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Eco-innovation, Environmentally oriented business

Vladimíra BIŇASOVÁ [*], Marta KASAJOVÁ [**]

ECO-INNOVATION AS A SPECIAL TYPE OF INNOVATION

Abstract

The paper deals with the case for eco-innovation policy that is stronger than for normal innovation because the benefits of eco-innovation are undervalued in the market place and because of problems of lock-in to well-developed and well-embedded technologies in power supply and transport. Markets are a poor selection mechanism for eco-innovation because prices do not reflect environmental costs and cannot be easily made to do so.

1. ECO-INNOVATION BOOSTS ECONOMIC GROWTH WHILST PROTECTING THE ENVIRONMENT

Eco-innovation may be defined in the following way [1]: Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives.

The term environmental innovation, or shortly 'eco-innovation', relates to innovations aiming at a decreased negative influence of innovations on the natural environment. There is no generally accepted definition of eco-innovation. Various definitions have been proposed in the literature since the mid-1990s.

As for any other innovation, eco-innovations have several types and can result in a new or significantly improved product (good or service), process, a new marketing or organizational methods. Eco-innovation should be seen as an integral part of innovation efforts across all production and service sectors [2].

An alternative classification is whether or not the innovation is technologically radical and institutionally radical [3], For example, smart grids [4] are technologically and institutionally radical, electronic fuel injection systems are only technologically radical and organised car sharing is only institutionally radical (Fig. 1).

Innovations that do not fit with existing rules and practices require changes in the institutional set up. Radical innovations usually come from outsiders. Barriers may be economic and institutional, an issue which is examined in section 1.2.

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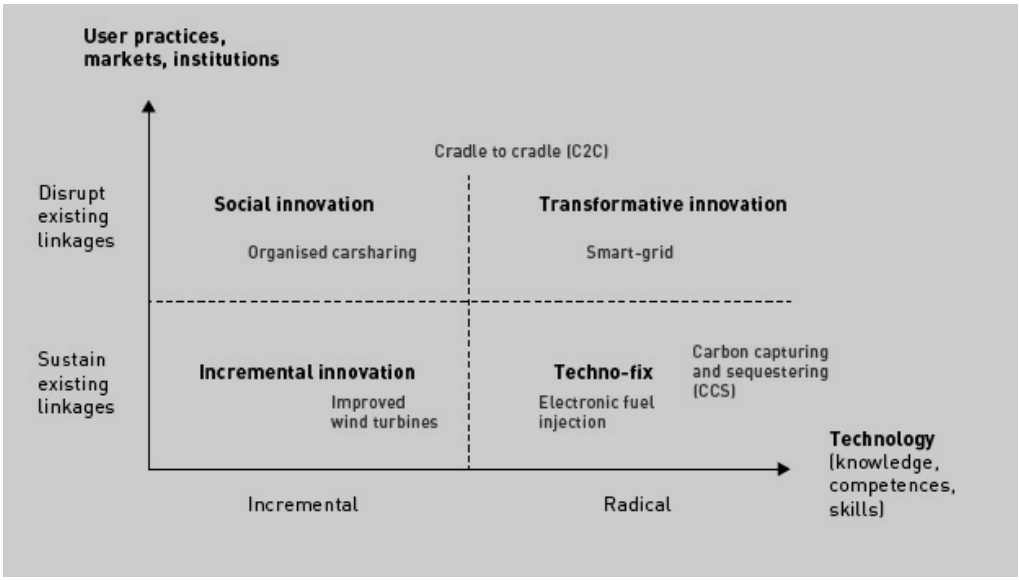

Fig.1. Classification of eco-innovation based on technology and market/user practices

1.1. Strategic intelligence for innovation

The development of enabling technologies such as smart grids and innovations such as for example eco-friendly driving, modular vehicles and intermodal travel requires strategic intelligence. The report *Towards a 50% more efficient road transport system by 2030* the European Road Transport Research Advisory Council, analyses how the transport sector can be made more energy-efficient, cut carbon emissions, become more safe, reliable and efficient from a logistical point of view. The vision is based on the following concepts:

- eco-friendly driving,
- safe and smart driving,
- basic, affordable vehicles,
- passenger comfort,
- modularity; terminal efficiency,
- driver and transport efficiency,
- logistics efficiency,
- cost-effective vehicles,
- vehicle efficiency.

1.2. Barriers and opportunities of eco-innovation

It would have been interesting to learn about the barriers to different types of eco-innovation but the survey did not examine this. It also did not make a distinction between process changes and product changes. *It would also be interesting to compare the barriers for different types of eco-innovation with those for normal innovation, to gain information about specific problems faced by different types of eco-innovation.* Increasing pressures on business are creating favourable conditions and opportunities for eco-innovation (Fig.2).

