plug-in specification was released as version 1.0 on 3 March 2011. WebGL is a non-profit organization managed by Khronos Group.

2.3. The most used Internet browsers rendering engine

Rendering engine internet browser is software the primary task is to load the source code of a website that is written in HTML, XML. This code is the content and formatting information (CSS, XSL, etc..), Along with pictures and other objects and displays the formatted content to the Web browser window. Rendering engine is frequently used as part of web browsers. According to statistics, in November 2012 was the most used WebKit, which is part of the example. browsers such as Google Chrome or Safari. Rendering engine is usually independent software component that is part of a stand-alone software library and thus can be used for other products than for which it is primarily developed. This applies in particular cores which are

available under open licenses available. A typical example is the Gecko rendering engine used by Mozilla, as well as number of other web browsers like Flock, K-Meleon and Epiphany. Trident core, which is part of Microsoft Windows, can be used using ActiveX. Thanks to this, it can use any installed application without requiring the installation of custom rendering core.

Tab. 1. Support WebGL to desktop web browsers

		Windows	Mac os	Linux	WebGL supported versions
Desktop web browsers	**Mozilla Firefox**	●	●	●	4.0
	Google Chrome	●	●	●	9
	Safari		●		5.1
	Opera	●	●		11 a 12
	Internet Explorer	●			11

Tab. 2. Support WebGL to mobile web browsers

		Andro id	iOS	Windows phone	WebGL supported versions
Mobile web browsers	**Firefox for mobile**	●		●	4
	Google Chrome	●			25
	iAd		●		pre iOS 4.2
	Opera mobile	●			12
	Internet Explorer			●	pre windows phone 8.1

2.4. Autodesk QuickShare - online viewing 2D/3D CAD data

New technologies of modern web browsers open up new possibilities for interactive viewing of 2D and 3D CAD data . Web standards HTML 5 and WebGL in particular allow powerful display CAD drawings and 3D models online , wherever there is access to the Internet for help ordinary web browser without having to install and maintain special of browser applications . On these web standards is also built new project from Autodesk Labs Autodesk designreview - QuickShare . Builds on the successful web cloud Autodesk Freewheel (Freewheel and Project) and ShareNow . Working with CAD data in DWF and DWFx that can be published in any CAD application . DWF file can be uploaded to

QuickShare and browse them directly , or using embedded HTML code to place on a web page (like YouTube videos work) . QuickShare supports fast zooms , 3D orbit , switching levels , views , or single-sheet DWF project .

Fig.2. Mobile version Autodesk 360 mobile

2.5. Mobile version Autodesk 360 mobile

This is an application by Autodesk for mobile device s(Fig.2). The application is completely free and offers a variety of options such as opening and viewing files saved in an account based in the 360th supports Autodesk 2D and 3D DWF and DWG files.

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Operačný program
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Manufacturing, assembly, design

Mária JANČUŠOVÁ*

DESIGNING AN ASSEMBLY SYSTEM

Abstract

The article deals with assembly system design. Assemblies are the product of the assembly process. This process involves defining the functions that the item must perform and then defining physical objects that will work together to deliver those functions. Assembly, which actually creates the product, is by comparison much less studied and is by far one of the least understood processes in manufacturing. The topics in this article are basic steps in designing an assembly system and assembly links unit manufacturing processes to business processes.

1. INTRODUCTION

This article deals with assembly system design. It lays out the basic issues, the choices that system designers must make, and some approaches to making these choices systematically. Manufacturing system design is not a science, even though several of it is supported by well-developed computer aids. There is still a great deal that is subject to expert judgment, arbitrary decisions, and lack of information about future conditions that the system may face. No design can cope with all future events and still retain adequate efficiency. No single technology can do all jobs, much less all jobs well.

For these reasons, our approach to system design emphasizes careful specification of the information needed for good design decisions. It also encourages the development of hybrid systems made up of suitable mixes of specialized or fixed automation, flexible automation, and people. Even though we present the topics in a particular sequence, it should be kept in mind that the actual process is highly iterative.

2. BASIC FACTORS IN SYSTEM DESIGN

Manufacturing system design can begin when a candidate product design is available along with the requirements for each process step and a candidate assembly sequence.
The process is illustrated schematically in Figure 1. It comprises these steps:

1. Analyze the product and the necessary fabrication and assembly operations. Determine alternate fabrication methods, fabrication and assembly sequences, and candidate subassemblies. Determine fabrication and assembly process requirements. Assess the maturity of these processes and estimate process yield. Identify flexibility

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requirements such batch sizes and model mix. Identify problematic assembly steps and suggest product modifications.

2. Select an assembly sequence for use in assembly system design.
3. Determine the production capacity required of the system, taking into account factors like downtime, time to switch models, employee breaks, process yield and other factors that effectively reduce capacity.
4. Tabulate feasible fabrication and assembly techniques (equipment or people) for each operation and estimate the time for each.
5. Using either intuitive techniques or the computerized method described later in this chapter, select a set of equipment or people that can make the product at the required rate for a reasonable cost.
6. Either makes preliminary economic analyses or proceeds to detailed workstation designs and then performs economic analyses.

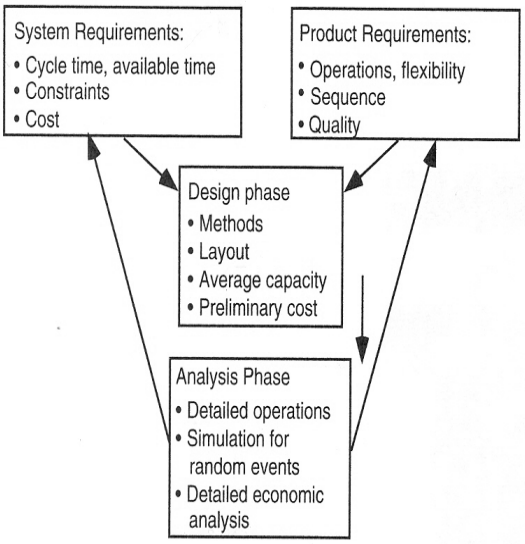

Fig.1. Basic steps in designing an assembly system

The system and the products both provide constraints to the design process. Some modifications to the product are design may be desirable or necessary (Fig.1.).

At any stage in this process, economic or technical evidence may appear that forces a reconsideration of product design, selection of subassemblies or assembly sequence, timing requirements, and so on. If all of the required information is not available, or if system design reveals knowledge gaps, then additional product or process design effort, engineering, or experiments may be necessary. The alternative is a system design with less robustness and predictability than desirable. Product quality, delivery, or cost may suffer, or the time to reach full production may be prolonged, as a result.

Even if the analysis is incomplete, performing it has great benefits. Visibility into the lack robustness of processes or product design gives management the evidence to decide whether a product is ready to be manufactured.

Assembly is different from traditional unit processes in another important way: It is the key link between the unit processes and top-level business processes. For example,

- An appropriate sequence can permit a company to customize a product when it adds the last few parts.
- Properly defined subassemblies permit a company to design them independently or outsource some or all of them from suppliers, as well as to switch between suppliers.
- A well-defined and executed product development process focused on assemblies can make ramp-up to full production faster because problems can be diagnosed faster.
- Property defined assembly interfaces can allow a company to mix and match parts or subassemblies to create custom products with little or no switching cost.

Tab. 1. Assembly Links Unit Manufacturing Processes to Business Processes

Domain	Context	Example Application
Assembly in the large	Business level	-Market size and production volume -Model mix -Upgrade/Update -Reuse, carryover -Outsourcing and supply chain
	System level	-Data management and control -Quality management -Subassemblies -Assembly sequences -Involvement of people -Automation -Line layout
Assembly in the small	Technical level	-Individual party quality -Individual part joining -Part logistic, preparation and feeding -Manual vs. automatic -Economic -Ergonomic

In general assembly is the domain where many business strategies are carried out, all of which depend on careful attention to the strategic aims during product design. Some of these are listed in Table 1. In this table, the terms “assembly in the large” and “assembly in the small” are defined in context by means of the items at the far right in the table.

Manufacturing and assembly processes must be prepared. These must not only be able to generate parts that meet the specifications and assemble them properly, but must also be capable of producing at the rate required to meet demand. Different fabrication and assembly processes are appropriate for different production rates. For example, low-volume fabrication might be done by machining while high-volume fabrication could be done by molding or

casting. Similarly, low-volume assembly is typically done by people while high-volume assembly is done by machines, but only if the parts and the final assembly are smaller.

3. CONCLUSION

Assembly is more than putting parts together. Assembly is the capstone process in manufacturing. It brings together all the upstream processes of design, engineering, manufacturing, and logistics to create an object that performs a function. A great deal is known about the unit processes that are required to fabricate and inspect individual parts. The structure of the item must be defined, including all the interrelationships between the parts. Then each of the parts must be defined and given materials, dimensions, tolerances, surface finishes and so on. Before computer aided systems existed, design followed a top-down process in which the most skilled person, a layout man, put down the basic boundaries and centerlines of a concept on black paper. Detail men, the least experienced in the profession, were assigned to design each part, providing detailed geometry, dimensions, and tolerances. A more experienced person took these detail designs and built up an assembly drawing, while a checker looked for errors and interferences by adding up all the dimensions and tolerances. The structure of the item must be defined, including all the interrelationships between the parts. The whole cycle depends largely upon the design process which, regardless of its structure, must be guided by a strong knowledge of design engineering, material and manufacturing.

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Tracking systems, TX Jack, Kinect, Motion Capture

František KALL[*], Martin KRAJČOVIČ[**], Jozef HNÁT[***]

TRACKING SYSTEMS IN ERGONOMICS

Abstract

This article describes possibilities of tracking system implementation in ergonomical analyses. Ergonomical analyses are made on biomechanical exact human model in environment of Tecnomatix Jack software. At present there are many technologies of tracking systems. We present Motion Capture Suit and optical body tracing using Microsoft Kinect.

1. INTRODUCTION

Highest concentration of manual working processes is usually in assembly. Because of that we focused largely on this area of industrial production.

Assembly is a collection of activities aimed at creating a functional unit (machine, equipment, etc.) by means of joining various components. Usually it is the last stage of production, followed by functional testing and running in. It has decisive impact not only on quality and reliability of products, but also on productivity and efficiency of the whole assembly and production system. Assembly of difficult products is still manual work even in automotive or mechanical industry. Therefore it is necessary to ensure suitable working conditions during designing assembly workstations. When we design an new workplace using this tracking systems we can simulate future loading of an operator through working processes and we can find some harmful impacts of operator health in the proposal phase and so change it simply. Creating of movement of human model in virtual environment is relatively simple so we can test also longer series of movements.

2. TRACKING SYSTEMS

Tracking systems deal systems with movements recording. There are several categories of these technologies. First category is tracking of one point. We track only position of the beholder. Movement is saved in three axes x,y,z. Second alternative is to track whole body of user. This is called body tracking. We can track whole body with scene identification systems (for example Microsoft Kinect) or by adding several markers on user´s body. This method is usually done via special suit called Motion Capture with precise disposition of markers. Last alternative are special tracking systems focused on special areas of tracking like eye or face tracking.

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In the next part we will introduce two of these technologies Motion Capture and Microsoft Kinect and their interference with Tecnomatix Jack.

3. MOTION CAPTURE

Using this device you can record the movements of operator very accurately. This technology is indeed very expensive. Price is about 15000-40000 €. This special suit can work on few technologies for example at optical principle. Man has suit with optical sensors. He is tracked with more than two special cameras, whose detect his position at workplace.

Another tracking technology provides company Animazoo. Motion Capture from this company was used in connection with TX Jack for the first time in Škoda Mlada Boleslav in Czech Republic. For connection with Jack it is necessary to use special software IGS Jack. It is part of the Motion Capture package. This Suit works on detecting position on sensors consisting from gyroscope and accelerometer. A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. Mechanically, a gyroscope is a spinning wheel or disk in which the axle is free to assume any orientation. At present it can be based also at electronic or fiber optic principles. An accelerometer is a device that measures proper acceleration. Motion Capture IGS 180 has 18 sensors tracking movements.

Fig. 1. Motion Capture Animazoo IGS 180

3.1 Microsoft Kinect

It is device used for body tracking. It was originally developed for game console Xbox 360. But some people have started thinking about industrial usage too. The first Kinect can recognize movements from 1,2 m. In the year 2012, Microsoft introduced Kinect for Windows. This device is designed for operation system Windows and it´s versions Win 7 or Win 8 and can recognize movements from 0,5 m. Microsoft also released Kinect´s SDK (Software development Kid). It allows developers to write their own applications in programming languages Visual Basic or C++.

Kinect for Windows consists of VGA camera that capture three basic color scene (it enables human recognition ability), depth sensor that enables 3D space recording, microphone that enables also voice commanding in applications and from tilt motor that enables tilting of Kinect.

- Color VGA video camera - This video camera aids in facial recognition and other detection features by detecting three color components: red, green and blue. Microsoft calls this an "RGB camera" referring to the color components it detects.
- Depth sensor - An infrared projector and a monochrome CMOS (complimentary metal-oxide semiconductor) sensor work together to "see" the room in 3-D regardless of the lighting conditions.
- Multi-array microphone - This is an array of four microphones that can isolate the voices of the users from the noise in the room. This allows the user to be away from the microphone and still use voice comands.

A further look at the technical specifications for Kinect reveal that both the video and depth sensor cameras have a 640 x 480-pixel resolution and run at 30 FPS (frames per second). The specifications also suggests that sensor allows about 1,8 meters of visible space between you and the Kinect sensor, but it depends on where you put the sensor. If it is in optimal height and nothing disallows the view.

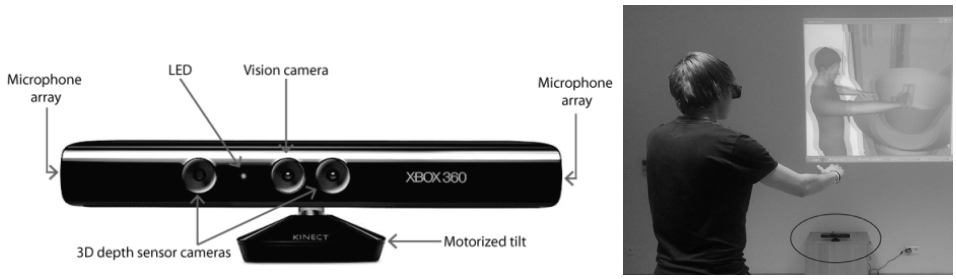

Fig. 2. Kinect for Windows

For using Kinect with Tecnomatix Jack you have to use special Plug in. This Kinect Plug in has two different modes.

Exploration mode is focused on developing of surrounding. You select one human figure and you fly through created scene. For orientation you use hands. Right hand enables movements to the sides and to the front. Left hand enables movements up and down.

Posture mode is focused on quick postures creation. Kinect records your movements and they are carried to virtual figure in Jack. Current version can recognize well only movements when human is oriented directly on Kinect and for posture creation is used not all sixty nine joints, but only twenty of them. With this device we can´t track fingers at present. It is also impossible to record movements created via this device you can just save static postures.

Usage of these tracking technologies in Tecnomatix Jack can significantly shorten time of animation creation and of dynamic loading appraisal. They can save hours of time when evaluating longer movements, because you don't have to create movement manually, you create it thanks to the saving your own movements. These technologies don't work always properly yet, but they are rapidly developing. I believe that in the future this type of operator loading appraisal will be common and often used.

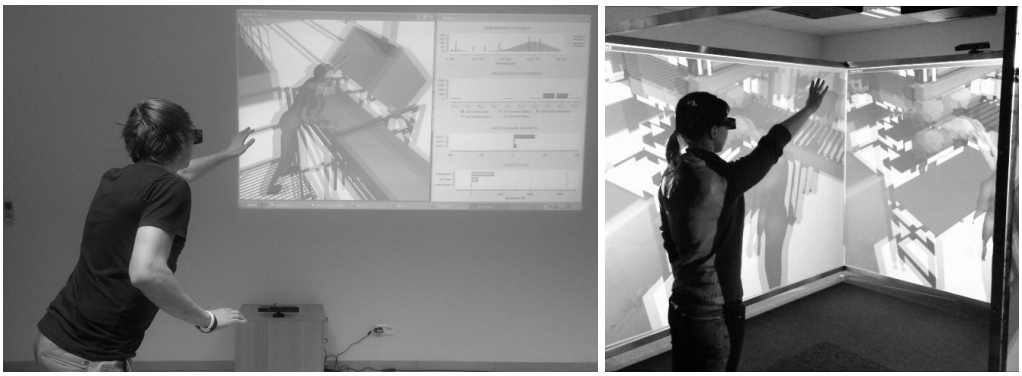

Fig. 3. Posture creation using MS Kinect

4. CONCLUSION

These new and modern technologies have large potential for usage also in environment. But For common usage they must be better described and tested. Also they should be more user-friendly and cheaper. But they should be used more and more often because only this way we can find their new purpose and potential of usage.

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ferrosilicon, carbon balance, resistance-arc furnace

Grzegorz KOPEĆ*

ESTIMATION JOB OF FERROSILICON FURNACE BASED ON MEASUREMENTS OF ELECTRICAL PARAMETERS

Abstract

In industrial practice, control operation of the furnace used for the production of ferrosilicon, based on the observation of current electrical parameters of power supply the furnace and taking action to correct the noted deficiencies. In addition to states of emergency, to maintain a stable operation of the furnace requires a high level of service and is based on controlling and correcting the of current amount of carbon entering the reducer to the mix a charge. The article shows the relationship between the current changes of reactive power and harmonic coefficients of the electrode voltages and currents, and the amount of carbon in the reaction zones during the smelting of ferrosilicon FeSi75.

1. MODEL OF THE REACTION ZONE

Ferrosilicon is melted in electric resistance-arc furnace with carbon electrodes Söderberg submerged in the charge. Charge composed with quartzite, coal, scaled and wood chips for a suitable granulation is loaded into the furnace portions on the top and gravity moves to down by intensely warming. In the reaction zone at a temperature above 1785K in melting charge appears well electrically conductive SiC, which alters the chemical properties of the charging mixture and its resistivity [1, 2]. The increase of SiC, increases the electrical conductivity in the charge in this area intensifies the resistance heating by direct current flow through the carbonise charge a positive effect on the course of chemical reactions in which the key role played by carbon. At temperatures above 2080K in the chambers gas are located near the ends of Soderberg electrode where in an electric arc is burning, a disintegration of the silicon carbide and products to drip to the bottom of the process. At the same time through individual layers of charge, flow into the top large quantities of gases CO and SiO, which in contact with the charge piece re-used in chemical reactions [1, 2]. In a properly working furnace, you must maintain a constant thermal power and the correct temperature distribution in order to realize the right place the required chemical reactions. Other causes variations in resistivity may be caused by faults or fractures chipped Söderberg electrode , a vicious Tracking mix batch furnace or operating errors [1]. To maintain a constant active and reactive power of the furnace is used impedance controller , which controls the position of the electrodes Söderberg in the bathtub. If there is a reduction in the charge resistivity electrodes supply will be raised up and lengthen the burning arc . If an increase resistivity of the batch will be advanced in Soderberg electrode down excessively.