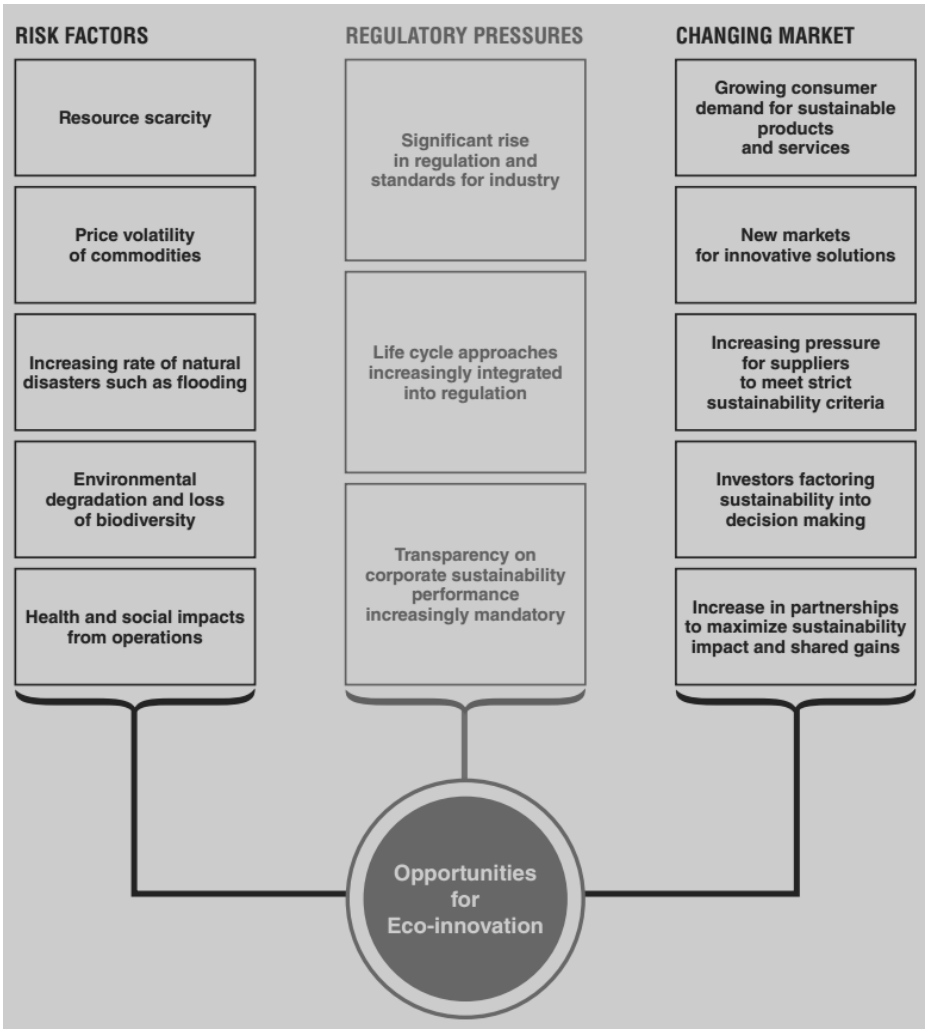

Fig.2. Increasing pressures on business are creating conditions for eco-innovation

1.3. Cleantech solution

Cleantech solutions are suitable for all industries. It is important to take this trip not only management of the organization, but all employees of the organization.
A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses [5]. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics [6]. Product eco-innovations include any novel and significantly improved product or service produced in a way that its overall impact on environment is minimised. Increasingly, the distinction between the goods and services is becoming blurred, indeed it can be argued that people need services (utility, value), rather than goods themselves. However, from an eco-innovation perspective, it is important to underline

that a service society can be as, or even more resource demanding than our present 'commodity' based society since all services require resources.

2. CONCLUSION

Eco-innovation and cleantech solution may be fostered through generic policies for improving the national (and regional) system for (eco)-innovation and through technology-focussed policies for specific technology innovation systems. Eco-innovative companies are attractive to acquisitions, mergers and partnerships. Eco-innovation entails a process of organizational change enhancing human and social capital, which are key assets of a company.

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Warehouse, Autonomous, Energies, Prototype

Monika BUČKOVÁ[*], Martin KRAJČOVIČ[**], Dariuzs PLINTA[***]

WAREHOUSES OF THE FUTURE

Abstract

In this article there are processed basic information for cost reduction in warehouse facilities by new technologies. The core of article constitutes description of these technologies and their impact on design warehouses. The article mentioned how much new technology can influence way of data collection, storage of goods and their processing and subsequent delivery of goods to customers in the requested format and quality.

1. WAREHOUSING

World of technologies evolves over time, whereas limits, that were established are losing importance. The world of today does not have place for long reflecting on strategies that lead to success. On the other side, we must decide as soon as possible. [3] One of the most important parts of well-functioning logistics system is storage that has to interwoven place and time. It is activity where physical or other parameters of stored material change. Economically, stored material does not acquire higher value, on the contrary, raises costs, which affect profitability of products [5]. Crucial question is how much money company spends on improving warehouse processes, and developing integrated logistics.

2. NEW TRENDS IN WAREHOUSING

The basic function of warehouse is volume balancing and harmonization of different dimensioned, complicated material flows. The warehouse have the most significant connection with problems of transport, internal logistics, supplying and purchasing. [4]
That's why automation in warehouses heading mainly for automated order picking or automated delivery goods. Items of automation should bring benefits such as reduction of freight costs, faster delivery of goods to customers, safer and less congested roads or facilitate work of truck drivers. The most important item in development of automation in warehouses and delivery of goods will be software and sensors. Computer simulation will also play its task by which these processes will be possible to plan ahead and will be able to experiment with them.

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1.1. Creating integrated logistics

Focusing on flexible fulfilment of unstable requirements of final customers and continuing pressure to reduce costs and for realization of individual customer requirements cannot be achieved without crucial changes in management of entire supply chain, even extensive delivery networks.
Nowadays, everything is variable, products are different and warehouse operations are frequently changing. Integrated logistics solution is based on systematic basis, consisting generally in connection process of purchasing and supply firstly, then production and marketing inside the company. This step, when company customers are involved to chain of integrated logistics, is called internal integration, and it leads to complex connection of all parts of supply chain. Then there is connection of company with its suppliers, distribution and commercial cells, to end customers.

1.2. Autonomous trucks

The first semi-autonomous trucks are testing since 2015 [2]. The basic idea is to create an autonomous truck which will be controlled primarily by stereoscopic cameras, radars and sensors.
Currently, trucks are adjusted to keep control on road, safe distance from other vehicles, and to stay in its lane. In the case that truck comes in situation that cannot be cope safely, it warns the driver by a special beep sound and icon on the dashboard, to react. If driver does not react during five seconds, the truck will gradually slow down and then truck stops. In his lane, truck will be kept by using of stereoscopic cameras. Radars are used for scanning road about 800 feet / 250 meters ahead [2].
The disadvantage of these trucks is question of their reliability in various locations and under various conditions. Test trucks operate without any problems only in ideal conditions. The question is how they will react on urban environment with pedestrians, cyclists, rain, snow or on extreme temperatures. According estimates [2] setting these trucks on different conditions should take around ten years.
The indisputable advantage of these trucks is high demand for freight transport, expected reduction in number of road accidents caused by human factors, reduce cost on human resources, energy saving, possibility of quick delivery etc. A specific benefit of these trucks is possibility to go through long distances, on the other hand driver would have to rest during transportation. The machine does not get tired and it´s not distracted.

1.3. Optical system for selection of goods

To foreground is getting technology that allows code reading and optical picking of goods directly from warehouse. The picker of goods wears on head small camera that is directly connected to the control system in the warehouse. This technology works on principles of augmented reality, using 2D barcodes to connect with environment. The obtained information are displayed on transparent screen which is located at head collector with small camera. Picker in this display can also see information about product, information about sources and target locations in warehouse. Movement in warehouse is allowing to workers by integrated navigation system. The basic benefit of this technology should be reducing number of picker steps in warehouse, when he is looking for goods to be picked up and complete releasing of his hands. This technology allows relatively quick and error-free picking.

Other advantages are:

- shorter time needed for staff training,
- language independent navigation inside warehouse, because camera reads particularly codes,
- depending on type of camera and its possibilities can be optically warn picker for example: to exchange of paper, check codes, visualization (lights) in the warehouse or voice alerts,
- by connection on warehouse management system is possible automatic monitoring of serial numbers or batches of goods,
- is usable in any warehouse. [6]

1.4. Drones

According to estimates [7], since the year 2017 aircrafts without drivers - drones will start to use to transport shipment over short distances. Foundations of transfer by drones are based on assumption that drones should deliver shipment to 30 minutes and they should complete more routes. This solution of transport of small packages to customers should eliminate long waiting times for delivery of goods, reduce cost of human labour, reduce energy costs and improve situation on the roads by improving safety or eliminate creation of traffic jams. Current drones are not yet adjusted to this kind of transport, they have relatively low performance, they can carry only one package, and after shipment delivering, they must be sent to home station in warehouse, because their batteries must be recharged periodically. Other problems include backup battery, high cost of drones, drones mapping zones and improving them. For customers, this option has not had success, because delivery of goods by drones could be very expensive too. [7]

1.5. 3D Printing

In recent years 3D printing is the fastest exerted technology. Therefore this technology become more price affordable for consumers, their price decreased. Its development refers to fact that 3D printing will gradually replacing selected steps in assembly, because aim is to produce increasing number of prototypes and components, primarily moving parts of components.
This technology will have big impact on design of warehouse and building supply chains by lowering number of steps in handling of with components, number of warehouses, what subsequently will also reduce the costs incurred on distribution. Nowadays companies are set to accurate delivery of parts and goods in the shortest possible time, or on the other hand, they are creating unbalanced inventory levels. 3D printer could be solution to these problems, for example in car factories, where there is high variety of parts. Another area of development of 3D printers is connecting them with software, which are designed to facilitate and speed up work of engineers from designing components to finished prototype. [1]

1.6. New types of batteries

Electricity costs form some of the highest costs in the warehouse. Currently, the developers tested the battery which is designed to impose energy from solar panels throughout day. Stored energy is producing during night.
These batteries are independent of the grid and its craftsmanship offer the possibility of creating a security emergency backup. This is what strengthens ability of battery to keep power supply during normal power outages. Basic idea of these batteries is producing amount of energy as

company consumes. Their further development can drastically reduce not only electricity costs, but also the way of designing warehouses, and especially their placement.
These equipment need for the proper functioning a solar panel that converts sunlight into electrical energy, which charge the equipment. The inverter converts DC electricity from the solar panels on AC, which is commonly used in homes and companies. The last main part of equipment is the backup and switch panel. Larger facilities may also include a secondary electrical panel.
For applying without solar energy equipment can be connected to the grid, when the equipment is charged by electricity produced by power companies. [7]

3. CONCLUSION

Building supply chains, autonomous trucks, optical systems for picking of goods, drones, 3D printing, and new potentials for reducing energy costs represent so-called warehouses of the future. Technology development affecting logistics of company progressing rapidly and companies will have to adapt to this situation. These technologies do not entail only benefits, especially in terms of reducing costs, but questions too, because machines, also intelligent, are still machines. In case of doubts, experts must be prepared to apply policy decision that reverses recommendations transition to automated systems. Another question is whether customers are prepared to accept such a rapid and large technological progress, such as drones or autonomy trucks.