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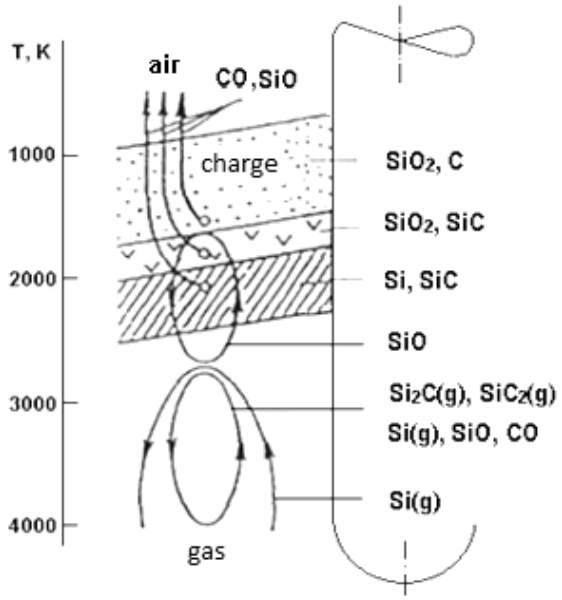

Fig.1. Graph of the reaction zone around the electrode in the electric resistance-arc furnace for smelting of ferrosilicon [1]

Change of parameters the arc due to change of the position of the electrode due to incorrect carbon balance in the charge, can be seen in changes in the amplitude of the higher harmonics of the measured voltage and current electrode, and the values of reactive power. Invalid field of temperature interferes with the chemical reaction and causes the appearance of large quantities of slag, an increased energy consumption of the process and a lower performance furnace [1].

2. CONTROL CARBON BALANCE IN REACTION ZONE

To analyze the operation of the industrial furnace smelting ferrosilicon FeSi75, we used the measurement data recorded during the trouble-free and continuous operation of the furnace for at least one day during which achieved good technical and economic indicators of the process. Control the carbon balance in the reaction zone in the industrial furnace producing ferrosilicon FeSi75, is based on the observation of the reactive power and correcting the amount of reducer in the mixture charging. Figure 2 shows the phase diagram of reactive power measured at the terminals of the first electrode 20 MVA furnace industry. The graph indicated information about changing the amount of reducer in the mixture charging. The decision to change the amount of reducer (5 kg or 10 kg), is taken by the personnel operating the furnace and written in the book of the furnace. Another parameter used to control the electrical properties of the reaction zone is parameter k proposed by Andre'a[1] (Fig. 3).

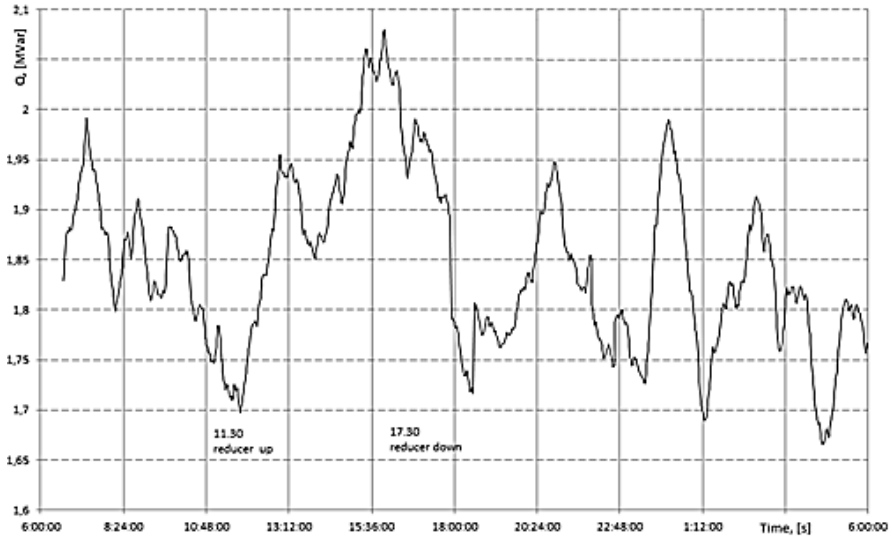

Fig. 2. Graph of electrode reactive power, measured during operation of industrial furnace smelting ferrosilicon FeSi75.

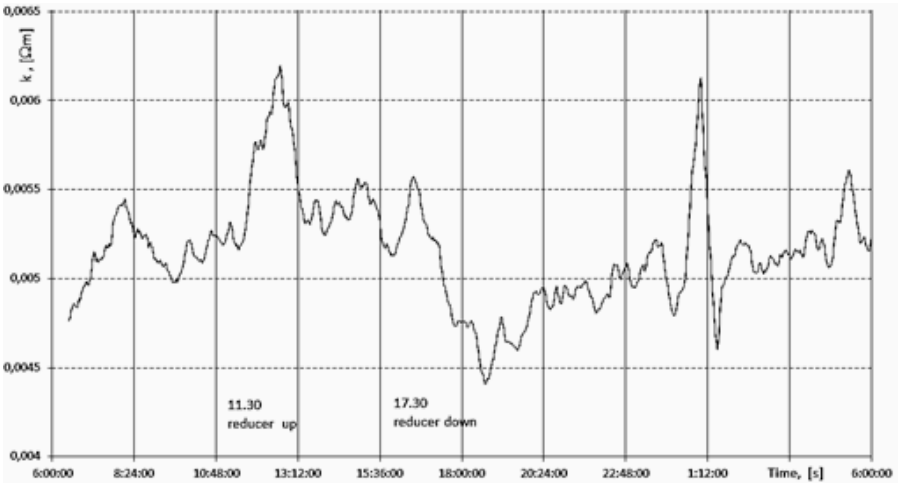

Fig. 3. Graph of the parameter k (Andre'a) characterized the electrical properties of the reaction zone.

Decisions to make adjustments in the amount of reducer in the mixture charging, marked on the graphs prove accurate and correct personnel operating procedure to correct the amount of carbon in the reaction zone. Service furnace requires a lot of experience, because the mixture of modified composition reaches the reaction zone after a few hours from the time of its introduction. Minor changes in the physico-chemical properties of charging mixture components are compensated by the automatic control systems of the furnace. Neglecting good practice and

control of furnace operation exceeds the range used by regulator and reach a state of emergency furnace.

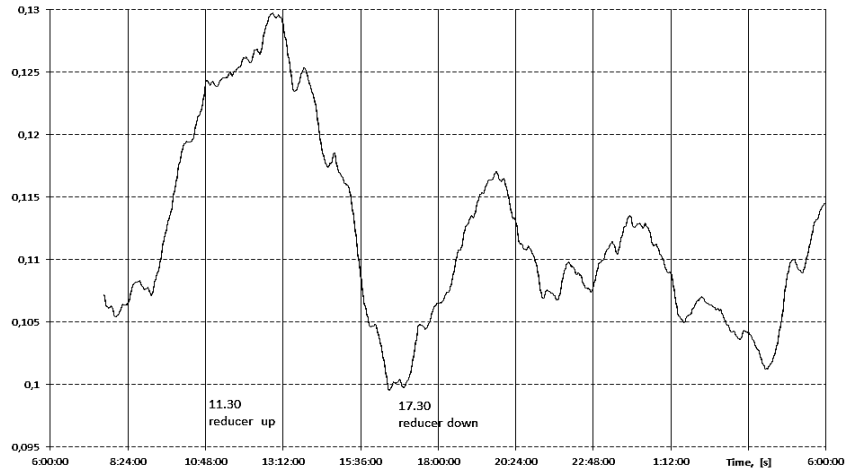

Fig. 5. Graph of the coefficient from the third harmonic and above relative to the sum of all the harmonic voltage measured at the terminal electrode number 1.

Another indicator of the carbon balance in the reaction zone is a parameter determined coefficient content harmonic and calculated as the ratio of the third and higher harmonic voltage or current electrode to the sum of all harmonics. In Figure 4 showing a graph so the calculated ratio of harmonic voltage first electrode. Variable participation of harmonic voltages or currents, involves a change in the foundation of the electrodes in the furnace due to changes in resistivity of the charge caused changes in the amount of carbon in the charge. Changing the length of the burning arc is visible in the measured values of voltage and current electrode.

3. CONCLUSION

Graphs presented in this article were made from data recorded in one day during normal operation in an industrial furnace. Analyzing many parameters graphs we get complementary information which may be used to assess the amount of carbon in the reaction zone. Using these parameters in industrial environments can assist the decisions of employees serving furnace, be used to identify irregularities occurring during operation of the furnace smelting ferrosilicon or be used in automated systems, the preparation of charging.

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Zero Base Budgeting, Costs, Management

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ZBB, METHOD OF BUDGETING FOR HIGH ECONOMICAL EFFICIENCY

Abstract

Zero-base budgeting (ZBB) is a budgeting process that asks managers to build budget from the ground up, starting from zero. However, ZBB has been the subject of a fair amount of controversy over the years, owing primarily to questions about the value derived from ZBB analysis versus the cost required to put ZBB into practice. This paper is focused for this method as a progressive new way how to make budget.

1. INTRODUCTION

The use of Zero-Base Budgeting (ZBB) as a managerial tool has become, increasingly, popular since the early 1970s. ZBB has been gaining acceptance in the business world as a tool in integrating the managerial functions of planning and control.

In Zero Base budgeting, justification of expenditure is to be made for the past as well as new projects. In the traditional budgeting, the figures of the previous years are taken as base and additions are made for the current year. But, in Zero Base Budgeting, even the running projects are to be justified for continuation. If the past projects were allowed to continue, without justification, the past inefficiencies would continue, automatically. So, the manager has to justify, why he wants to continue to spend. In ZBB, the manager has to justify the essentiality of the new projects for their starting and continuation of previous projects, every year. Equally, the concerned manager has to justify the amount of spending, thereon, is reasonable.

2. DIFFERENCES BETWEEN TRADITIONAL BUDGETING AND ZERO BASE BUDGETING

Tab.1. The differences between Traditional Budgeting and ZBB

Traditional Budgeting Vs Zero Base Budgeting		
	Traditional Budgeting	Zero Base Budgeting
1. Emphasis	Lays emphasis on "How	Lays emphasis on "Why"

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	much“	
2. Focus	Focus is on increase or decrease in expenditure.	Focus is on cost benefit analysis.
3. Communication	Communication is, usually, vertical.	Communication is , usually, both vertical and horizontal.
4. Approach	Past is taken for granted and never questioned for continuation.	Past is questioned and justification needed for continuation and fund allocation.

Tab.2. Three Essential Questions of Planning and Budgeting

Prerequisite: What is Affordable?	Planning	Budgeting
	What are the community's priorities and how can government action add value?	What programs should we fund in order to best achieve the priorities?
	How much and what quality of service does the community need from a given program?	What level of service should we fund within a program?
	Is the service provided efficiently?	For a given service level, are the requested inputs reasonable for the output we expect to receive?

3. STEPS FOR PREPARATION OF ZBB

The following steps are involved in Zero-Base Budgeting:

- **Determining the Objectives**: Determination of the objectives is the first step. The objective can be cost reduction in staff overheads or dropping those projects that do not fit in the organisational objectives or focus.
- **Extent of Coverage**: It relates to the decision whether Zero-Base Budgeting is to be introduced in all areas or certain select areas on trail basis.
- **Developing Decision Units**: Decision Unit can be a functional department, a programme, a product-line or sub-line. Each decision unit must be independent. Then only, they come under consideration. Cost benefit analysis is to be done to the decision units. Decision is to be taken, whether the units are to be continued or dropped. If the cost benefit analysis is favourable, the decision unit can be implemented, otherwise can be dropped.

  Benefit should be more compared to the cost. Cost benefit analysis is the foundation of ZBB, which helps in ranking the projects.

If the decision unit is dropped, no further thinking is needed about those activities.

- **Developing Decision Packages**: This is the most important step involved in the ZBB process. After decision for selection of the units, the concerned manager of the activity is given the freedom to come out with the alternatives to achieve. He does the cost-benefit analysis and selects the best course of alternative. He summarises the plans and resources required to achieve.
- **Preparation of Budgets**: This is the last stage involved in ZBB process. Once the top management has ranked the various decision packages keeping in view of the cost benefit analysis and availability of funds, a cut-off point is established. All packages (programmes, products etc), which come within the cut-off point are accepted and others rejected. The resources are then allocated to the different decision units and budgets relating to units are approved.

Zero Base Budgeting is an extension of the cost benefit analysis method to the area of corporate budgeting.

4. BENEFITS OF ZERO BASED BUDGETING

ZBB is a revolutionary concept. The benefits are as under:

1. Proper Allocation of Funds: Funds are scarce. Priority in allocation of funds is made on cost-benefit analysis.

2. Systematic Evaluation: Manager has to justify the demand for resources, every year. So, it provides the organisation a systematic way to evaluate different programmes and operations undertaken. So, for the ongoing projects too, review is made, every year. Funds allocation for the ongoing projects is made, if there is justification to continue, further. In other words, there is no difference between the new projects and ongoing projects from the view-point of allocation of funds.

3. Links Budgets with Goals of Enterprise: Those projects that do not fit within the overall goals of the enterprise are not continued, even if they were commenced. Goal oriented approach of the enterprise would be developed.

4. Zero Base Approach: Zero is taken as the base, every time. Only those activities and programmes that are essential are undertaken, which improves the overall efficiency of the enterprise. Alternative courses of action are always studied. Economies are achieved, eliminating wastage. The focus of the management is on analysis and decision-making.

5. Optimum use of Resources: As cost-benefit analysis is the guiding principle in fixing priorities, resources are used to the optimum advantage of the organisation.

6. No Incremental Approach: Normally, budgets are based on incremental approach. The usual feature of functional heads is to seek information from the accounts department for the previous year's expenditure, add 'something' for the current year and try to justify the increase. This incremental approach is not possible with Zero-Base Budgeting. Manager has to justify their activities and the funds requested.

7. Most Appropriate for Non-Manufacturing Areas: Zero-Base Budgeting is very appropriate for the staff and support areas (Non-Manufacturing Areas). In these areas, the output of these areas is not, directly, related with the final output of the organisation.

Within the business world, ZBB can be applied to research and development, data processing, quality control, marketing and transportation, legal staff and personnel office.

5. LIMITATIONS OF ZBB

In spite of the many advantages, it suffers from the following limitations:
1. Computation of cost-benefit analysis is essential for ZBB. This is not possible in respect of non - financial matters.
2. The system of ZBB has no scope to adjust for changes. So, ZBB has no scope in flexible Budgeting.
3. ZBB involves lot of time and cost of operating is also high.
4. Formulation of decision package is a difficult process and all the managers may not have the necessary expertise.

6. CONCLUSION

To conclude, Zero-Base Budgeting is not a panacea for all evils. But, it can certainly overcome the weaknesses of the conventional budgets and improves the usefulness of budgeting process, but Zero-Base Budgeting' is the latest technique of budgeting. This is a managerial tool, where every manager has to justify each rupee of expenditure on the basis of cost-benefit analysis. This is applicable to the new as well as on-going projects/activities. This is more applicable in non-manufacturing areas such as research and development, training, legal, staff and support areas. This type of budgeting is ideal in Governmental activities.

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ENTERPRISE RESOURCE PLANNING (ERP) – TOOL OF PROGRESSIVE MANAGEMENT

Abstract

Enterprise resource planning (ERP) system solutions are currently in high demand by both manufacturing and service organisations because they provide a tightly integrated solution organisation's information system needs. This paper describes evolution of Enterprise Resource Planning systems, theoretical knowledge of ERP and implementation process in companies.

1. DEFINITION OF ERP

An Enterprise resource planning system is a fully integrated business management system covering functional areas of an enterprise like Logistics, Production, Finance, Accounting and Human Resources. It organizes and integrates operation processes and information flows to make optimum[*] use of resources such as men, material, money and machine.
Enterprise resource planning promises

- one database,
- one application,
- one user interface

for the entire enterprise, where once disparate systems ruled manufacturing, distribution, finance and sales.

2. EVOLUTION OF ERP

In the ever-growing business environment, the following demands are placed on the industry:

- Aggressive cost control initiatives,
- Need to analyse costs/revenues on a product or customer basis,
- Flexibility to respond to changing business requirements,
- More informed management decision making,
- Changes in ways of doing business.

One or more applications and planning systems have been introduced into the business world for crossing some of hurdles in achieving growth. They are:

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- Management Information Systems (MIS)
- Integrated Information Systems (IIS)
- Executive Information Systems (EIS)
- Corporate Information Systems (CIS)
- Enterprise Wide Systems (EWS)
- Material Resource Planning (MRP)
- Manufacturing Resource Planning (MRP II)
- Money Resource Planning (MRP III)

ERP has evolved from the system known as MRP II (Manufacturing Requirement planning) system with the integration of information between Vendor, Customer and Manufacturer using networks and common databases. MRP II system again evolved from MRP (Material Requirement Planning) system. MRP is a technique that explodes the end product demands obtained from Master Production Schedule (MPS) for the given product structure which is taken from Bill of Material (BOM) into a schedule of planned orders considering the inventory in hand. MRP II has a number of drawbacks. For example:

- The main problem is that it has not been able to effectively integrate the different functional areas to share the resources effectively.
- The traditional application systems, which the organizations generally employ, treat each transaction separately
- They are built around the strong boundaries of specific functions that a specific application is meant to cater.

For an ERP, it stops treating these transactions separately as stand-alone activities and considers them to be the part of the inter-linked processes that make up the business.

3. ERP CHARACTERISTICS

Any system has to possess few key characteristics to qualify for a true ERP solution. These features are:

- **Flexibility:** An ERP system should be flexible to respond to the changing needs of an enterprise. The client server technology enables ERP to run across various database back ends through Open Database Connectivity (ODBC).
- **Modular & Open:** ERP system has to have open system architecture. This means that any module can be interfaced or detached whenever required without affecting the other modules. It should support multiple hardware platforms for the companies having heterogeneous collection of systems.
- **Comprehensive:** It should be able to support variety of organizational functions and must be suitable for a wide range of business organizations.
- **Beyond Company :** It should not be confined to the organizational boundaries, rather support the on-line connectivity to the other business entities of the organization.
- **Best Business Practices :** It must have a collection of the best business processes applicable worldwide. An ERP package imposes its own logic on a company's strategy, culture and organization.