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Ergonomics, Ergoaudit

Kinga BYRSKA-BIENIAS*, Marcin ZEMCZAK**

ERGONOMICS AS A TOOL FOR WORKERS HEALTH PROTECTION

Abstract

Article presents a set of tools used in ergonomic diagnosis. Methods are divided into 3 types of ergonomics. The person making the study should first identify the objectives and criteria of diagnosis and then select use one or group from proposed tool.

1. INTRODUCTION

Statistics in Europe indicates the status:

- 30% - workers complain of backache (total 44 million)
- 17% - complain of pains in the muscles of the upper and lower extremities,
- 45% - report that they work in painful or tiring positions of the body,
- 33% - increases while the heavy objects,
- 7% - must perform short repetitive actions,
- 57% - their work involves repetitive movements of the hands and arms.

Studies conducted in German industry indicate about 50% of quality problems has its source in the lack of ergonomics. Among the most difficult situation are:[6]

- time pressure at work (67%)
- one load-sided body (64%)
- making working hard – with high energy expenditure (41%)

Ergonomics is the science dealing with the study of the work process and the process of adapting work to human capabilities. Ergonomics is divided into 3 types:[5]

- physical - anatomy, anthropometry, physical aspects of workstation design, dynamic operation,
- cognitive - analysis of the processes of thought, perception, reaction speed, coordination,
- micro / macroergonomy - testing work methods, social processes, the structure of movements employee.

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Each of these ergonomic types developed his diagnosis tools. In practical use it is often combined with different tool.

2. AREAS OF WORKING CONDITIONS DEVELOPMENT

After the analysis next step is to propose improvement action. The next stages of the procedure should be in accordance with the principles of Deming circles (plan-do-check-act). One of the proposals to determine the main directions of the changes in workstation is shown in Figure 1.

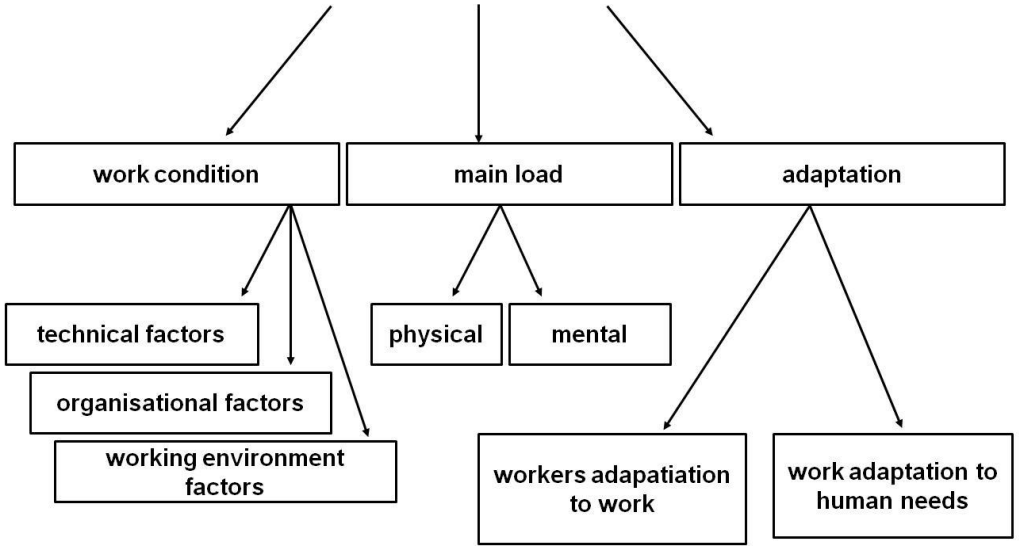

Fig.1. Workplaces development areas example

It is not possible to achieve appropriate ergonomic development if is not set the main criteria and if is not treated as a priority during changes.

3. ERGONOMIC DIAGNOSIS TOOLS

Literature presents many different methods of ergonomic evaluation. Due to Handbook of Human Factors and Ergonomics Methods can be mentioned some physical diagnoses tools: [7]

- PLIBEL method,
- NIOSH analysis,
- DMQ questionnaire,
- QEC checklist,
- REBA analysis,
- RULA analysis,
- fast analysis of body posture,
- analysis of the strength index,
- analysis of attitudes PDA,
- analysis of the involvement of muscle groups in the work processes,
- method of analyzing the movements of the lumbar,

- OCRA method

Among the methods of psychological loads: [7]

- method of measuring skin resistance – galvanic skin response,
- electromyography study of peripheral nerve conduction - EMG,
- study variability and heart rate to return to resting pressure,
- electroencephalography used to study the bioelectric activity of the brain - EEG,
- analysis of brain function and mental timing - ERP
- magnetoencephalography - recording magnetic fields produced by the brain - MEG and fMRI,
- analysis of the blood pressure,
- monitoring of the eyes,
- measurements of lung ventilation.

The ergo-diagnosis of the working environment: [7]

- analysis of the environmental temperature,
- Analysis of cold indicator,
- analysis of the ratio of heat,
- analysis of thermal comfort,
- Analysis of exposure to chemical agents,
- exposure to biological agents,
- olfactometry,
- light analysis, analysis of uniformity of the luminance,
- noise analysis,
- vibration measurement,
- analysis of spaciousness adjustment to operator needs.

Manual proposal some methods where the person performing the work become a member of the band which perfecting ergonomics. Examples of such methods, often called sociological methods: [7]

- group training, method of adaptation of the team,
- measurement of knowledge the team,
- group awareness questionnaire,
- method of team-decision,
- scenarios method, behavioral observation,
- network analysis of social relationships (search sociometric stars),
- MOQS analysis,
- Kansei method,
- HITOP procedure,
- TOP-method Modeler and other virtualization systems work.

Can be additionally use the tools made independently and prepared for the specific conditions of the company. An example of such a tool are discussed in other publications of the author. [4][5]

4. CONCLUSION

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. [3] If company want to maintain and have continuous improvement in high levels of safety must:[2][1]

- ensure proper organization of work,
- systematically perform job environmental survey,
- use the best technical and safety process, best practices,
- improve the system for the estimation of risk in the system man-machine-environment,
- perform advisory, supervisory and control workstation organization and compliance with standards,
- organize training and workshops,
- raise awareness among employees and employee involvement.

Protective actions leading to risk reduction should be applied in the following order: technical measures to eliminate or reduce risks at the source, collective protection measures, organizational and procedural measures, personal protection. This sequence of actions conducive to maintaining the health of workers for a long time. [3]

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Knowledge, Knowledge audit, Application of knowledge

Mária CUDRÁKOVÁ*, Milan GREGOR**

KNOWLEDGE AUDIT AS A PART OF THE CURRENT SITUATION ANALYSIS IN COMPANY

Abstract

The article represents one of the parts of the dissertation thesis focused on the collection, processing and use of knowledge in the chosen company. Part of the solution has been implemented through knowledge audit focused on the analysis of the current state of knowledge in company.

1. DETERMINATION OF THE MAIN TASKS OF THE AUDIT

Knowledge audit has represented the first step of the project application in the selected company, where its main objective was to identify, quantify, measure and assess the existence of tacit and explicit knowledge in company. [3]
The main task of the audit was to identify the knowledge with which workers of selected division operate. Subsequent analysis and evaluation of the audit was intended to highlight the effectiveness of the use and sharing of knowledge in the chosen division on the first level of knowledge - explicit knowledge.
Result of the audit was to highlight and suggest a more appropriate method of creating, storing and sharing of knowledge in company on the second level of knowledge - tacit knowledge.
An additional task of the audit was to identify and evaluate the subsequent facts:

- Utilization of knowledge within work process of employee.
- Determination of the critical knowledge, and knowledge necessary for effective employee operation.
- The rate of utilization of identified knowledge and subsequent sharing.
- Identification of a state where the sharing of knowledge does not occur.
- Determination of the bearer of knowledge from the employee's perspective.
- Employee suggestions to remedy any shortcomings in relation to knowledge.
- Employee expectations and their suggestions for improvement.

1.1. Before commencement of the audit

Audit objective, its course and structure was introduced to management (divisional director) of group selected for the initial meeting, when an initial analysis of the project was conducted; the

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participants were defined, along with the final version of the questionnaire. The audit was conducted on a sample of workers from selected department division through a structured questionnaire with detailed specifications. Anonymity of workers was not maintained, as it could possibly remove all emotional and individual obstacles distorting relevant statements and answers of the employee. [1] This fact has been secured by organizing the initial "Kickoff Meeting," where all the reasons for the implementation of this form of analysis in the workplace, all questions about the ambiguity of the audit were explained and the fact that this is a process that serves to more effective use of knowledge within the group was clarified. Group was presented with structure of the course of the audit, the expected timetable for implementation and subsequent commencement of the audit. [2]

Activities before the commencement of the audit:

a) Development of a questionnaire.
b) Drawing up a timetable for knowledge audit.
c) Initial meeting and analysis of the project.
d) Staff meeting.
e) Initiation of the audit.

1.2. During the audit

Analysis of the current has been conducted through a structured questionnaire and controlled interview, with the use of free associations technique and was recorded. The task of controlled interview was to further specify questions. The aim of the interview is controlled interaction between employee and the auditor, openness and resolving confusions, as this is a pilot project. All participants agreed with creation of an audio recording before the commencement of the audit, which also indicates a high degree of cooperation and positive perception of the activity. As a positive, I see the fact that the planned meetings did not proceed in the individual form of free associations, as planned, but in groups – this represents openness of employees to subject and awareness of the need for action.

Activities during the audit:

f) Filling the questionnaire and data collection.
g) Interview with the individual employees.
h) Processing of questionnaire data.
i) Conclusion of the audit.

1.3. After audit

Conducting the knowledge audit is the first step of the pilot focused on the analysis of knowledge of specified group, with the aim focused on a reasonable improvement in the economic indicators in relation to knowledge. Group consisted of six members of the division, which make two separate teams. The sample was identified from a small number especially because it is a pilot project which is intended to identify quantifiable values of the project and the gaps.