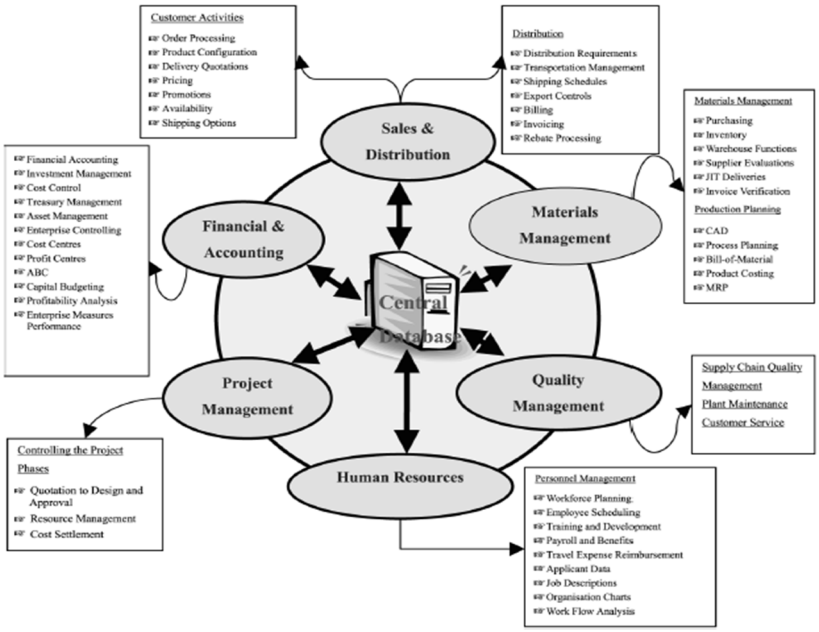

Fig.1. The basic structure of ERP

Features of ERP : Some of the major features of ERP and what ERP can do for the business system are :

- ERP provides multi-platform, multi-facility, multi-mode manufacturing, multicurrency, multi-lingual facilities.
- It supports strategic and business planning activities, operational planning and execution activities, creation of Materials and Resources.
- ERP covering all functional areas like manufacturing, selling and distribution, payables, receivables, inventory, accounts, human resources, purchases etc.
- ERP performs core activities and increases customer service, thereby augmenting the corporate image.
- ERP bridges the inormation gap across organisations.
- ERP provides complete integration of systems not only across departments but also across companies under the same management.
- ERP is the solution for better project management.
- ERP allows automatic introduction of the latest technologies like Electronic Fund Transfer (EFT), Electronic Data Interchange (EDI), Internet, Intranet, Video conferencing, E-Commerce etc.
- ERP eliminates most business problems like material shortages, productivity enhancements, customer service, cash management, inventory problems, quality problems, prompt delivery etc.
- ERP provides intelligent business tools like decision support system,

- Executive information system, Data mining and easy working systems to enable better decisions.

4. BENEFITS OF ERP

Following are some of the benefits they achieved by implementing the ERP packages :

- Gives Accounts Payable personnel increased control of invoicing and payment processing and thereby boosting their productivity and eliminating their reliance on computer personnel for these operations.
- Reduce paper documents by providing on-line formats for quickly entering and retrieving information.
- Improves timeliness of information by permitting posting daily instead of monthly.
- Greater accuracy of information with detailed content, better presentation, satisfactory for the auditors.
- Improved cost control.
- Faster response and follow-.up on customers.
- More efficient cash collection, say, material reduction in delay in payments by customers.
- Better monitoring and quicker resolution of queries.
- Enables quick response to change in business operations and market conditions.
- Helps to achieve competitive advantage by improving its business process.
- Improves supply-demand linkage with remote locations and branches in different countries.
- Provides a unified customer database usable by all applications.
- Improves International operations by supporting a variety of tax structures, invoicing schemes, multiple currencies, multiple period accounting and languages.
- Improves information access and management throughout the enterprise.
- Provides solution for problems like Y2K and Single Monetary Unit(SMU) or Euro Currency.

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supply chain, material flow, MIFA, logistics analysis

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CONTROL OF SUPPLY CHAIN BY USING THE MIFA METHOD

Abstract

The paper deals with application of the new method called MIFA (Materials and Information Flow Analysis). It describes the principle of method MIFA, its importance and application to the selected company. Furthermore, an extended analysis of the present situation of the selected company identified critical areas that need to be solved. Within the mapping by method MIFA the aim is to harmonize the conditions of suppliers on the same level under the given conditions. Thus try to lower level of delivery time and simultaneously reduce the material price due to discounts.

1. INTRODUCTION

Generally MIFA is a tool for the analysis of physical flows of materials and information flows within the supply chain. It is also a diagnostic tool that allows us to evaluate the Value Stream Mapping in the company to achieve the improvements and render target flows. MIFA is always accompanied by an Action Plan to achieve the target flow. MIFA performed in supply chain focuses on the concept of the logistics chain. The methodology MIFA shows the physical places where goods are stored, manufactured and distributed. Within the method MIFA we can also monitor information flows, primarily fixed and anticipated demand horizons, but also times of availability of information and emission frequency. The aim of this paper is to introduce a new method MIFA and its application as a case study in the selected company. This case study describes the material flow in the supply chain. The main goal is to balance the flow of material from various suppliers, while ensuring smooth collection of finished products from individual customers.

2. METHODOLOGY

MIFA considers all delivery links in the supply chain from all suppliers (deliveries of parts for production). MIFA represents the present state, future state and the ideal state. For different suppliers the goal is to establish balanced demand (through S & OP and MPS). Pull flow

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system is applied for all significant suppliers. For each vendor is prepared a contingency plan. FMEA logistics is verified for the whole supply chain system. MIFA follows the implementation period and the status of purchase order. Performance assessment of supplier is conducted at regular basis (weekly or monthly). Metrics and evaluation criteria are defined and strictly followed.

The method can also monitor information flows (primarily fixed and anticipated demand horizons) but also times of availability of information, information vectors and emission frequency. Information flows are shown in dashed lines. The method shows the physical locations where the goods are stored, manufactured and distributed. The quantity stored, the geographic location and the delivery performance is written down.

3. CASE STUDY

This study is deals with the optimization of production processes and thus the goal is to increase the total output of production. The study is based on the application of Value Stream Maping in the company, which manufactures parts and subassemblies for the automotive industry.

MIFA (Materials and Information Flow Analysis - Analysis of the flow of material and information) is shown on the example of two selected products within the framework of supplier links: supplier – company; company - customer.

For practical application of MIFA we selected two products: “VO 4011918 AB – TRUBKA” and “AL 1300 636 313 OBJÍMKA”.

Fig.1. VO 4011918 AB - TRUBKA and AL 1300 636 313 OBJÍMKA

The data necessary for MIFA:

- List of all PN (parts, components and materials) needed for selected products
- Information about the size of batches - manufacturing, handling, etc.
- Information about the average size of customer orders
- The following documents for all PNs:
    - information about supplier
    - delivery time
    - minimum order quantity
    - frequency of orders (or deliveries from suppliers)

  - average quantity of order,
  - package size and number of pieces in a package
- Average consumption for a certain period
- Inventory status
- Safety stock and monthly consumption within the whole year
- How are deliveries calculated, etc.

The following figures show the graphical analysis using the principles of the MIFA method. Fig 2 shows the link between the supplier and the company. Fig. 3 shows the link between the company and the customer. Furthermore these figures graphically display the size of the batches and monthly consumption frequency (see Tab. 1).

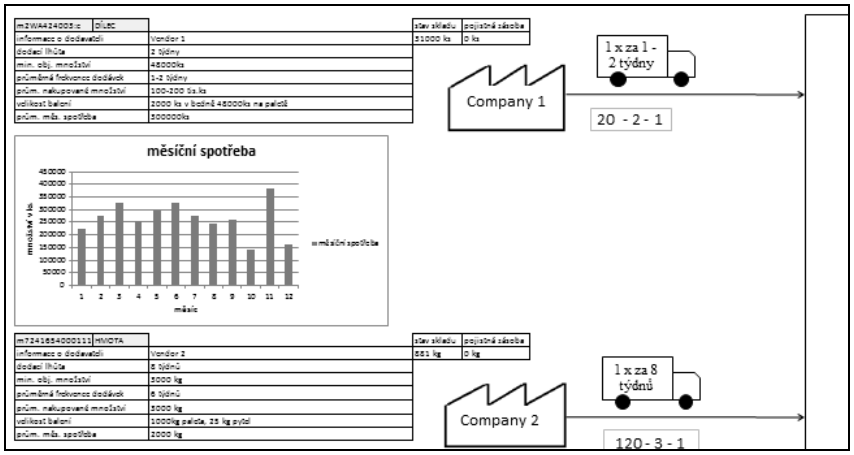

Fig.2. Link between the supplier and the company

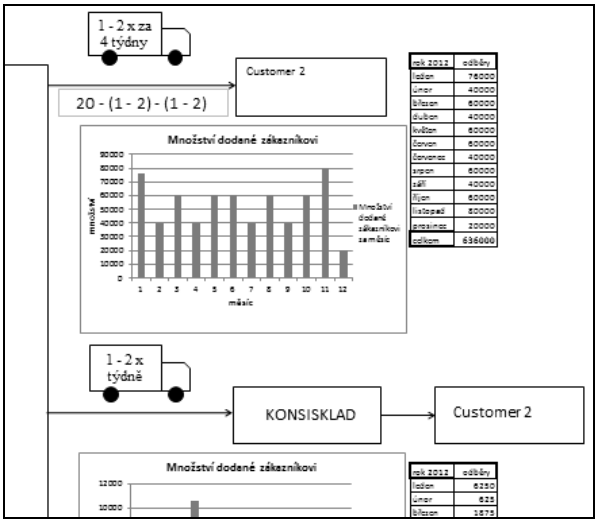

Fig.3. Link between the company and the customer

Tab.1. The delivery cycle

Delivery cycle = X - Y - Z X: time period (= 1 day; 5 = week; 20 = month) Y: number of deliveries within the given time period Z: number of trucks between the order and the corresponding delivery (reaction time) For example: delivery cycle = 1 – 5 – 4. For each day are planned five trucks and the delay between ordering and the corresponding delivery of parts are four lorries.

4. CONCLUSION

The aim of MIFA mapping is to harmonize the conditions of different suppliers on the same level, thus try to lower the long delivery times or to prolong extremely short delivery times in order to achieve quantity price discounts. The other goals are: to calculate the size of orders by comparing the storage costs and the costs of ordering; respect quantity discounts; analyse the size of storage areas and accordingly verify the size of orders; seek to change the suppliers minimum order quantities and try to harmonize the delivery time for all suppliers; extend the possibilities of usage the suppliers consignment warehouses, etc.

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Joanna LISOK*

USEFULNESS ANALYSIS OF OPTOELECTRONIC MEASURING SIGNALS FOR DIAGNOSTIC OF THE BURNING

Abstract

The article describes optoelectronic measuring methods available to assess the stability of the combustion process. A review of time - frequency methods was conducted for the analysis and control of a variety of non-stationary signals , especially for signals generated in the combustion process. Because the combustion process is a representative of random physical phenomenon, it cannot be described by precise mathematical dependence, since the result of each observation is unique.

1. MEASUREMENT SIGNALS ANALYSIS METHODS

The analysis of widely understood signals and interpretation of the results of their analysis is now the basis of many fields, including those that go far beyond technical applications. Modern methods of analysis of signals, regardless of their type and application, almost always operate on the data stored in a digital form. Due to its diversity and areas of application, signals can be processed and analyzed using a variety of methods. Their use depends primarily on the type of signal, the conditions in which the signal was registered and the purpose of analysis. The paper presents the results of the analysis of measurement data which is based on the time – frequency method, among others, the spectral analysis of signals, short-time Fourier transform, Gabor transform, Wigner – Villa transform and multiresolution wavelet transform. Simulations were carried out in the work using Matlab environment in order to verify the assumptions and select the most effective method. Selected diagnostic parameters were characterized which would prove useful in the combustion process based on the chosen method.

1.1. Methods in the field of time:

a) statistical analysis of signals, we mean statistical parameters, and the autocorrelation function.

b) Spectral analysis of signals here we have a power spectral density and spectrum of mutual.

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c) Mathematical models of time series [1-5]. We are thinking of model AR, MA, ARMA, ARIMA, ARX, ARMAX and NARMAX.

1.2. Methods in the frequency domain:

a) Methods based on Fourier transform (fig. 1). There are: fast Fourier transform, Gabor transform, short-time Fourier transform [6]. A windowed Fourier Transform (STFT) in the time domain and the frequency domain:

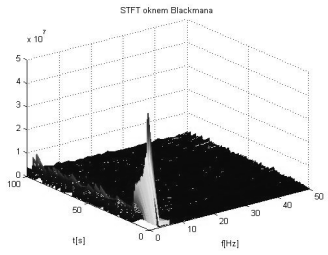
$$STFT_x^T(t,f) = \int_{-\infty}^{+\infty} x(\tau)\gamma^*(\tau - t)e^{-j2\pi\int\tau} d\tau, \qquad STFT_x^F(t,\int\ ) = e^{-j2\pi\int t} \int_{-\infty}^{+\infty} X(\nu)\Gamma^*(\nu - \int\ )e^{j2\pi\nu t} d\nu,$$

where:

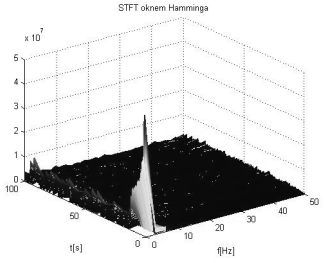
$\gamma(t)$ – time window of observation , $\Gamma(f)$ – Fourier spectrum ,

b) Other types of transformations They are: transform Wigner - Ville, wavelet transform, multi-resolution analysis (fig.1). Each area was analyzed using the same method with different types of time windows such as Hanning window, Bartlet, Boxcar, Blackman, Hamming. The research shows that the type of the window does not affect the appearance of the Fourier transform of the analysed signal fragment.

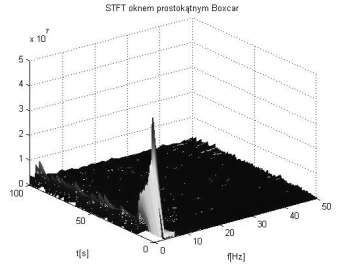
a) Blackman window



b) Hamming window



c) Boxcar window



d) *Bartlett* window

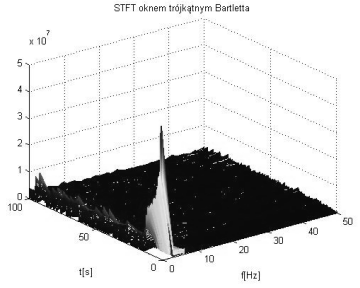
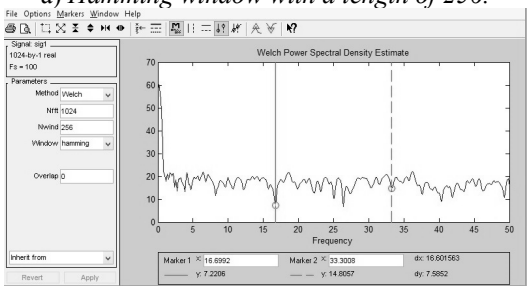


Fig.1. Short-time Fourier transform - the different types of time windows.

The next step was to apply different lengths of time windows within the same type of windows in stable and unstable (fig.2). We note that changing the window size has an impact on the determination of the frequency of the signal. Then, short-time Fourier transform analysis was carried out in the frequency domain. We see that, unlike in the case of time windows, the

shape of the spectrum of the window has a decisive influence on the frequency resolution and amplitude analysis (fig. 3).

a) *Hamming window with a length of 256.*



b) *Boxcar window with a length of 256*

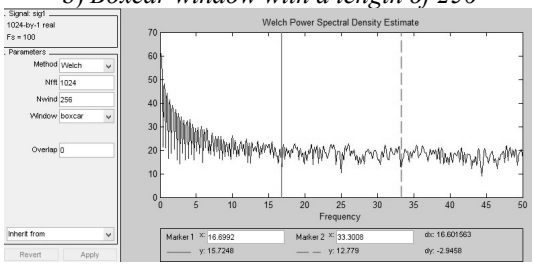
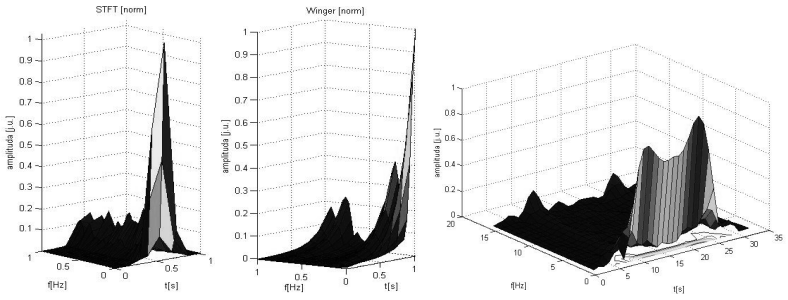


Fig.2. The estimation of power spectral density.



Comparative analysis transform STFT, Wigner- Ville'a and Gabor transform (fig. 3).

Gabor transformation is more computationally complex, but the result is a better time-frequency resolution. The change of the type of the time window in the event of a Gabor transform has an effect on the signal analyzed and measurement data obtained at the level of the time - frequency after the application of the transform, rather than the different time slots in a Fourier transform. We note that the time - frequency representation of Wigner-Ville`a has the highest concentration of energy in the time - frequency. In low-latency as opposed to the Fourier transform to be Ville-Wigner representation there are no parasitic interference impeding its interpretation, but it is achieved at the cost of considerable averaging the two-dimensional spectrum. Another method used for analysis of multi-resolution analysis is signal that appears to be quite a useful tool in the analysis due to the possibility of using almost any function during analysis, i.e. during the search for similarities between the largest signal and

the function of the base (7-9). Multi-resolution signal analysis is based on discrete wavelet transform (fig.4).

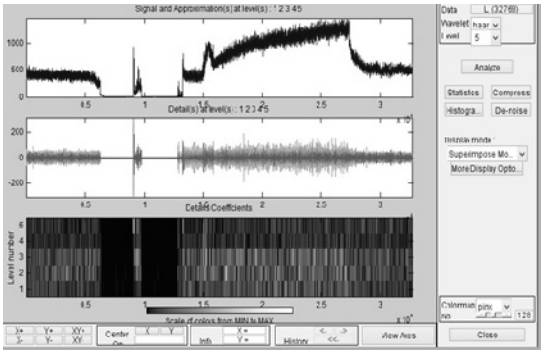


Fig. 4. Results of using the Haar wavelets for signal analysis on level 5.

The comparative analysis of different methods of measurement and simulation studies made it possible to assess their suitability for use in the diagnosis of the combustion process.

2. INFERENCE

It appears that studies using optoelectronic measurement methods allow us to determine the sensitivity of the combustion process parameters that can be used to diagnose and assess the quality (stability) of the combustion process. It should be noted, however, that the choice of a particular method does not always guarantee a correct interpretation of the observed phenomena. The interpretation of the results of signal analysis is particularly difficult in the case of non-stationary signals , and these were subject to analysis.

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Knowledge, manufacturing, management, indefinite knowledge

Peter LONC*

INDEFINITE KNOWLEDGE – INTEGRAL PART OF KNOWLEDGE MANAGEMENT

Abstract

This article deals with indefinite knowledge as an integral part of knowledge management. In the first part, the indefinite knowledge as o term is discussed. Later, the types of indefinite knowledge are examined and finally, the representation of indefinite in knowledge base is described.

1. WHAT IS INDEFINITE KNOWLEDGE

Indefinite knowledge does not look like explicit statement. Instead, it often represents different ideas and best practices. Indefinite knowledge is a natural part of expert's problem solving process and as such is an integral part of the knowledge system.

Indefinite knowledge is necessary because only a small part of expert's knowledge is created by formal theories that provide explicit computational procedures leading to the clear solution. Nevertheless, expert is able to solve problems using knowledge derived from his experience and his individual mental models, i.e. with indefinite knowledge.

The unique computational process is algorithm that works with certain knowledge. Informal judgmental process is represented by heuristic that works with indefinite knowledge. Characteristics of algorithm and heuristic are clearly illustrated by the following table.

Tab. 1. – Algorithm and heuristic

Algorithm	**Heuristic**
Result	Result
Finiteness	Finiteness
Mass	Not mass
Optimal result	Suitable result
Slower	Faster
Impractical	Practical

The algorithm is characterized by resolution, finality, multiple solutions and guarantees the optimal solution. Multiple solutions means that the solution is always found. It is slower and less efficient. Heuristic guarantees only resolution and finality of the solution. It does not

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guarantee its multiplicity. It does not guarantee an optimal solution. However, in most cases it provides satisfactory solution. It provides a practical solution in a shorter time.

Heuristics, as informal judgmental process, may be trusted in a certain situation. This trust is based on the existence of a sufficient number of cases where heuristics was proven to be reliable. Heuristic gives us a solution which in most cases is difficult to scientifically prove but it can be very conveniently used.

Thus, one of the characteristics of heuristics is its indefinity. Knowledge of the indefinity makes the fourth type of human knowledge in addition to general, factual and specific. This group has a special position among other skills. We say that it has a panoramic nature because it relates to all other types of knowledge. Expert knowledge not always have an exact nature. Individual knowledge is used according to the expert's varying degrees of confidence in the outcome. The degree of confidence is based on 4th type of knowledge – indefinite knowledge.

2. INDEFINITY IN THE KNOWLEDGE BASE AND DATABASE

The existence of indefinite knowledge in the knowledge system is enforced by the indefinity of knowledge and facts with which system works. This indefinity occurs not only in the knowledge base - KB but also in database - DB. Indefinity in the KB and DB occurs for the following reasons:

- Indefinity in KB is caused by the fact that expert knowledge is not quite exact. The knowledge is often made by assumptions which are based on experience.
- Indefinity in DB is usually caused by uncertain answers of the user, by subjectivity of judgment, also by estimating of unavailable or by inaccurate data burdened with noise.

Solving problems is a derivation, i.e. inference of new knowledge. Newly derived knowledge also enters the inference process and is used to derive additional knowledge. Whether the new knowledge will have rigorous or indefinite nature depends on the nature of knowledge from which it was derived. There are 4 possible combinations listed in the following table.

Tab. 2. – Inference process of new information

Knowledge base	Data base	Inferenced information
Certain	Certain	Certain
Certain	Uncertain	Uncertain
Uncertain	Certain	Uncertain
Uncertain	Uncertain	Uncertain

The former implies that once indefinite knowledge was used either in DB or KB, the result is a newly derived, indefinite knowledge.

The third case in the table (there is indefinite knowledge in KB and definite knowledge in DB and thus, result is indefinite knowledge) can only be used for one-stage inferences. In this case, derived indefinite knowledge cannot be used in the further derivation because it is assumed that DB is a definite and therefore indefinite fact cannot be entered into it.

There are systems that can deal with this problem. For example EXSYS can proceed in subsequent stages of inference process even if there is indefinite knowledge in KB and definite

in DB. EXSYS uses scales. This system transforms derived indefinite knowledge into definite knowledge by means of thresholding.

3. TYPES OF INDEFINITY

Idefinite knowledge have different causes. Logically, there are different types of indefinity. The types differ in external manifestation because they require different ways of processing and handling.

The most commonly used division is based on the causes of indefinity:

- Incompleteness – is based on fragmentation of human knowledge - what we know are only islands of knowledge. One can overcome the incompleteness of their knowledge using assumptions about the world. However, the general rules (general knowledge) used by a person are not applicable in all cases. There are some exceptions. Therefore, thinking of a person is considered to be non-monotonic (non-monotonic logic). Since knowledge is understood as conditionally false, newly incoming information may result in revision of previous knowledge. Indicator of incompleteness is the occurrence of the following linguistic qualifiers: mostly, usually, generally, typically.
- Vagueness - is related to the process of gaining knowledge from a person, i.e. sharing of knowledge. That little what we know (incompleteness) is distorted when referring to another person (vagueness). Vague knowledge is expressed by using words with vague meanings: high, low, old. Since these terms have ambiguous meaning, they can be misunderstood. Vagueness may grow with a combination of linguistic quantifiers and vague words: usually tall, very wise, very painful ....
- Indefinity - is sometimes understood as the sole representative of uncertainty in knowledge-based systems. It reflects the subjective nature of knowledge, resp. "human factor" of knowledge, namely: use of heuristics instead of algorithms and mathematical theories, assumptions and experiences instead of exact knowledge - a generalization on the basis of two or three cases, ignorance and lack of knowledge of certain things and contexts, superficiality of understanding, personal bias and high self-esteem of the expert.

4. REPRESENTATION OF INDEFINITY

Uncertainty of KB (strength of production rules) can be expressed in forms other than indefinity in DB (indefinity of facts).

Indefinity may take the symbolic or numeric form. The following table shows both forms concisely.

Tab. 3 – Representation of indefinity

Symbolic representation of indefinity	Numeric representation of indefinity
Words	Numbers
With origin	Without origin
Knowledge sharing is problem	Knowledge sharing without a problem

In a symbolic representation of indefinity is exactness of knowledge quantified by verbal description with precise origin. For example, production has slowed down (prediction of production manager).

Derivation of indefiniteness from the new knowledge is problematic in this representation.

In numerical representation of indefinity is exactness quantified by numerical value without origin. Derivation of indefinity of new knowledge is not problematic, it can be quantified. Example: raining (70%) drops falling (90%), result is that it is raining (65%)

The numerical representation is also divided by:

- The number of values used for single or multiple valuable indefinity (typically double value). Trust and distrust are expressed separately in double value indefinity. Distrust is a complement to trust: P (H) + P (-, H) = 1. These two values can be combined into one called certainty factor, or into another pair called confidence interval). Confidence interval is the interval in which a true uncertainty may be found.
- According to the absoluteness of expression, it is further divided into the absolute and relative indefinity. The absolute indefinity is expressed directly, usually by a real number in the interval <0,1> or <-1.1>. The limiting values of this interval indicate the absolute validity / invalidity of knowledge. Often, the value is selected from N values for the needs of many-valued logic. The relative indefinity shows the change in the absolute indefinity. The strength of rules determines how the indefinity of conclusion changes when prerequisites are fulfilled. This includes chances, certainty factor, the degree of necessity / sufficiency and so. Chance is being referred to as the likelihood ratio and is defined as follows:

$$O(H) = \frac{P(H)}{P(-,H)} = \frac{P(H)}{1-P(H)} \quad (1)$$

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Knowledge, manufacturing, paradigms, management, DSS, expert system

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DECISION SUPPORT VIA KNOWLEDGE MANAGEMENT

Abstract

Manufacturers have long recognized, that, much like their service industry peers, they find themselves competing in a knowledge economy. The article deals with the definition of knowledge based manufacturing, knowledge it self, with computer aided knowledge management and with its most important subtopics. Later, the concept of various decision support systems are described, as they are seen by author as a leading trend in the concept of future knowledge manufacturing.

1. INTRODUCTION

Knowledge economy is built on the possession and configuration of intellectual resources and knowledge production, distribution and reuse. Market competition is becoming more intense, more and more enterprises cannot depend on single factor to obtain competitive advantage. In fact, manufacturing industry has become the main engine of Europe's economy.

At present, knowledge economy and knowledge management has become a common concern in economists and management scientists. But as a main part of social economic, manufacturing industry pays little attention to intellectual capital, and it is necessary that knowledge capital management should be regarded by manufacturing enterprise in order to benefit from the potential opportunities and challenges. Under knowledge economy environment, modern manufacturing enterprises are changing from production-based enterprise to knowledge-based enterprise.

A typical characteristic of the manufacturing process is dynamic, where conditions are constantly changing and decisions have to be made within a short space in time. It is often preferable to make a decision at the right moment rather than to seek the optimum decision without any time limit. The better we have the available relevant data at the right time, the better decision we can reach. A computer is a tool that can be employed to narrow the gap between the conflictions demands of "time" and "decision".

Due to a rapidly changing business environment, organizations are increasingly facing the challenges of global competitiveness. Achieving high degree of competitiveness and sustainability leads to the recognition of the effective use of information and communication technologies as an essential resource for a survival and profitability of any company in the

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knowledge-based economy. In addition, companies must continually face challenges caused by rapid technological change, shortened life cycle of the products, high market volatility and downsizing, hence, the need to reduce costs and administration as well as storage areas. If companies intend to cope with these and other challenges, they must be able to effectively manage their highly distributed and diverse knowledge. Knowledge is seen by many as a key resource for achieving a competitive advantage or for implementation of innovative projects in the organization. A major challenge in this regard is the identification of key knowledge which may have an impact on the improvement of the business processes. From the above it is clear that companies must take care of their most important asset which is represented by corporate knowledge. Decision-making tasks (multifactor optimization) in advanced manufacturing systems are extremely difficult and decisions have to be made in real time. Such intensive tasks already exceed the capacity of human decision-making abilities and therefore, these tasks will be solved in the future with the aid of artificial intelligence, such as expert systems, knowledge-based systems or DSS.

2. DECISION SUPPORT SYSTEM (DSS)

Decision Support System (DSS) is a computer system that includes mathematical models, computer databases and user interface in order to provide recommendations for manager's decision-making process. DSS is different from a traditional information system in a way that it provides answers for the user, i.e. it decides by using modeling techniques. This is an interactive computer system that collects and presents data from a wide range of sources.

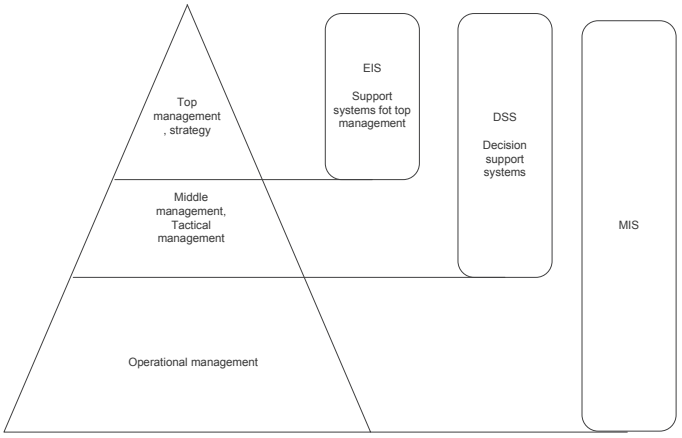

Fig.1–The management pyramid

Individual applications can be characterized as support systems of knowledge management, or systems that are knowledge-oriented, are various applications that are used to control at different levels with varying degrees of sophistication. This category includes:

- expert systems (ES),
- executive information system (EIS),
- decision support systems (DSS),
- management information system (MIS),

Expert systems create a specific category of knowledge-intensive systems. They are built on the principles of artificial intelligence, and a sense of their operation is to simulate decision-making experts. Since they use a sophisticated knowledge, processing algorithms and combinations of elements of artificial intelligence, we can state that it is the highest form of knowledge-intensive systems. ES are sophisticated and intelligent way of organizing and distributing knowledge. Their advantage is the added value in the form of rational decision-making support, based on previous experience, "learning" system simulating decision-making experts. The basic building block of the system is an expert in a particular field, who often carries tacit knowledge. The role of the knowledge engineer is explicitly representing this knowledge for the system use. Representation of the knowledge is closely tied to the process of obtaining, processing and representing the knowledge to the end user. Based on the input data the user of the expert system can get recommendations and conclusions that simulate responses and use expert knowledge in the field. Expert systems are specialized to specific, relatively narrowly defined issues, to ensure the greatest possible degree of accuracy. Therefore they cannot replace the entire information system for knowledge management, but it is rather considered as the superstructure (Miklošík - Hvizdová, 2011).

Executive Information Systems, can be defined as infrastructure that mediates for the top management of the company key operational data in real time, obtained from heterogeneous databases, which are used for taking qualified decisions. An example of the information mix is financial information,

tasks and work, which are in implementation, inventory reports, data on sales results, trends, the market share of the company and other information.

Decision Support Systems, computer systems that support the identification and evaluation of alternatives act or progress. The objective is to evaluate what would happen if we take the variant X. DSS ambition is to replace the manager's decision.

Management Information System is an integrated system that includes all the necessary tools and information for taking quality decisions. Management information system integrates information from production, business departments and also contains a subset of the marketing information system.

Group of systems that share common characteristics and can be considered as a basic level of the knowledge management systems is called support cooperative system. They are systems with different nature and focus, which common feature is the work with information’s, sharing and some form of usability for the management and distribution of knowledge in the company. They are these following tools and software (Miklošík - Hvizdová, 2011):

- CMS - Content Management Systems or ECM - Enterprise Content Management,
- DMS - Document Management Systems,
- Office software packages with support of sharing and labor groups, respectively. collaborative platform,
- Wiki,
- Others - forums, chats, email.

It is interesting to know the real rate level deployment and use of various forms of KMS in organizations. In a survey, which in 2004-2005 implemented Xu and Quaddus (Xu - Quaddus, 2005), the respondents expressed, which application, respectively information systems are

used in the company to work with knowledge. The following table shows the different systems and the percentage of companies that use them as a form of KMS.

Tab. 1. - Use of various forms of KMS in companies

KMS technology / application	% deployment
E-mail and communication systems	91,9
Internet	89,5
Databases	86
Intranet	80
Document management system (DMS, ECM, etc.)	60
Customer relation management (CRM, etc.).	48,1
Videoconferencing	43,2
System for online discussion	40,4
System to support processes (workflow)	38,6
Data warehousing / data mining	36,5
Executive information system (EIS)	34
Electronic Wall	28,4
Electronic system to implement meeting	26,3
Tool for learning	25,3
Archive information of personnel	23,2
Decision support systems (DSS)	22,8
Support of teamwork (Groupware)	22,1
Database of verified practices (best practices)	21,8
Company Yellow Pages (directory)	21,8
Online analytical processing system	21,4
Repositories knowledge	20,7
Knowledge portal	18,6
E-learning	17,9
Extranet	16,5
System management tasks / project management	16,1
Directories of knowledge	14,7
Expert systems	8,4
Artificial intelligence	4,9

The mentioned survey shows that companies mainly use for sharing information's and knowledge normally available tools such as email, internet or intranet. A large part of companies uses to manage and archive data databases, but only a small percentage of companies use the most effective promotion of knowledge sharing as DSS systems, expert systems and various knowledge portals. The reasons for this fact should be sought primarily in the financial and time-consuming implementation and administration of these systems.

Application of the principles of knowledge management and especially the means of computer support is currently a major challenge for the society to which the company should react as a unit. Sharing knowledge constitutes a key aspect of success in today's highly competitive environment. If an organization wants to be successful and make progress in their development, they need to think on their processes, the knowledge that one of them may be related, but most particularly the way to procure one's knowledge and identifying their wearers. Software tools support knowledge management solutions are likely to organizations helped to obtain the much needed competitive advantage. Complex and systematic approach to knowledge constitutes one of the main factors of effective corporate governance. The actual management of the company, whether as a whole or its individual processes is becoming more demanding challenge. Information overload does not allow taking into consideration all available information and, moreover, it is difficult to combine this information with existing knowledge in this field. There could help methods such as artificial intelligence, expert systems, knowledge systems and DSS systems. Their advantage is that they can effectively replace human decision-making capacity and also support the implementation of the decisions in real time. The work factor in a real time is a key requirement of advanced manufacturing systems.

3. CONCLUSION

Characteristic function of technical systems is a high degree of data accessibility which can be processed into knowledge. These data mostly come from measuring systems or directly from the databases. These data has an objective and undisputed nature. The performance of technical systems is clearly and well defined by these data. In terms of the acquisition and processing of knowledge (just on the basis of these data), this created base is complete and based on rules and facts.

By contrast of technical systems, social systems are not clearly recognizable, and therefore are difficult describable. It is a result of the high fragmentation of knowledge, respectively their total absence. Necessary condition of taking decisions is to look at the organization as a socio - technical system.

Individual applications can be characterized as support systems of knowledge management, or systems that are knowledge-oriented, are various applications that are used to control at different levels with varying degrees of sophistication.

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In-Memory Computing Database, Digital factory

Vladimír MAGVAŠI*

NEW GENERATIONS DATABASE ENVIRONMENTS FOR INTELLIGENT MANUFACTURING SYSTEMS

Abstract

The intelligent manufacturing systems are currently experiencing massive increase of data necessary for their efficient functioning. The dynamically changing environmental conditions are constantly creating a need to react to changes in shortest time possible. The common database system cannot be applied and this role is taken over by In-Memory Computing databases. Their application will certainly become a normal part of life in the field of information technologies.

1. THE PRESENT WAY OF USING DATA IN INTELLIGENT MANUFACTURING SYSTEMS

The manufacturing system is understood as a system that uses work operations and procedures to change the composition and shape of materials to products, i.e. in this way we acquire new utility values of materials. It is a set of subsystems that change inputs to outputs, while increasing the added value of the system.

The intelligent manufacturing systems are focused on the use of new methods, procedures, services and technologies with the aim of continuous optimization and the increase of efficiency. These systems are at present designed as holonic systems with embedded intelligence, the ability of autonomous reconfiguration and adaptation to changing conditions. If we consider the intelligent manufacturing system as information system using up-to-date technologies, then the data base of today is a relational database. The relational databases, as known today, have been part of programs and information systems since 1970s. They have overcome various changes, tried to adapt to the needs of demanding applications. However, the main principle remains the same, i.e. they are based on the transaction on the level of raw data. The information systems that support company and manufacturing processes in order to increase efficiency pool increasingly more data of various sub-processes and activities. With such amount of transaction data it is necessary to conduct various types of analyses and predictions in short time. Today with relational databases containing large amounts of transaction data there is used the aggregation method in certain time interval. For example at night aggregated data from the production line for a specific day is formed. This process, depending on the amount of data, can run as long as several hours. With data prepared in this way it is possible to do pre-prepared analyses. If there is a situation where it is needed to analyze other, unprepared data, it is necessary to restart the whole tedious process of aggregation. The information system may experience a dramatic decrease of performance and the users may complain about significant slowdown in their work.

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2. DEVELOPMENT OF INFORMATION TECHNOLOGIES TOWARDS REAL TIME

The present trends affect intelligent manufacturing systems directly or indirectly in the full range of application. The concerned technologies include 3D scanning of production halls, creation of libraries of virtual objects, production registers as well as data information from heterogeneous environments of company information systems, for example CAD systems, PDM or ERP and CRM applications that can be mutually integrated. They create an amount of information that is difficult to be processed by common database systems. The information from the external environment, e.g. interaction with suppliers, subcontractors and customers is added to this. The present known database systems enable to scale their performance, storage capacity and high availability**.** These capabilities have their limitations, though**.** If we need to collect data out of tens various in-house information systems, manufacturing systems, systems of suppliers in real time, compare this information to data sets collected in several years and on the basis of predictive analyses to provide the results in seconds, the common database systems cannot be applied here (Fig. 1).