Activities carried out at the conclusion of the audit:

j) Evaluation of audit course and evaluation of the current state of knowledge.
k) Final participants meeting, analysis focused on achieving the objectives.
l) Realization of measures for improvement.
m) Evaluation of the results of implemented measures

2. EVALUATION OF THE AUDIT

Comparison of audit duration schedules can be generally characterized as very positive. All the deadlines envisaged for the duration of the audit were held, even shortened on average by half. Negative impact on the audit duration indicator has, however, its actual length. Estimated duration scheduled for audit was 18 days, but the actual duration of the audit was 37 days.
In addition to precise numerical evaluation of the audit we may evaluate the results of the completed questionnaires answered within the audit:

- 100% of respondents when solving problems turn to their colleagues, or reach for the base of the company's' books and external sources (eg. Internet). Only half of those surveyed use the standards, guidelines, training records and company documents.
- When expressed in terms of knowledge utilization (on a scale from 1 to 5) 70% of respondents use knowledge of colleagues, books and knowledge acquired during trainings, while 50% reported moderate usage of knowledge acquired during their studies and their own resources.
- Respondents acquire their knowledge mainly from colleagues / superiors, and from internal company resources (4 of 6), three of six gained knowledge from previous employment, the least utilized resource (1 of 6) is by problem solving or self-study.
- Knowledge transfer is carried out at 100%, but not in terms of a full sharing of all documents, the most common form of exchange is a discussion or informal conversation, however many documents are stored on private PCs.
- 100% of respondents know who bears the knowledge they need to solve problems.
- Within identification of the knowledge, several levels (bottlenecks) were defined, where information exchange does not take place: between establishments, between the teams, among team members or members who have left the company.
- Among the critical knowledge the audit participants list:
    - so-called specific – necessary to solve individual projects,
    - based on which is derived knowledge oriented on company know-how,
    - knowledge about fields of other divisions,
    - knowledge extended with new findings - news from a specific field.
- Also, the critical knowledge listed above was stated by the employees as knowledge, which should expand the knowledge base.
- From the view of meeting the expectations and suggestions of employees:
    - 4/6 employees state their idea of knowledge base as a centralized database of project solutions,
    - 2/6 employees expect improvement of quality of staff recruitment and their adaptation from knowledge,
    - 1/6 expects increase of efficiency and quality of projects, speeding up the solutions of projects and implementation of a knowledge base development standardization process.

3. THE AUDIT CONCLUSION

The findings of the audit were included into the final solution of knowledge base in order to achieve the following:

- remedy the weaknesses identified during the audit in connection with knowledge and then later to achieve the stated objectives,

- increase the company's value (the largest value of the company is its know-how),
- improve the creation of value for customers (recommendations for product correction, improve employee service quality, ...),
- improve the productivity of project managers and consultants and increase the quality of their work by at least 10%,
- improve product quality (best practice, ...),
- decrease lead time of project implementation,
- improve the communication among specialists,
- improve project management.

After conducting the analytical part and based on the findings of the audit, I can state subsequent facts:

Fact no. 1: The space for gathering knowledge is not satisfactory enough, so that we could speak about effective use of knowledge, this fact is reflected in the modifications of knowledge base, which are part of further developing the knowledge base.
Fact no. 2: Also in terms of the needs of employees on content that is formed by this base, the content is rated as inadequate.
Fact no. 3: The employees are aware of the space for knowledge creation, but they do not use it fully.

4. CONCLUSION

The audit conducted in the selected company was tasked to analyze the current state of company's knowledge. It is one part of an analysis conducted as part of a doctoral dissertation realized in chosen company. Based on the facts found during audit and its conclusion, implementation of the findings has been further developed into the final output of doctoral dissertation, which aims to develop an overall concept for the collection, processing and utilization of knowledge in the chosen company.

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Robots, Collaborative, Virtual, Prototyping

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ROBOTS – THE PATH TO INDUSTRY 4.0

Abstract

The path to Industry 4.0 is not short and not even simple. The first successful step was presented through integration of the secure collaborative robot without fencing. Breakthrough application reflects the development trends in automation and robotics as the future of industry.

1. KNOW – HOW OF INDUSTRIAL ROBOTS

Nowadays, Industry 4.0 is a phenomenon and the direction where the whole society is leading to. It's not only about the factories and the product monitoring. Industry 4.0 exceeds the industrial production and it interferes into the everyday world.
Each producer who follows the trends in the world wants to contribute in some way – whether with integration or solving certain part of business problem. If we wanted at least to keep up with the development in the world, we had to start working on our own development and on our own way in the Industry 4.0. After analyzing the issues and applications on our own capacities, we considered that the driving force of our development will be know-how that we have gained during the construction of robotized workplaces.

- Complete understanding of industrial robotics.
- Preparation for development activities.
- Find a way to integrate them into industrial environment.

2. ROBOT NAVIGATION

One of the headstones of Industry 4.0 is communication. In order for the device communication it is necessary to create the infrastructure and particular devices interconnection. Therefore, at first we started to extend our know-how, especially in the way of communication and interconnection of multiple systems. Creating the application "The Robot Navigation" a new door was opened for us into the possibility of extension the industrial robotics. Using the mobile phone with Android we have started the connection on the PLC over Wi-Fi network and subsequently we created the connection from the PLC to the industrial

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robot. In this application, we linked together devices from five different types of network. Therefore we were able to create a structure where each participant of different network was able to communicate with the participant funded on a completely different platform. Thereby we have created IoT (Internet of Things) as one of the important elements of Industry 4.0.

3. OBJECT ORIENTED PROGRAMMING

As we wanted to unify and to create a new connection in "The Robot Navigation" application, we knew that we needed to increase our knowledge also into the conventional solutions. We saw the huge potential in the connection of object-oriented programming with industrial layer. The programming language JAVA was selected mainly for the support in Android, and also for a wide range of available manuals. And naturally it was a challenge to control the industrial robot using JAVA program.

- Official start of our JAVA activities in the year 2014.
- The first demo of the navigation system was launched shortly after.
- Utilization of 5 different communication device types.

4. BIN PICKING

Since we created the infrastructure, on which we were able to build our other developmental activities, we have started to interfere much more into the robot collaboration with external devices, such as mentioned Android or later the direct connection between robot and computer in the communication that took place in 12ms cycle. Algorithms designed by us until now were used to establish the communication with a 3D camera. As soon as we began to navigate a robot through the visual system, we had to start creating new ways of synchronization between the robot and the camera. Each device has worked in the different units and of course in the different coordinate systems, so we had to combine these two different worlds into one in which they should operate together. Our aim from the beginning was to create an application that would be able to work with non-oriented subjects and to manipulate with them without collision. "Without collision" meant for us not only to remove the certain part and its subsequent placement into the next operation, but also during selection and enumeration the trajectories consider gripper and as well as the possibility of collision between the robot and for example, the container in which the parts were situated.

5. COLLABORATIVE ROBOTS

Each robot integrator is trying to create a safe robotic cell to help humans. Until now for the proper robot work, it was necessary in the terms of occupational health and safety to create a mechanical or other barrier, to protect human against the robot. The primary feature that comes on mind when looking at the collaborative robot is exactly the method of its integration. Collaborative robot's integration is without any mechanical or optical barrier which would protect human against the accidental contact with the robot. Naturally, for us to be able to work with a collaborative robot, we had to at first create a development cell, where the safety properties of a KUKA robot LBR iiwa were tested.

- Development of a working prototype.

- Application of a robot without safety fence beside humans.
- Revolution of production processes.
- Cooperate with OEM partner – ŠKODA Auto Vrchlabí & ŠKODA Quality.

MATADOR Group Robotics Laboratory was established in 2013. Use cases:

- Development of control systems & applications.
- Application of virtual commissioning.
- Testing of new joining technologies.
- Preparation of industrial applications of collaborative robots.

6. COLLABORATIVE ROBOTICS

The first project with collaborative robot was the usage of automatic gear box during the assembly of mechatronic parts in the Skoda Auto Vrchlabi Company. Here we eliminated the non-ergonomic human work when inserting pistons to the press machine. [1] Whereas workers were moving around the workplace, in the terms of limited space, and it was not possible to integrate the robot into the cage, we have created a small robotic cell with the collaborative robot. The robot's task was to select the pistons from the blister pack in which the parts were oriented and to insert them into the press machine. In order for KUKA LBR iiwa to be certified for the safe work with human, it must contain sensorial system. This system would evaluate every touch with the obstacle with any part of moving arm and it has tentorial measuring forces on the shafts. This force (moments) measuring in the certain axis allows not only the collaborative mode, but also the feeling of external forces acting on the gripper. With these forces we can effectively navigate the robot to insert the piston into the press device.

- Cooperation with ŠKODA Auto Vrchlabí.
- 1st collaborative robot implemented in the VW Group.
- Application for DQ200 – automatic transmission production line.
- Assembly of mechatronics.

STEP 1 – Reverse engineering

- Create an in-house prototype of the production line
- Utilization of the latest scanning technology - ATOS 3D scanner
- Based on the scanning create "clouds of measurement points" – Point Cloud

STEP 2 – Virtual commissioning

- Display the collaborative robot inside a virtual model.
- Simulation of robot movements including possible reach.
- Singularity of 7 axes.
- 3D model from point cloud.

STEP 3 – Rapid prototyping

- Design of a working prototype based on the virtual model.
- Accelerating manufacturing and prototyping – 3D printer.
- As a result → cost savings in prototypes.
- Based on the prototype production of the working device.

Collaborative robotics

Further integration of collaborative robot was to create a workplace in which we were able to measure the forces curves when testing interiors buttons. The task was to use the robot for testing the force curves such as electronic parking brake. We have thus tested and recorded in the database several thousands of measurements using a robot and evaluated the quality of the button. [2]

- Quality check of automobile interior buttons and switches.
- Storage of measured data via database.
- Flexible system for different types of measurement and parts.

CONCLUSION

Our journey will continue by turning the experiences with collaborative robots over into the mobile robots. We can see the huge potential in logistics with collaborative robots assistance and in the robots deployment for operations in larger areas. One option is to place robots on the portable carriages that would safely second to the person in the factory. Trends that come from foreign universities show that the future not only of mobile robotics could be assembling and creating the open structures of programming based on a single platform. One possibility of such control system could be ROS system that we would like to apply in our solutions and that could change routing of development in the industrial robotization.

- Development of applications, which utilize mobile platforms.
- Navigation assisted by camera applications.
- ROS integration for industrial robots.

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Production layout, Interactive design, Augmented reality

Radovan FURMANN* Beáta FURMANNOVÁ**

3D DESIGN OF THE PRODUCTION LAYOUTS

Abstract

This paper describes area of production layout 3D design using an interactive design system and subsequent visualization of solutions using augmented reality tools. Modern technology and tools based on Digital factory concept transferred solving problems into virtual reality. Interactive 3D design of production system is created important part of implementation Digital factory concept.