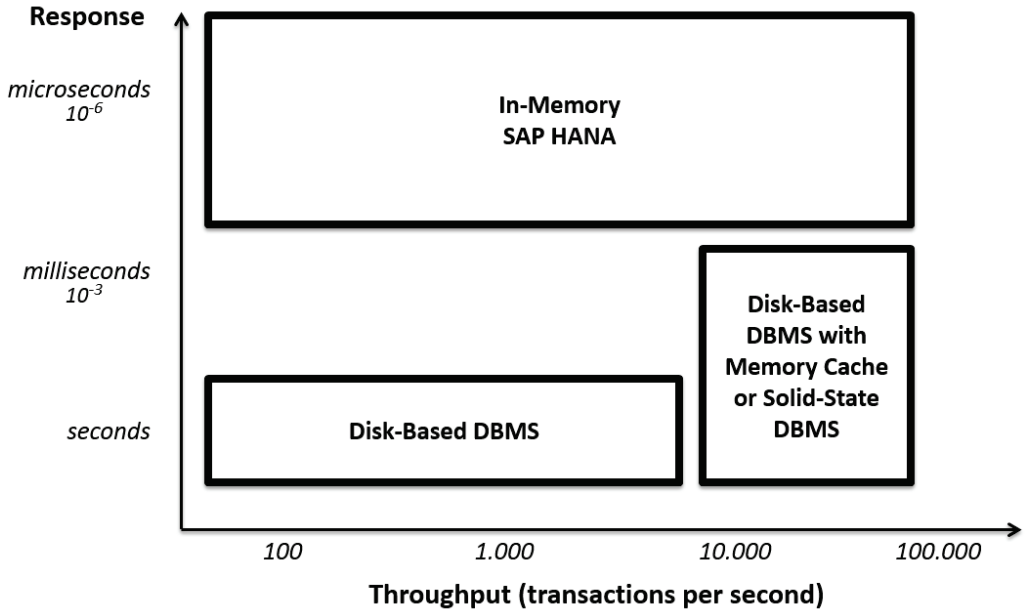

Fig. 1. Comparison of database types

Today there is a solution in the form of technologies using computer memory as a data storage (In-Memory Computing). It is, in fact, database technology that uses operating memory technology as its storage instead of conventional technology of hard disks. All the database is then only stored in the working memory that is several thousand times faster than hard disks. One of the first actually deployed and used technologies is the product SAP HANA™ by SAP AG Germany. SAP HANA™ extends the classic view of database system in the new part of predictive analyses. This product employs a well-known analytical, statistical and visual opensource programming language

named *programming language R*. The language R contains more than 3500 extensions, that cover wide range of application areas. The major change is the concept of calculations, which was transferred from the application layer to the database one (Fig. 2).

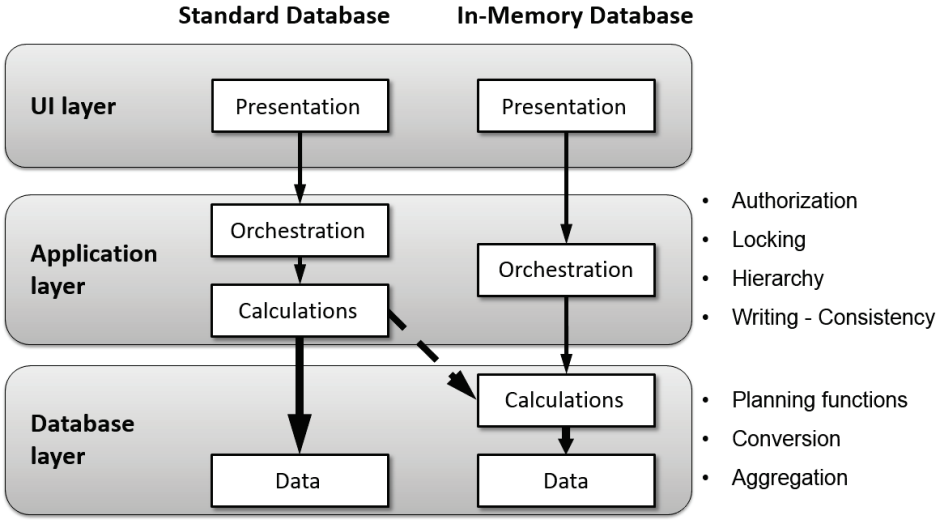

Fig. 2. Transfer of calculations in the in-memory database

SAP HANA™ enables to process large amounts of data in the server memory in real time, providing immediate results for analytical and transaction applications.

The SAP HANA™ solution is based on:

- multi-core architecture with massive parallel scaling,
- 64bit architecture, throughput 100GB/s,
- row and column database,
- data compression (up to 70%),
- partitioning,
- no necessity of aggregation,
- replication in real time based on transfers of differences in data.

The speed as executed by SAP HANA™:

- 2 billion records analyzed in 1 second by 1 CPU core,
- 10 million complex calculations in 1 second by 1 CPU core,
- 3600x faster creation of reports compared to the classic database.

3. CONCLUSION

The new breakthrough technologies for processing and storing information as well as in other areas of human activity create new opportunities in the field of intelligent manufacturing systems.

They mainly enable to create a purposeful data set that can be used in real time at various workplaces. In this way the conditions for efficient use of resources and matching the needs and capabilities of customers with the capabilities of producers are created. The concept of a digital company, as a set of techniques and methods in digital form reacts to these new technological opportunities. The system of digital designing is one of the key elements of the concept of digital company. It is a highly efficient modern way of designing manufacturing systems where the crucial role is played by new information and communication technologies.

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Humanoid robot, industrial robot, robot-human cooperation

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NEW APPROACH IN THE DESIGN OF INDUSTRIAL ROBOTIC SYSTEMS

Abstract:

The article deals with the description of a new approach in the design of industrial robotic systems. The purpose of this research is to identify the differences of the actual used industrial robots with the possibility of usage of humanoid robots designed to the industry. The study is to show how to create a new robotic workstation in cooperation with a human. Extensive research was conducted at the laboratory called ZIMS (Žilina´s intelligent manufacturing systems).

1. STATE OF ART

Nowadays, a development of new approaches used in an industrial automation and robotic applications is demanded. The potential of humanoid robots is being used in the show-business but what is more important, usage of such robots for the applications in the industry has still not been explored.

Intelligent manufacturing systems are considered to be highly discussed theme. Industrial robotic is a part of the discussion. While the actual trend in some big corporation is to move personnel to background of manufacturing, trend in smaller or middle level company is to create a cooperation of the robots with the personnel. This kind of robotic workstation includes a robot capable of a direct cooperation with the personal or includes robot controlled by remote control via SCADA/HMI. Because of the safety, the robotic station has to be in a separate area with no human access during robot´s job execution. To assure the safety, elements such are barriers, light curtains, scanners and so on have to be implemented by designer of the station. In the case of person´s occurrence in the defined safety area, the robot has to come to slacken speed or stop itself [1].

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2. NEW APPROACH IN DESIGNING ROBOTIC WORKSTATIONS

Nowadays, industrial robot´s producers and developers do a research in the field of robot-human cooperation, in which the injury of the personnel is completely excluded. In fact, cooperation human - robot offers complementary features to improve commonly performed tasks. The robot is designed to perform tasks for people considered to be debilitating or dangerous. However, a person is capable of performing the tasks which can´t be simply executed by the robot. There are mostly the tasks requiring a certain level of skills and intelligence. Merging of the attributes, mentioned above, contributes to advantages. One of the most important advantages is achievement of the continuous production even in the case of personnel´s presence in the robot´s defined safety area [2].

Robots called humanoid fall into the group of new robots. All over the world we can find many producers and developers to be concerned with the humanoid designed for industry. In general, it is a double-arm robot mounted on a static torsion or on a mobile chassis. Usually, industrial humanoids tend to be equipped with HMI (human-machine interface) system in the form of humanoid head intended for basic communication with personnel. The additional equipment of such robot can include image recognition, face recognition, guidance system, handling systems, and so on. These technologies offer, in addition to the above mentioned direct cooperation with the person, operator detection and subsequent modification of production processes according to predefined requirements of the operator. In the case of any changes in the production, the robot might be simply programmed and configured by using gestures of the personnel. Merging of the mentioned technical attributes of the humanoids contributes to huge potential to utilization of these robots in the industry. Today, however, their actual industrial applications are very rare in the world. This uncertainty is mainly based on their unexplored potential and from the absence of any methodology that would define their applicability, established principles and approaches of implementation and methodology that would be guidance for future technical standards [3].

3. COMPARISON OF THE CURRENT STATE OF ROBOTICS WITH A NEW APPROACH

Fig. 1. View of industrial robots with humanoid on the left side.

The demonstration of the both above mention approaches is depicted on the fig 1. The new one is on the left side in comparison with the actual commonly used approach of designing industrial robotic workstations on the right side.

3.1. Advantages and disadvantages

The brief characteristic of the robots and their advantages and disadvantages are following:

The robots commonly used in an industry (fig 1. – right side):

- + Strong and solid construction of such robots,
- + High speed – up to 5 m/s,
- + High accuracy/repeatability – up to 0.02 mm,
- - Higher costs. We have to take to account above mentioned safety systems, solid constructions of robot workstations and so on,
- - Lower flexibility of such robot workstations [4].

Industrial humanoid robots (fig 1. – left side):

- + One of the most valuable advantages is the possibility of job execution even if the person is in the robot´s safety area. It means that there is no need to take to account the safety systems such are the barriers, light curtains, scanners and so on,
- + The humanoids are designed to help human in terms of direct cooperation,
- - Lower speed, repeatability and accuracy.

Disadvantages of the humanoids are especially because of their construction created in consideration to assure the safety of personnel.

3.2. Programming and designing robot workstations

The next and simultaneously one of the biggest differences might be seen in programming and designing of such robot workstations.

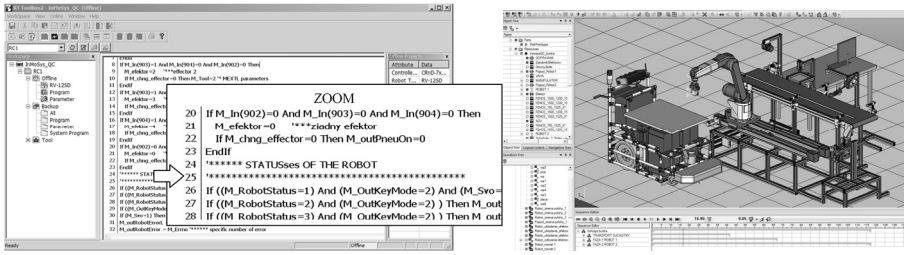

Fig.2. Screen shoot of the robot programming and simulation.

The typical approach of programming industrial robots is depicted on the fig. 2. The programmer has two choices. One of them is programming the robots by writing the codes exactly as it is shown on the fig. 2. (Left side). The positions of robots have to be taught by programmer directly in the workstation. The second one (fig. 2. – right side) is using programs that support 3D modeling. In this case, designer might create virtual workstation, implement 3D model of robot and then create a simulation. This is one of the approaches where the authors can simulate all the processes and thus avoid of robot collision and so on. After the simulation is created, designer can proceed to virtual commissioning. This process involves replicating the behavior of hardware with a software environment. In another words, designer of robotic workstation might use real hardware of PLC connected with virtual robot and thus simulate the process. After the simulation is considered to be finished, programmer might download the program and movements to robot and make corrections between the real and virtual workstation [5].

Programming and teaching industrial humanoids robots is much easier. Mostly it is just showing robot what is needed to be done. For example personnel in the factory need to help by

simply job “pick and place”. In this case operator just might show robot, where the source is and where is a destination of the components that needed to be transported [6].

As we can see on the Fig. 3., we can also implement 3D model of the humanoid robot to virtual digital factory. This implementation and simulation helps designer to create appropriate workstation for robot-human cooperation [7].

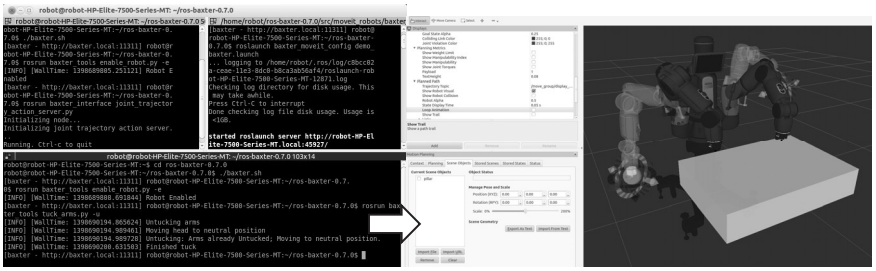

Fig. 3. 3D Software used for humanoids simulation.

4. CONCLUSION

The main goal of the article was to introduce the reader with new approach of designing robotic workstations. As the reader could read in the article, industrial humanoid robots can cooperate with human that is the most important benefit of the usage of such robot in an industry. Using this kind of robot has a big benefit. Especially it is for the cooperation that helps reduce the downtime and thus raise the profit of the corporation. Equally important is the fact that programming is very simply, hence the operator can teach the robot new movements without any knowledge about the architecture or without any robot functionality details.

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Energy efficiency, classic energy sources

Branislav MIČIETA*, Vladimíra BIŇASOVÁ**, Libor KUBINEC***

ANALYSIS USING OF CLASSIC ENERGY SOURCES

Abstract

The article deals with analysis using of classic energy sources, which are reserves estimate sources are finite in the short term.

1. CLASSIC ENERGY SOURCES

Over the past 20 years the population the earth has significantly increased. In the year 2013 population reached 7 billion and the world population is growing by 1.2 % to 1.5 % per annually. As the population grows and the living standards increases there is a grown demands for energy.

In the long term these requirements cannot be cover by traditional energy sources such as coal, natural gas or raw oil. On the other hand the energy supply option are threatened by rising prices the world markets by armed conflict and by climate change and its consequences. The resources reserves estimate sources are finite in the short term (figure 1).

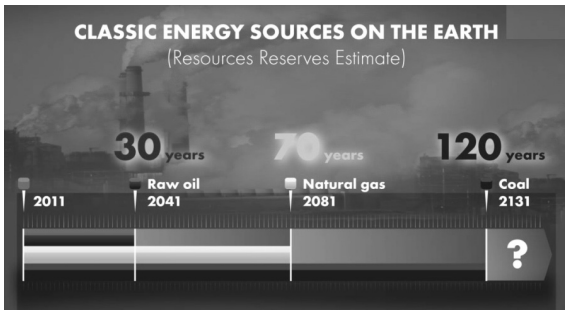

Fig.1. Classic energy sources on the earth

At the current consumption of raw oil are resources limited to 30 years, natural gas resources are limited to 70 years and coal to 120 years.

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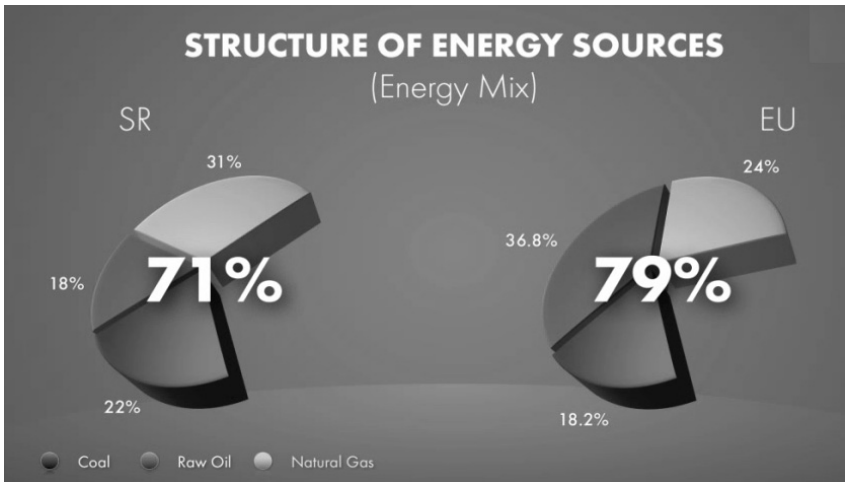

Fig.2. Structure of energy sources (Energy mix)

Growth and stability of the global economy is not possible without require energy sources and require an surest higher energy security of each state.
By minimizing the impact of energy crises. The gas crisis early in year 2009 has been a strong warning to Slovakia and have had negative impact on the economy.

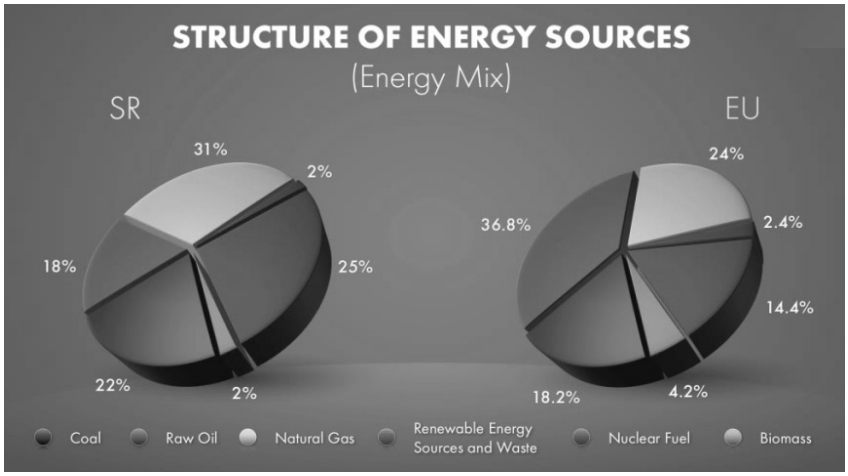

Fig. 3. Structure of energy sources

Energy production in the European Union have depend on traditional energy sources coal, natural gas and raw oil. The structure of energy resources, the European Union has a substantial 79 % share. In Slovakia the share is 71%.

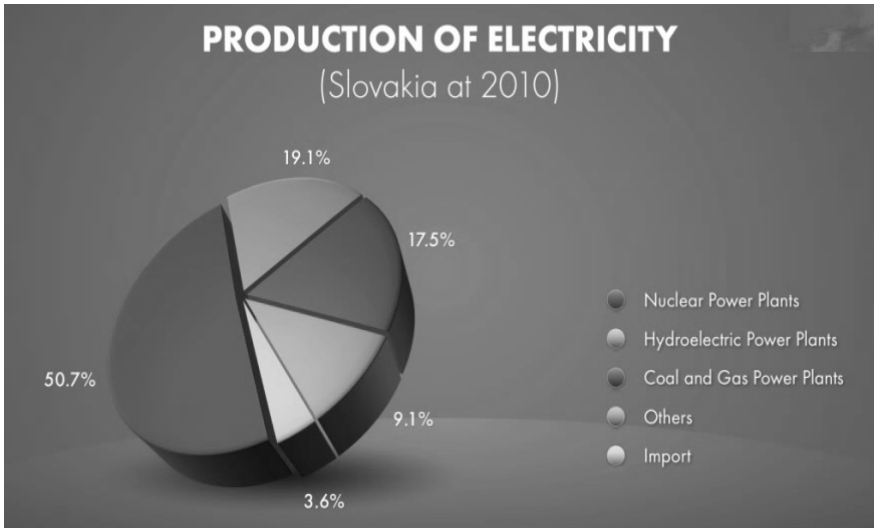

Fig. 4. Production of electricity

The production of electricity in Slovakia at 2010 is shown in figure 4. The largest percentage make up the Nuclear Power Plants (50.7%),. From foreign countries is imported 3.6% of electricity production.

The share of nuclear energy electricity production is 50.7 % then Hydroelectric Power Plants is 19,1 % and Coal and Gas Power Plants. This indicator shows the important role of the nuclear power plants, but also the exemptible energy price level sources as compared to conventional power plants that burn coal or gas.

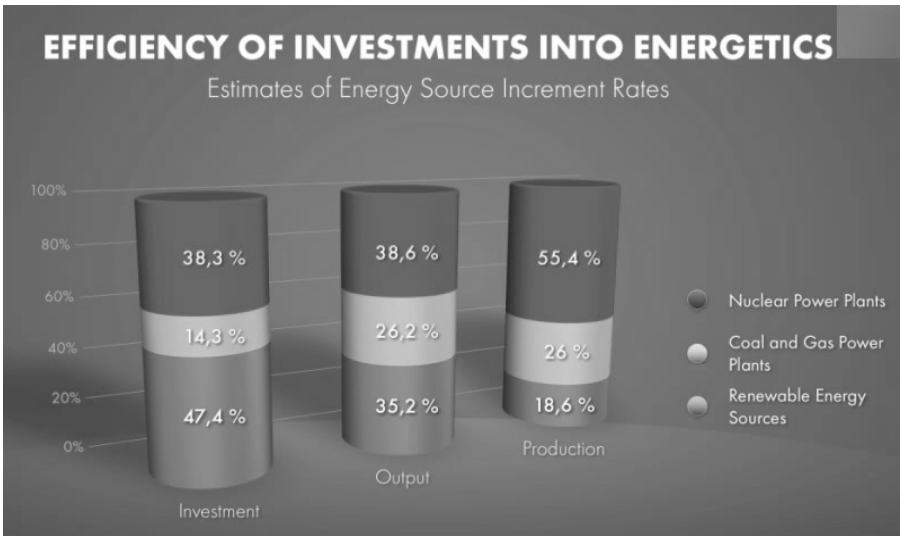

Fig.6. Efficiency of investments into energetic

Under the current energy scenario in Europe will gradually increase until 2030 deficit of electricity sources. The scenario is not yet included anticipated closure of all nuclear power plant in Germany.

Conclusion 7 blocks in Germany is currently the reserve funds may be covered in France, which is hereby exhausted.

Information about the conclusion of nuclear units in Germany raised the electricity prices on the stock markets and the trend will continue to increase in power production with high input cost (gas and oil), causing electricity prices will grow further.

In the development scenario the largest share of investments is planned for renewable energy sources to estimates of energy source increment rates, is expected to development in electro-energy sector in Slovakia in 2030 is planned 15 billion (Fig.6).

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machine vision systems, fault detection, manufacturing process

Marcin PILARCZYK[*],Tadeusz WIECZOREK[*],
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FAULT DETECTION SYSTEM ON CAR ASSEMBLY LINE

Abstract

One of the dominant development directions of quality control are machine vision systems which allow the analysis of images from cameras and vision sensors in order to obtain relevant information regarding the manufacturing process. Controlling the fuel lines connections with the use of machine vision system in the Fiat Auto Poland SA will eliminate the possibility of failed fuel line connection at the car assembly line.

1. INTRODUCTION

The use of more recent and more perfect production technology is also associated with new technologies to monitor and control production [1]. One of the dominant directions of development of quality control are vision systems that allow for the analysis of images from cameras and vision sensors in order to obtain any relevant information regarding the manufacturing process. The information obtained in this way are intended to identify features of the inspected object with the possibility of automatic rejection of the production process in case of failure [2].

In the processes of production control is frequently used sense of sight, which, unfortunately, is not immune to fatigue and de-concentration especially when repetitive activities. These factors result in the formation of the most common human errors that are associated with economic losses and decrease in production [3]. Vision systems have to eliminate these limitations. They are used primarily where previously was the need for supervisory of the process by people, especially in the processes that threaten their health. Vision systems are also used in areas where due to the high speed of production process control made by men is not possible [4]. Other applications of vision systems in the industry include positioning the arms of industrial robots, control of security zones, as well as control of autonomous vehicles for the transport of parts [5].

2. THE VISION SYSTEM TO CONTROL THE FUEL LINES

The procedure involves manually short circuit connectors connecting the fuel coming from the fuel tank with wires extending to the engine. Employees were instructed about the way they

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connect fuel lines. They should pay attention to the distinctive sound when connecting wires (Fig. 1). They should also check that by trying to disconnect the cord does not give to pull the connector [6]. It is possible, however, that due to fatigue or lack of concentration employee, this procedure will be performed not very carefully or wires will be discontinued. There is therefore needed a solution that will verify the correctness of the implementation of this important operation.

Fig. 1. Mounting fuel line connectors process instruction

At the fuel lines installation place the studies were performed to determine the optimal hardware configuration of the stand for vision control. Due to the limitations of working space, which can occupy the stand, one decided to use the smart camera. Intelligent camera combines in a single shared casing the image processor CPU and RAM and FLASH, and software enabling implementation of image processing algorithms [7]. Integration of the camera with the right lens and lighting, and possibly other control devices creates a complex vision system, which could lead the inspection [8].

The camera with accessories mounted on a dedicated stand was prepared by the staff of Fiat Auto Poland (Figure 2). The main objectives were appropriate altitude range, the ability to set the camera at right angles to the axes x, y and z

Fig. 2. Vision system location

During the work on the implementation of the solution to the problem was found that the car has to be in a certain place at the precise moment when the image acquisition by the camera is made. To detect the position of the car the sensor OY2TA403AT235 from the Wenglor company was used.

The sensor is configured in such a way that at the time of intersection of the laser beam by the object for the designated distance was generated a signal which is transmitted to the camera (Fig. 3).

Fig. 3. Wenglor sensor placement

The system for visual inspection of the fuel lines consists of hardware components positioned at the inspection stand, implemented image analysis algorithms , as well as programs for integration of the system with other computer systems of the plant. The inspection stand consists of an intelligent camera with the necessary equipment, which allows the implementation of algorithms for image analysis in the environment of National Instruments Vision Builder. Vision Builder environment also allows the use of LabView language , to extend the functionalities of the environment of new algorithms, and integration with other systems of the plant such as database systems.

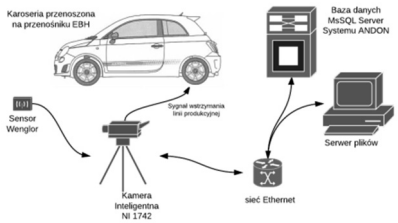

Fig. 4. Connection diagram of vision system components

3. RESULTS OF THE INSPECTION

During the implementation of the system there were carried out two series of validation studies. The research consisted of checking the proper operation of the implemented vision system. On the assembly line of cars, there were tested cars with properly connected wires and simulated errors, which can make an employee. Each validation test lasted about two hours. The need of a second validation test resulted from too low effectiveness of error detection during the first test, and hence the need to make modifications to the proposed methodology and implementation. Obtained results of effectiveness of vision inspection exceed 90%.

4. SUMMARY

One of the dominant development directions of quality control are machine vision systems which allow the analysis of images from cameras and vision sensors in order to obtain relevant information regarding the manufacturing process. Controlling the fuel lines connections with the use of machine vision system in the Fiat Auto Poland SA will eliminate the possibility of failed fuel line connection at the car assembly line. Currently the process of connecting fuel lines is done manually and employees are instructed to check if the connector holds fuel line firmly (Fig. 1). It is possible, however, that due to fatigue or distraction of an employee, that this procedure will be performed incorrectly or even omitted.

Fiat's internal WCM methodology analysis showed the need to increase the level of certainty of proper fuel lines connection already at the assembly line, due to the safe operation and use of the assembled vehicle. One of the proposed methods to increase the degree certainty was to implement machine vision system to deal with this issue in cooperation with Silesian University of Technology. Implemented machine vision system is based on smart camera NI 1742 (Fig. 2), which has CPU, RAM and FLASH memory on board to manage vision inspection without the need of an external computer system. Smart camera is equipped with 8mm focal length lens, and LED ring light (Fig. 3) to provide sufficient lighting conditions. Additionally vision system was extended with Wenglor laser sensor for triggering camera acquisition when fuel connectors are directly in the camera field of view. As for the implementation of vision algorithms National Instruments Vision Builder for Automated Inspection environment was used, which is implemented in the smart camera firmware. After two validation tests at the Fiat's assembly line 90,67% accuracy was achieved. Currently the vision system is deployed on the assembly line and all the system results are stored in assembly line management data base for further validation.

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Quality management methods, 5S, SMED, automotive industry

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5S AND SMED IMPLEMENTATION AS A METHODS TO IMPROVE THE PRODUCTION

Abstract

The article presents an analysis of the possibility of implementing two production control systems - 5S and SMED in one of the production companies. This company is a subcontractor in the logistics supply chain for the automotive industry. The author analyzed the simulation implementation with taking into account errors from the point of view of the system of management, their effects and possible preventive measures. Also presented an analysis of the expected effects and impacts of the proposed solutions.

1. INTRODUCTION

Short product life cycle due to strong competition and changing customer requirements means that producers are forced to seek out and implement changes aimed at increasing the profitability of their business. This phenomenon has resulted in the development of many methods to improve the production, transformed over time into quality management systems. This chapter presents and describes the two of them which belong to most commonly used in enterprises.

1.1. SMED – Single Minute Exchange of Die

SMED stands for Single Minute Exchange of Die. This means a single-digit exchange form, which is meant as an exercise changeovers in less than 10 minutes [1]. As a "changeover" the author means any process that affects the conversion machinery, equipment, team _ and does not give any added value (production). Can be additionally distinguish internal changeover (when the machine is not working) and external (when the machine is running). Most interesting for SMED is changeover internal, the time of production of the last unit produced good before retooling to produce the first good unit after changeover. [2] This means that within the concept of changeover includes a lot of activities. It is obvious that this system is not in all cases has reduced the time of changeover to less than 10 minutes. It has been proven, however, that its application results in a dramatic reduction in the time of replacement of machinery in almost every case.

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Basic assumption the SMED method is to reduce the size of the production batches in order to adapt production to changing market requirements. In principle, this shows the need to reduce changeover times, because it is these times will usually size batches [1].

1.2. 5S

5S is a strategy based on organizing the workplace, which allows a significant increase in productivity, without investing large financial outlays. It is based primarily on the introduction of discipline and order, which will cover the entire enterprise at all stages of production. The key to the system is the commitment of both management and employees, from whose conscientiousness and self-discipline depends on whether 5S fail to implement and keep. [2,3] Introduction of 5S practices should begin with a series of training for all employee groups. Its purpose is to clarify the meaning implement a management system so that employees themselves recognize this action as beneficial. The workshop should practice the method on a simple example to each of the participants understood the methodology of 5S elements. [3]

2. Analysis implementations in enterprise - results

Simultaneous implementation of 5S and SMED methods have been considered by the author as the best, as expected in this case, the largest of, among other solutions, the ratio obtained effects to costs. After the statement of expected results of the proposed improvements and empirical data collected during the work for the operator numerically controlled milling machines, assessed the effects of the implementation of 5S and SMED system. The results are shown in Table 1.

The collected data were drawn characteristics that show the costs and effects of the implementation of these systems. Analyzed five different cases, in which the changeover occurs at a frequency of from 0.5 to 8 changeovers per day.

Table 1 The impact of implementing 5s and SMED

	5S	**5S + SMED**
Duration changeover	25 [c.u.]	15 [c.u.]
The impact on the streamlining	5 [c.u./shift]	15 [c.u./shift]
Generated savings	Better utilization of machines, equipment and tools, as well as increase their service life.	As with 5S, plus: a significant reduction in the risk of incorrect implementation details, reducing wasted time and duplication of technical documentation.
The cost of implementing	6000 [c.u.]	18 000 [c.u.]

The time required to complete implementation of the system	96 [hours]	120 [hours]
The cost of maintaining	1300 [c.u./month]	11 300 [c.u./month]
The time needed to maintain the system	7 [hours/month]	20 [hours/month]
Other	Free up the space, improving the company's image and security, increase morale and work comfort.	As with 5S, plus: improving the quality, a significant increase in performance.

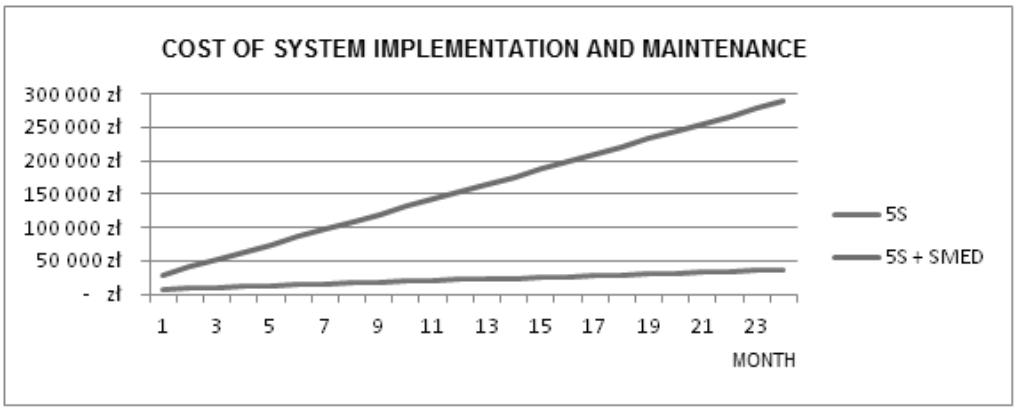

Fig.1. Cost of system implementation and maintenance

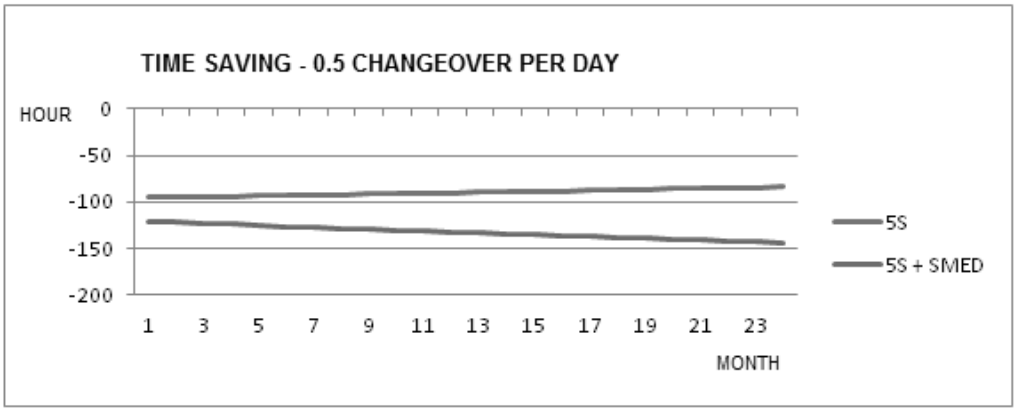

Fig.2. Time saving – 0,5 changeover per day

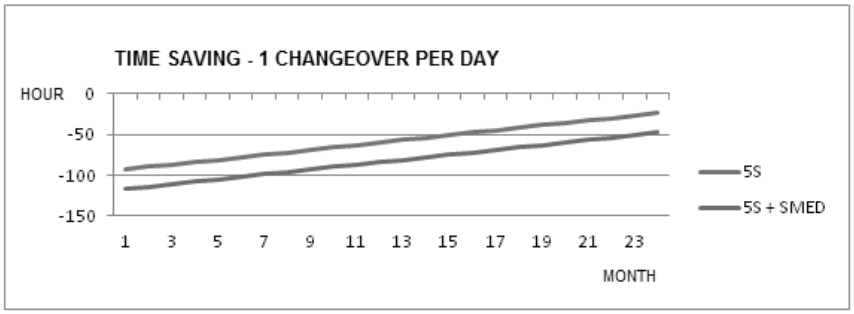

Fig.3. Time saving – 1 changeover per day

3. SUMMARY

From the characteristics of presenting costs can be seen that the 5S method is inexpensive both to implement and maintain (Fig. 1). The simultaneous introduction of methods of 5S and SMED is associated with considerable expenditure, which, however - in the whole budget of the company - not too big. Graphs showing the time it can save by implementing these methods of production control, give a clear picture of the profitability of the project, depending on the expected number of changeovers per day.

The analysis shows that when the value is 0.5 [changeover / day], the introduction of the 5S invisibly impact on productivity growth (Fig. 2). This will, however, for the reference of other benefits for the company, such as increasing the space, improve security and corporate image, increase morale and comfort. The implementation of both systems at the same time, the effect will be counterproductive - the amount of time required for maintenance of the system will be greater than that which manage to save. Of course, in this case, too, there are many benefits of ownership of these systems, however, taking into account the cost of maintaining them, this solution is not very profitable. For the frequency of changeovers equal to 1 [changeover / day] performance increase is small (Fig. 3), and the balance of the time required to implement and maintain systems and time gained a positive change after about 3 years. However, taking into account other benefits of their introduction, both variants are profitable.

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service activities, optimization, effectiveness

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DESIGN EFFICIENT SERVICE ACTIVITIES

Abstract

This paper is dedicated to the field of enterprise service activities, especially to optimising and increasing their productivity and consequently to increasing the productivity of main enterprise processes. It follows the design of enterprise service activities content definition upon the basis of Infrastructural Facility Management. The paper focuses on the incorporation of service activities into the organisational and managing enterprise structures and as well as on analysing the factors influencing their effectiveness, respectively the effectiveness of main enterprise activities. It makes review of the theoretical knowledge in service activities within domestic and foreign production enterprises.

1. INTRODUCTION

Service activities are used to be marked more and more like the key of economic success of production companies. It is as a result of changing conceptions to run the production enterprises having new and high requirements for the management of service activities. Getting prepared for requirements of the future under new conceptions means to be asking about present condition then to analyse it and create new ideas and new model of service activities. It is necessary to make the analysis of all organisational, technical and economic aspects in the way to give the guaranty of close cooperation with customers in terms of optimal cost of the service activities and contractual conditions.

Optimal solution of the service activities within an enterprise faces sizable fractionalism among various sections, divisions, departments and as well as among their subsidiaries or joint ventures when the responsibilities respectively sponsorship and consequent activity coordination (for example the coordination in terms of investment procurement, practicing the unified technical policy, etc.) are highly questionable. Planning functions and activity performance in terms of the service activities are not respected and their fractionalism leads to the isolated optimisation of partial goals of particular enterprise sections, departments and so on.

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2. MODEL OF SERVICE ACTIVITIES OPTIMISATION

Increasing the effectiveness of service activities is possible upon designing the model of enterprise service activities as the support activity or support process having significant impact on the main activities respectively main processes with the purpose to increase the profit and productivity or to reduce the expensiveness / costingness and increase the added value of organisation. Proposal of the service activities model (IMG 1) comes out of present theoretical knowledge basis, analysis of present situation within the area of service activities and best practices. Basis for this model proposal is the knowledge of Facility Management structures, which is the area directly following the history of services development and particular support functions development. Work flow to build the model up follows

- ⇨ Creating the environment
  - ▫ unifying the principals of planning, decision making, performing and controlling of such activities,
  - ▫ making the unity of understanding the service activities as a meaningful function of organisations;
- ⇨ Removing sizable fractionalism among various sections, divisions, departments, subsidiaries or joint ventures within a group / holding (not jus form the organisational point of view)
  - ▫ when the responsibilities respectively sponsorship and consequent activity coordination (for example the coordination in terms of investment procurement, maintenance, practicing the unified technical policy, etc.) are highly questionable;
- ⇨ Eliminating various disproportions (organisational, technical, controlling, etc.) to increase overall effectiveness, respectively to reduce overall expensiveness / costingness of an organisation and to increase the motivation for performing the service activities in this way;
- ⇨ Defining the rules of monitoring
  - ▫ by designing the key performance indicators (KPI-s) and setting their calculations up we can measure respectively assess the performance and effectiveness of service activities.

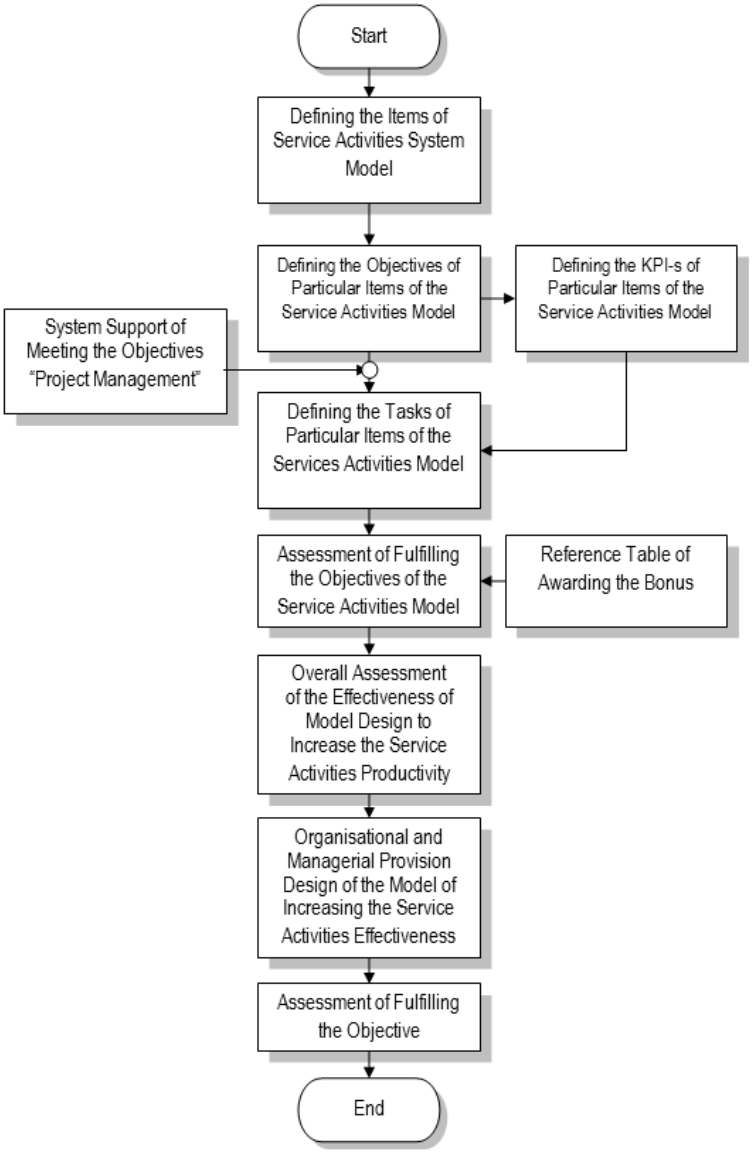

Fig.1. Work Flow of Building the Service Activities Model

For the fulfilment assessment of objectives the key performance indicators (Tab. 1) are defined to evaluate increasing the effectiveness of particular Service Activities System items.

Tab. 1. Key Performance Indicators of Service Activities

System Item	Objective	Key Performance Indicator (KPI)	
		Index	Description
Investment Procurement	Measuring / monitoring the process of Investment Procurement with the purpose to increase its quality.	KPI_{IP}	Indicator expressing the degree of Investment Procurement Process fulfilment.
Service of Production and Technological Means (PTM)	Reducing the accident rate and increasing the Work Safety Prevention of performing Production and Technological Means Service.	KPI_{WS}	Indicator expressing the degree of Work Safety.
	Increasing the Availability of PTM with the purpose to reduce the primary and secondary cost of PTM Service / Maintenance.	KPI_{A}	Indicator expressing the Availability of PTM.
	Reducing the Environmental Incidents and increasing the prevention in relation to the PTM Service / Maintenance.	KPI_{E}	Indicator expressing the degree of Environmental Fulfilment.
	Increasing the Quality of PTM Service / Maintenance and reducing the number of reclamations.	KPI_{Q}	Indicator expressing the degree of PTM Service / Maintenance Quality.
	Optimising the Target Cost of PTM Service / Maintenance.	KPI_{TCPTM}	Indicator expressing the degree of saving and optimising the Target Cost budgeted for PTM Service / Maintenance.
	Overall measuring of the quality and effectiveness of PTM Service / Maintenance.	KPI_{SPTM}	Summary indicator expressing the performance and quality of PTM Service / Maintenance with respect to the Work Safety, Environmental Aspects and PTM Availability.
Administration of Production Areas and Buildings (PAB)	Monitoring of fulfilling the Expensiveness / Costingness in relation to the Administration of Production Areas and Buildings.	KPI_{APAB}	Indicator expressing the degree of Expensiveness / costingness in relation to the Administration of Production Areas and Buildings.
Procurement	Monitoring of fulfilling the Expensiveness / Costingness in relation to Procurement expensiveness of services, materials, spare parts etc.	KPI_{P}	Indicator expressing the degree of Procurement expensiveness.

3. ASSESSING SERVICE ACTIVITIES EFFECTIVENESS

Assessing the effectiveness of Service Activities Model comes out of the formula

$$KPI_{SA} = KPI_{IP} \times KPI_{SPTM} \times KPI_{P} \times KPI_{APAB}$$

When setting up the values of particular indicators from the point of real capability to measure and assess Service Activities and consequently make the decision on proper corrective and preventive actions I used partially the analytical approach, if there was an usable data basis within an information systems, and partially the empiric approach when using my personal experience respectively the experience of the professionals acting within the area of various production organisations.

Reference Bonus Table (Tab. 2) to reward the responsibles for their performance is designed based on the values gained from calculating the objectives fulfilment of particular Service Activities items (Tab.1).

Tab. 2 Reference Bonus Table

Reference Bonus Table – Rewarding upon the Degree of KPI Fulfilment											
System Item	**KPI**	**Weight in %**	**Fulfilment of Parameter**								
			1,5	**1,4**	**1,3**	**1,2**	**1,1**	**1**	**0,9**	**0,8**	**0,7**	**0,6**
Investment Procurement	KPI_{IP}	30	130%	125%	120%	115%	105%	100%	25%	0	0	0
Service of PTM	KPI_{PTM}	45	130%	125%	120%	115%	105%	100%	25%	0	0	0
Administration of PAB	KPI_{APAB}	10	130%	125%	120%	115%	105%	100%	25%	0	0	0
Procurement	KPI_{NZ}	15	130%	125%	120%	115%	105%	100%	25%	0	0	0
Σ to Reward		100										

Within the above table there are the KPI-s to measure the fulfilment of each system item and proper quotient of the sum is awarded upon the weight within the Service Activities System. Setting up the percentage weight of particular Service Activities System items has been designed based on the analysis of present situation respectively pareto analysis. It means that particular percentage weights express the influence on primary expensiveness / costingness of an entire organisation and as well as on the secondary expensiveness / costingness respectively on the loss of profit due to stoppages of the production and technical means or late

launching the subjects to investment procurement (production lines / machinery, etc.) into full operation and so on.

4. CONCLUSION

Implementing the Service Activities System is complex process for the long run. If we would like talking about the presumptions of successful and effective implementation of the system then clear declaration of Top Management and Stakeholders to support implementing the Service Activities System must be given officially.

Functionality of the Service Activities System and its particular items has been tested by practical implementations. Methodology of designing the model respects the principals coming out of Facility Management. It is usable within stable enterprises as the process of ongoing improvements and as well as within the enterprises under business processes reengineering.

Solution of the model of Service Activities System and its particular items has proven significant contributions from the point of qualitative and as well as quantitative view.

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motivation, the performance of the enterprise, the enterprise world class.

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MOTIVATION AND ITS IMPACT ON THE PERFORMANCE OF THE ENTERPRISE

Abstract

Article discusses the principles of the process of motivation, its application in the enterprise world class. It refers to the relation between motivation and growth enterprise performance management process.

1. INTRODUCTION

Concept of business performance are currently often used term. Concept of business performance used in defining the very essence of an enterprise, its success and ability to survive in the future. The concept of business performance are currently often used term. It is used in defining the very essence of an enterprise, its success and ability to survive in the future.

Performance management process is a closed control system with feedback, which represents the policy and strategy of the organization and obtains feedback from many levels of the organization for the purpose of effective management. Performance management system is an information system that is the heart of the organization's performance management process and plays a vital role in setting goals, evaluating performance and future activities of the organization determined.

Organization, which depends on its long-term performance and competitiveness, actively interested in what needs to be done to achieve and maintain consistently high performance of its employees and the organization. It means to measure and manage performance of the organization and pay due attention to the most appropriate way to motivate people through such tools as various incentives, rewards, leadership and - most importantly - the work they do and the team in which they work. The aim is to create a motivating processes and work environment that will help that individuals and groups achieve results corresponding to the expectations of shareholders, management and other stakeholders.

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2. MOTIVATION AND ITS IMPACT ON THE ON PERFORMANCE OF THE ENTERPRISE

The motivation occurs when people expect that a specific action is likely to lead to the achievement of any goal and rewards that meet their individual needs. Human behavior is a function of the consequences. If the behavior is valued, and such behavior is repeated in practice.

2.1. Principles of motivation

¶

People do things according to what they receive from their activities.

- If a person performs some activity and result is positive (pleasing, encouraging, rewarding, useful), and most likely will repeat this activity,
- If a person performs some activity and result is negative (unpleasant, uncomfortable, disgusting, punitive) then the person will immediately stop the implementation of activities,
- And if a person performs some activity and finds that there is no consequence, in other words, nothing happens, than probably stop carrying out activities also.

2.2. The requirements of motivation

The primary requirements of work satisfaction may include reasonable degree of confidence, freedom of choice and participation, higher pay, fair pay system, a real opportunity for advancement, friendly and fair management, a sufficient degree of social interaction at work, interesting and varied role and a high degree of control over pace and working methods.

Money plays an important role in motivating. Money in the form of wages or other rewards is the most common type of extrinsic rewards. Money providing what most people wants. But it is not just money that motivates.

Studies of employee motivation and specific knowledge from practice show that:

- Criticism has a negative impact on the achievement of the objectives,
- Defensive as a result of criticism produces worse performance,
- Recognition has a different impact on people,
- Performance is dominantly increases, if they are established clear objectives,
- Common setting goals and elimination of criticism improve performance,
- Employee participation in setting goals helps to achieve the desired results,
- Coaching staff needs to be regular daily activities.

Well-motivated people are those with clearly defined objectives, which took steps by which expected to lead to the achievement of these objectives.

Approaches to management incentives are too often simplify ideas on how motivation works. Motivation procedures will work effectively only if they are based on sound knowledge and understanding of what is important.

Motivation of people and manage their performance is not a quality control. Quality experts to manage the process according to the principle, if the processes are carried out properly and in accordance with the standards should be left unnoticed. Attention should be paid to those aspects that deviate from standard. If this approach was applied to human

performance, the vast majority of people would be ignored because their performance is not out of positive and negative tolerances.

The performance management people would have been such a qualitative approach a serious mistake. Employees should receive recognition from his superior only in cases of exceptional performance

2.3. Motivation in the enterprise world class

Organizations at the enterprise world class insist that managers consistently demanded their example standards compliance by all employees and gradually lifted these standards. Persistently working to identify employees with the highest potential and develop them quickly. Eliminate non-executive employees to block the path of talent. Human resource departments are taken as partners and occupy their most talented employees and require them to be active agents of change in the organization.

In principle, there are four basic parameters for the evaluation of the production organization:

- Quality,
- Quantity the required range and time,
- Costs,
- Flexibility.

The role of managers is to reveal the maximum performance of each individual organization, although it occasionally for workers is not pleasant. Essential key success factors are:

- employee involvement of the in the planning and implementation of goals and problem-solving,
- understanding of the key responsibilities of individual employees,
- understanding of the objectives that the organization expects from them,
- understand individual employees competencies,
- planning of training and development of employees raining and development of employees.

The next phase is the actual implementation of the work and performance of the program. At this stage, it is the primary responsibility of the employee to perform his job and achieve the goal. A key task of management is:

- ensure motivating conditions,
- provide feedback, coaching and support to employees,
- confrontation and correction of performance problems.

2.4. The impact of motivation on organizational performance

Motivated employees are provided to ensure a sustainable high performance production plant. Employees are motivated when they see clearly and specifically how their work is done and how to pay for it. Motivated employees perform their work better and with more effort and less motivated. What really motivates people is the job satisfaction - opportunities to the objectives and implementation of performance, recognition, learning and growth, welfare, utility work, and others. These are factors that generate a strong sense of loyalty, satisfaction, enthusiasm, which wants to see the management of their employees.

Money is a very important element of motivation equation. People are unhappy, if they feel that the pay does not reflect their commitment and effort, responsibility for the work, or is out of market reality. If people do not feel that their wages are competitive, they are not satisfied and are looking for other possibilities of application. In this case, regardless of the amount of wage growth, it is difficult to generate motivation and satisfaction because job satisfaction is a function of the content of work.

Conversely, if people feel that their wage reflects the quality of their contribution to the organization conducts and is competitive, and can be an important source of real wage incentives.

Satisfy mental needs of employees - healthy, safe and attractive working environment, clearly defined rules and objectives, delegating important powers and responsibilities to individuals and teams and their involvement in problem solving, fair system of pay-for-performance and accountability, evaluation and appraisal work, education provision and professional growth, considerate and fair management with the natural level of confidence, positive support, joint efforts on long-term job security - a key factor in motivation.

3. Conclusion

Enterprise management is a summary of various activities, each of which requires a detailed knowledge of the details and context.

Person needs to the successful implementation of any activities other than the ability of any higher level of motivation. In the current business practice is characterized by the orientation of business owners and managers to motivate employees, which significantly increases efficiency and productivity, thus organizational performance.

Successful companies are constantly developing management methods, which are based on knowledge of regularities industrial competitiveness and knowledge of the laws of the free market. Their development builds on advanced information technologies and systems to be able to meet the ever increasing demands of the customers. Measurement systems and performance management are strategic management tools for ensuring long-term competitiveness and success of the organization.

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Spinal dynamics, posture of body, Brügger´s sitting posture

Martina SMUTNÁ*, Martin GAŠO**

GOOD POSTURE AS ONE OF THE PRINCIPLES OF HEALTHY AND PRODUCTIVE WORKER

Abstract

Health musculoskeletal system is not related only to working conditions in the workplace, the workplace layout and detailed designing workplaces. We can ergonomic solutions and using various analysis tools improve its workplace to the worker, to facilitate, accelerate and to streamline its working operations, but the habits and posture of man depends to what extent its operation "ergonomic".

1. GOOD BODY POSTURE

The fact that worker we optimize the workplace and working environment using the principles of ergonomics is a big step for the worker, but it does not mean that we will achieve 100% relief from his difficulties with the musculoskeletal system. There are a number of factors that affect this. We are trying to expand into other ergonomics, a therefore we would like to offer something like "standard - user" to eliminate another factor and that is - incorrect posture while working activities, but also in life in general.

In childhood we have naturally good posture because the baby instinctively moved a way that the body burdens minimal. But what we are older, you grow worse habits to poor posture. Bending, stiff shoulders, or carrying a weight on one leg at standstill are bad habits that burden our body and cause long term damage or pain.

1.1. Spinal dynamics

In anatomical structure of the human body is hidden definition of meaningful use of the musculoskeletal system, in the shape of bones, muscles and joint structures. The function of muscles, joints and bones is all movement. In our body we find such a muscle, joint or bone, which should clear the function. All are elements of a comprehensive musculoskeletal system. Everything in our body has given a clear function.

If so, why there is more and more often to the Musculoskeletal System? Why suffer musculoskeletal pain, why is our body overloaded, worn out?

Everything started by inventions and technological development of various tools and equipment to facilitate the human labor. Relocate from place to place, we have escalators,

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elevators, many hours sitting at a computer or TV with a controller in hand. Just what it can make life easier for us and causes difficulty here is why today we have so many problems with the musculoskeletal system. We do not use your body for a dynamic movement - to which it was intended, but the long and often found in static positions - sitting, standing. Our muscles lose elasticity and strength. Cause a muscle imbalance in our body and is looking for a replacement stereotype movement.

1.2. Brügger´s sitting posture

Novelty, which can each principle to support good posture is called. "Brugger seats". Doctor Brügger (Swiss neurologist) within its research classification of disorders of the musculoskeletal system using experiments dealing with functional disorders the musculoskeletal system and their causes.
He proposed method of seating, which is currently recommended worldwide by doctors, physiotherapists and other specialists. Sit consists of basic principles:

- The hip joints are slightly higher than the knee (not - right angle in ergonomic sitting position).
- The knee joints are spaced apart from 10 to 15 cm.
- The legs are securely stored on the floor (mat) - the whole area.

These principles will cause the spine is upright and the body doesn´t falls into un-physiological position. Important is the regular rotation of this method with the classical ergonomic sitting - recommended ergonomics - the principle of right angles (right angle at the ankle, knee joint, hip, spine upright with the cervical spine and right angle at elbow joints). Ideally substitution along with occasional stands (walking).

Fig.1. Demonstration of correct sitting position (left side) and wrong seats (right side) [5]

2. ANALYSIS OF BODY POSTURE

Posture analysis, based on the concept of spinal the musculoskeletal dynamics, anatomically correct motion. It is a three-dimensional, systematic and distinct movement. Spinal dynamics is based on medicine, physiotherapy and occupational therapy. Basic principles of posture, contained in this document can help us control our body. The important thing is perceive their movements and discern right - coordinated movement in our body from improper coordination of movement.

The basic principles of good posture include:

1. Head – keep your head in line with your spine. Chin parallel to the floor and cervical spine relaxed. The chin is pushed inwards.
2. Shoulders – have to remain relaxed and in the same plane. Scoops tries to download back down.
3. Pelvis – hips, we should keep in one plane. The coccyx is to support the spine and should be inserted inside.
4. Knee – should remain slightly bent - not locked, unpaved.

Feet - the basic principle is evenly split on standing full body weight on both feet (to avoid transferring the weight on only one leg). The feet are parallel oriented.

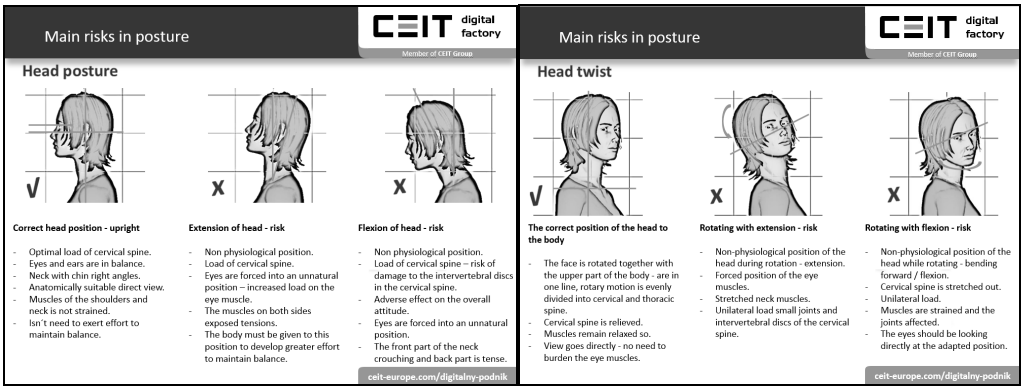

Fig.2. Show of head basis posture analyses [Smutná]

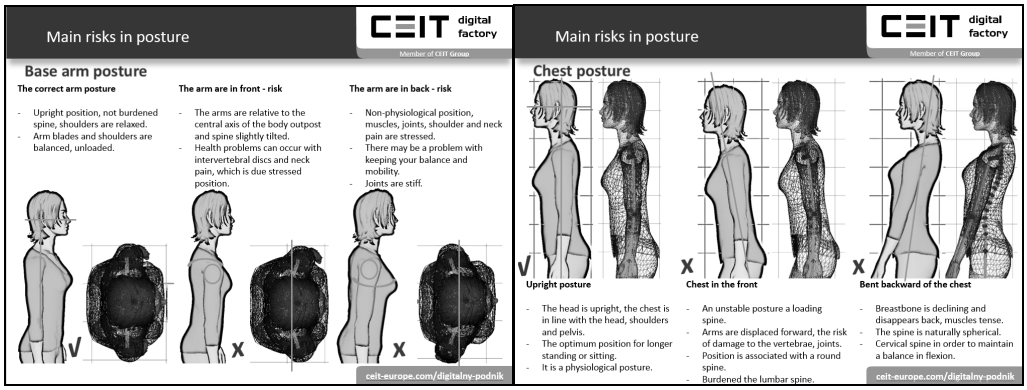

Fig.3. Show of basic arm posture analysis [Smutná]

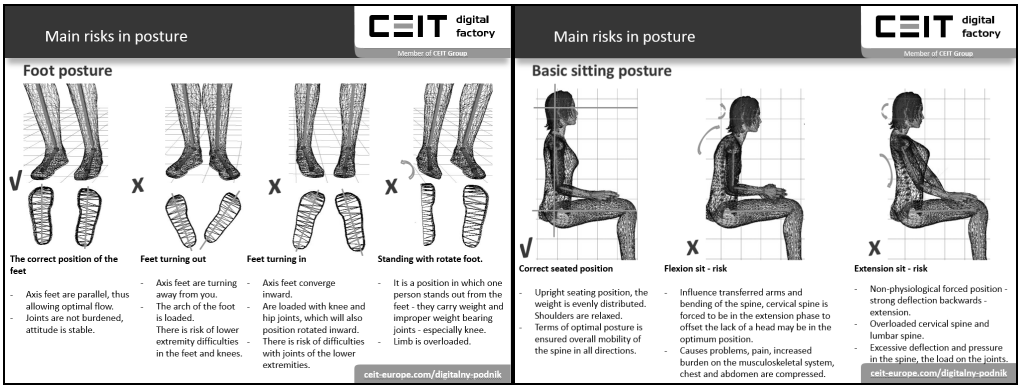

Fig.4. Show of basic foot posture analysis and basic sitting posture [Smutná]

3. CONCLUSION

Do you realize that the longer you sit down your spine and bend forward is allows? That when you look through the computer or TV, your neck tilted to one side? That states your head gently dropping? No - that most would not realize. Improper use your body to overload the musculoskeletal system and if we are talking about the so-called. Faulty movement patterns. The result is pain that we feel. Solution as medication and exercise, but this solution is not, if we do not know the origin of our worries and do not remove it. For this reason, the document was prepared, which can be used as a standard for all workers, factory, office, at work and personal life.

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Ergonomics, logistics, evaluation system

Martina SMUTNÁ[*], Andrej ŠTEFÁNIK[**], Martin GAŠO[***]

ERGONOMIC ENSURING OF LOGISTIC

Abstract

Currently in the ergonomics runs effort to create a system for the assessment of ergonomics in logistics. The main part of the system should consist of evaluation of physical stress modified for logistics processes and in particular the methodology of ergonomic security logistics flow. It is essential to check in practice. Creating a unique system for assessing critical operations and improve ergonomics in terms of maintaining the health of workers and increasing productivity at work, as part of a comprehensive logistics system in production may provide the competitiveness of companies, because only a healthy worker is working quality and productively

1. ERGONOMICS IN THE LOGISTICS SYSTEMS

Currently, companies must find ways to ensure the necessary productivity growth. Means the improvement of the basic factors that affect it, including largely ergonomic factors. Workplace and work processes in logistics should be designed so that they are not only highly productive, but also conducive to workers who work in it.

Ergonomics is a very difficult multidisciplinary field of science, which is difficult to handle even for researchers. The aim of ergonomics is to maintain health, thus physical, mental and social well-being of man, creation of conditions for optimal human activity, as well as create a sense of well-being in the workplace. The use of ergonomic principles in practice contributes to creating well-being, the humanization of work and at the same time it also brings economic effect.

Ergonomics in the logistics system is focused on creating optimal conditions for the exercise of logistics and ensures the health maintenance of logistics, namely the physical, mental and social well-being and work satisfaction. Modern ergonomics deals with the efficiency of human work in complex organizational system of labor-man - machine - working environment through relationships subsystems man - machine, human - organization of work and man - the working conditions.

Advanced ergonomics at the level of existing knowledge and technical possibilities of modern science applies initial natural process and practical verifying solutions from the impact

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on workers' health to economic benefits. That person could effectively use their workforce and their personality a must have for professional activity created optimal conditions, which are a precondition for growth performance, and thus the productivity at work.

As time began to place greater emphasis on the management of its production during all aspects of logistics and manufacturing. The next stage in development, which extends up to the present time, the design of workplaces in relation to the human factor.

The aim is to adapt the logistics process so as to have as little negative impact on humans and caused no damage or only minimal. In order to be able to develop methods of ensuring ergonomic logistics flow is necessary to a proper understanding of the links between ergonomics and design logistics workplaces and work within logistics. For the design methodology ergonomically correct security logistics flow is essential to the process itself developed on the basis of practical experience in the relevant field in industry.

2. ERGONOMIC FACTORS AFFECTING ENSURING OF LOGISTICS FLOW

Ergonomics, which deals with the work and working conditions of man - worker, based on the fact that "where the optimizing conditions for workers are achieved higher performance, increased quality and recorded better indicators of productivity of work". Just ergonomic factors influence the workers and influence to productivity of work and laboriousness are associated with their job and working conditions in which the work tasks performed.

1.1. Factors affecting the logistics workers

It is understood that we cannot well adapted to man his work, and modify all factors, but the work must be adapted to man the maximum possible extent. Said ergonomic factors affecting logistics workers are divided into the following groups:

- Anthropometry and spatial conditions
- Physical and mental load in the work,
- Work movements,
- Overload at work,
- Rational creation of workflow,
- Time and motion studies,
- Working environment.

1.2. Ergonomics risk assessment methods in logistics

The initial proposal was found in the risk assessment of ergonomics in the logistics of these methods:

a. Evaluation of the spatial conditions and collisions in logistics operations:
    - Visually conditions in logistics.
    - Handling planes in logistics.
    - Collisions in logistics operations.
b. Assessment of the physical load logistics workers:
    - Fatigue analysis.
    - Evaluation of working postures.

- Evaluation of cumulative traumatic disorders risks.
- Analysis of upper limbs load.
- Evaluation of working postures for identifying problems wiht CTD.
- Risk analysis of musculoskeletal system with emphasis on the upper limbs.
- Evaluation of load manipulation with using of multiplicative model.
- Assessment of the risk injury by the actions of upper limb.
- Evaluation of physical load by Burandt Schulte.
- Evaluation of logistics workers load in lifting and putting.
- Evaluation of logistics workers load in carrying.
- Evaluation of logistics workers load in pushing and pulling.
- Using a key indicators method.
- Analysis of energy expenditure of logistics workers.

3. EVALUATION OF PHYSICAL LOAD IN LOGISTICS

In the evaluation exercise capacity in logistics is necessary to revise the process of implementation across such a project. In Table 1 is an example of one risk assessment in logistics. The entire evaluation process begins with physical activity data from the data collection, capturing images of risks activities during the work of logistics, we talk about identifying critical risk activities. Of course it is necessary to obtain information on the organization of work, conditions in the workplace, stress and load worker.

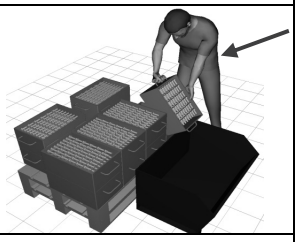
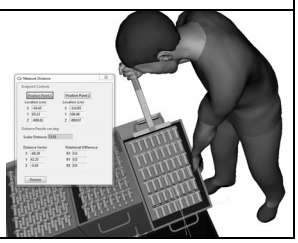
The basis of the analysis of the labor consumption of logistics. Existing data will be processed in the digital environment. It is possible to use the modeling of risky working position, or the entire animation process risk activities, such as removal from fertilizing components, repacking process components and the like. Will be assessed physical activity relevant analysis using software and legislation.

Subsequently, propose corrective actions and verifying the decline in the risk. Corrective actions must be consistent with the quality of work does not disrupt the current productivity or other activities or workplaces.

Tab.1. Demonstration of a single risk assessment - ergonomics in logistics

Input data / activity:	Pouring components in the container.
Duration of workshift	8 hours
Weight of empty metal container	8 kg
Weight of component	11,32 g
Weight of full metal container	53,2 kg
Repetitive of manipulation	≥ 170 x/PZ
The age of the worker	52 years

Tab.1. Demonstration of a single risk assessment - ergonomics in logistics - continuation

<table>
<tr><td colspan="2">Show from workplace:</td><td>Model of risk</td></tr>
<tr><td colspan="2">  </td><td>  </td></tr>
<tr><td colspan="3">Analysis of physical load: LBA – (Low Back Analysis)</td></tr>
<tr><td>Risks</td><td>Limit values</td><td>Recommendation</td></tr>
<tr><td>≥ 3400 N</td><td>Push force to L4/L5</td><td rowspan="2">Necessary action to difference</td></tr>
<tr><td>≥ 1000 N</td><td>Shear force to L4/L5</td></tr>
<tr><td>0 - 2000 N</td><td>Musles tension in spine</td><td rowspan="2">Reconsider the activity</td></tr>
<tr><td>0 - 200 N</td><td>Axes moments in L4/L5</td></tr>
<tr><td colspan="2">Calculation of reduction force</td><td>Corrective action - fixture</td></tr>
<tr><td colspan="2">Mz = Mg
G.a = F.b
F = (m.g.a)/b
F = (53,2 . 9,81 . 0,255) / 0,73 = 182,30 N
Limit pressure and shear on the intervertebral discs is not exceeded. (The condition of the preparation: the palette is only 8 containers.)</td><td>  </td></tr>
</table>

4. Conslusion

Logistics activities are by their nature different from assembly and manufacturing operations. This needs careful consideration and work with these differences. Classic ergonomics is adapted high repetition in the present conditions of production. The logistics plays a big role in the fact that the activities are diverse, we cannot talk about stereotypes and monotony. Nor are the most recurring case of activities with high frequency. Another factor that is often used to handle the load using the working device (balancer, barrow, trolleys without fixed rollers, rail cars). Should be given to issues and finalize in order to create a system for evaluation of ergonomics logistics.

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Milk run, distribution vehicle routing, mathematical algorithms, simulation

Lucie Heligar SVOBODOVÁ*

OPTIMIZATION OF THE MILK RUN VEHICAL ROUTING

Abstract

Lean principles have become the standard. In one hand directly in the shop floor in the other hand in the support processes like logistics, maintenance ect. Companies are using logistics systems kanban or milk run more often than before. But the implementation is not so easy and requires lot of details. This article focuses on the Milk run implementation. It defines and compares the possibilities. Mathematical solution or simulation.

1. INTRODUCTION

According to this characterization, **milk run** schedule is considered as a special vehicle routing problem (VRP) with time windows and a limited number of vehicles. Components are very often delivered by milk run system.

Definition: A milk run is a manually operated, cyclic transport system delivering raw materials and finished goods, using a fixed routes and time schedule.

In order to plan feasible milk run cycles with the lowest operating costs, the shop-floor constraints have to be taken into consideration. The limited capacity of vehicles and time consumption of the logistics processes require effective vehicle routing approaches so as to support production without glitches. [7]

The system got its name from the practice of farmers who have committed themselves daily milk cans and then they picked up them empty.

The concept of Milk run has the following steps:

- Check the quantity, distance and process of supplying
- Specification of the logistics routes
- Defined parameters of milk run such as weight, volume, time units, the frequency of deliveries, and the maximum number of milk run supply.
- Development and evaluation of milk run alternatives
- Specification of the milk run with a description of routes and timetables and with the standard positions of loading and unloading described in the shop-floor layout.
- Process implementation: Documentation of the definition, trainings, workshops, evaluation and manage. [4]

Schematic representation of the milk-run is described in the following figure Fig. 1. There is station for the vehicle and there are four working places. Roads and positions for loading and uploading the incoming material described according the alphabet A-G.

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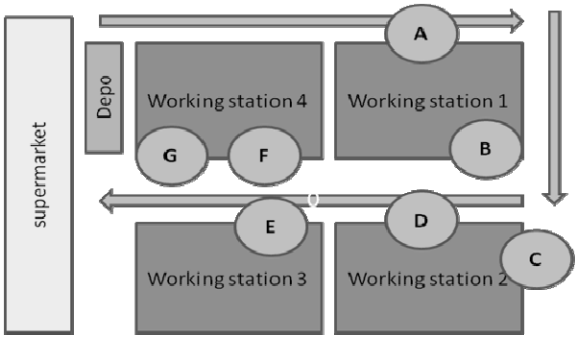

Fig.1. Schematic description of the milk-run system

2. MATHEMATICAL MODELS

It could be possible to use the several algorithms for the description of logistics roads:

1) Mathematical algorithms of the linear programming.
   - Traveling Salesman Problem
   - Littl`s algorithm [5]
2) The optimal path in the graph - finding the shortest path [1]

Linear programming is used in the situation where it is necessary to predict the mathematical outputs. Target of the distribution tasks is to find the shortest road and decrease the transportation costs. Objective function to be minimized is the length of path. This distribution task is defined by an algorithm of the Traveling Salesman Problem.

Next solution of the distribution task is an issue of vehicle routing problem (VRP). Capacity of the suppliers, customers and distribution systems are considered in this solution.

Vehicle routing problem is really top issue in the solutions. Typical issue is to deliver components from depot by supermarket into the loading stations. There is limited capacity of the vehicle. Vehicle is transferring a material and then it is return back to the depot station. Target is to define the timetables of vehicles to decrease the operating costs. Littl`s algorithm can be used. [5]

Optimal roads in the graph represent distribution network. Main parameter is length. This value is evaluated by edges which could be directed or undirected. The goal may be to find the shortest or longest path between two points and the determination of the shortest circuit, etc. [1]

3. USING OF COMPUTER SIMULATION

Simulation is a research method whose essence lies in the fact that the examined system will be replaced by the simulator as it is performed experiments to obtain information about the original review of the system. The simulation model is a dynamic system in which the events and conditions occurring as in the evaluated (simulated) system in the same order but generally in other time intervals. Elements of the model do not have to be in the model permanently. It can be changed dynamically. [6] Simulation is used for the experiments. Target is to known the real form.

The results of such simulations can be created as a realistic view of the process and results of graphical and tabular values. The real system could be simulating by the computer models.

Faithfulness of the simulation models and their results closely related to the quality of the simulation tools and their creators. [8]

The simulation model can be determined using the following scheme. See fig. Nr. 2.

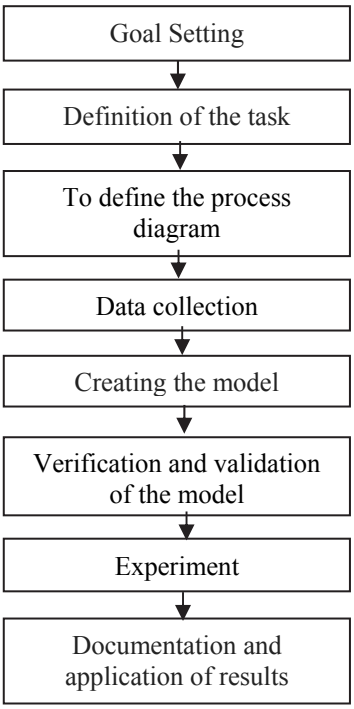

Fig.2. Processing simulation project [6]

4. CONCLUSION AND SUMMARY

Finally we will review a short summary and comparison of two approaches:

Mathematical models (analytical modeling):

Advantages:

- It can be predicted according to the selected algorithm.
- Analysis is less time-consuming.
- It can be used as defined analytical methods.

Disadvantages:

- Often oversimplify. It is not possible to see the dynamics of the process in time.
- You cannot monitor the impact of the consequences of unforeseen production interruptions on the parameters which you are monitoring.
- You are not able to predict the possibility and to assess variations in time.

Simulation approach:

Process simulation is the possibility to see the dynamic behavior of the process in time.

Advantages:
- You can evaluate the predictive behavior of the process (ex. if the technology is not yet purchased or production hall is not yet built).
- It shows the behavior of the process in time and helps to make a decision.
- It can simulate the effects of process changes (ex. breakdowns, changes in the production plan, and changes in quantity).
- It can be used to work with staff such as training, discussions to the possibilities, changes). Simulation shows the effect and increase the trust.
- Preparation of a simulation model requires data collection. This allows us to find the bottleneck in the process during the data collection.

Disadvantages:
- Simulation of the process needs the preparation which takes the time of employees.
- High demands for the creation of a simulation model.
- It takes a time .
- Special software should be used.

As you can see each approach has its advantages and disadvantages. Their using depends on the objectives of the project or phase of the solution. Computer simulation becomes to be the unnecessary solution of the projects. Today's market demands and the need of comprehensive and dynamic approach to solving bring the main applying of simulations.

Acknowledgements

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