1. CURRENT SITUATION IN THE FIELD OF PRODUCTION SYSTEMS DESIGN

The globalization of the market scene have effect of cumulating pressure on industrial companies, which if they want to survive rising concurrency contest, must continually reassess their industrial activities and search possibilities for their improvement. A big disadvantage of many Slovak companies is that they cannot react flexible enough to changing conditions on fast developing market. From layout point of view, with modification of product line should be changed the layout conception itself. Recently the requirements on industrial companies are increasing from the side of customer. The market doesn't want to produce products en masse anymore. Instead, it requires a big variance of products. [1] This requirement forces many companies to offer large product line, which requires high claims on organization and management, high requirements on factory floors, on production equipment and in the end also on people. Hence, if a company wants to satisfy demanding needs of customers, it must constantly perform corrective measures. One of them is also more efficient design of layout.

What can cause an ineffectively recommended layout in company:

- ✓ bad arrangement,
- ✓ inefficient movement of material,
- ✓ inefficient movement of employees,
- ✓ wasting of factory floors,
- ✓ growth of manufacturing costs.

Why do we have to deal with question of layout? What can we achieve with its rationalization?

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- ✓ reduction of capital investments,
- ✓ reduction of manufacturing costs,
- ✓ growth of work productivity,
- ✓ reduction of savings,
- ✓ better utilization of production equipment,
- ✓ increase in quality.

In the area of layout design play important role mainly supporting software tools, which help us remarkably by modifying the final layout design. The disadvantage of software systems is their attribute to prefer certain computational models for solution optimization. Many analytical methods for layout design have implemented strict mathematical procedure, which practically exclude the designer from design process. In end effect intellectual capabilities and experience of man, which is participating on final layout design, are not involved. [2] A big advantage of software solutions to support material flow length analysis is its ability to include these intellectual capabilities of individual team members, who create final designed layout form with help of results obtained by simple calculations implemented into software solutions. Using heuristically arrangement methods with inclusion of important limitation such as technological, architectonic- energetically investment-economical conditions into the software and by creating of a database of 3D objects of manufacturing system elements it is possible to obtain a base for layout design in virtual environment.

1.1. Interactive design of the production layout

Interactive design of the production layout is represented by CEIT Table, integrated solution to support intuitive, team-oriented design of production systems. By suitable combination of hardware and software it is possible to speed up and optimize the entire process of design, while maintaining of team-decision. [4]

The basic interface is divided into two windows and adapted to display the layout of the production system in the "classic" 2D view and to display 3D model of the production system. These two views are linked. Changes in the layout are implemented directly in the 2D view and automatically transferred to the 3D view.

Advantages interactive 3D designing:

- ✓ finding possible crashes in detail variant solution organization workstation,
- ✓ animation selection motion material flow for documentary critical place in projection solution,
- ✓ examination proposition variant solution by analysis and test material flow,
- ✓ reduction of the process creation layout relative interaction projection team during working meeting,
- ✓ superior visualization planning solution – possibility moving in the digital hall (verification hygienic request, principles for space production mechanism, simulation effectiveness organization workstation assembly, etc.).

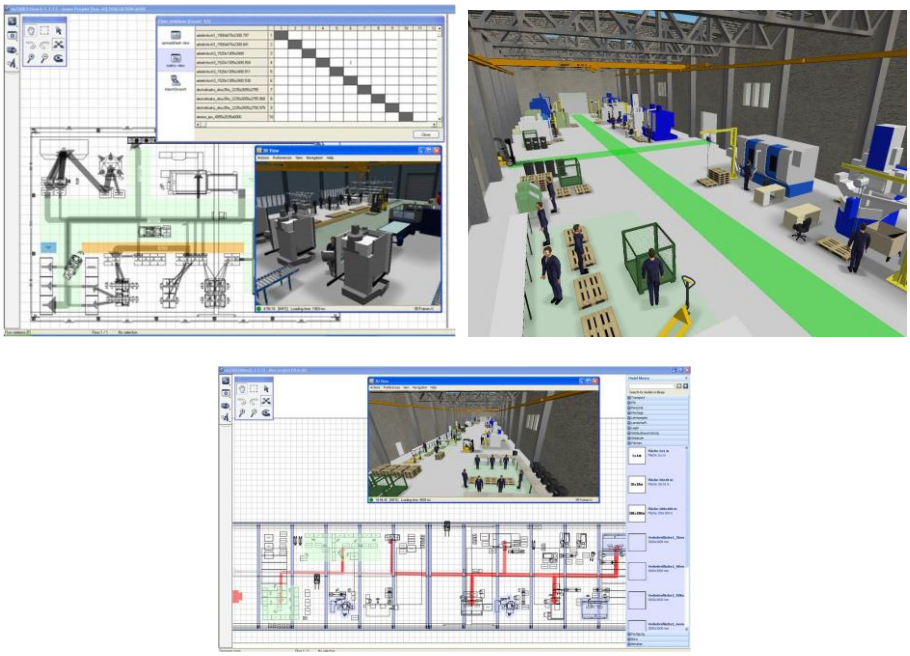

Fig.1. Environment CEIT Table

1.2. Visualization using technology of augmented reality

Augmented reality is a term for a live direct or an indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input, such as sound or graphics. It is related to a more general concept called mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer. As a result, the technology functions by enhancing one's current perception of reality. [3]

Augmented Reality is a progressive field of computer research that deals with combining real world and computer generated data. This technology allows a person moving in real -time environment and perceive objects constructed in a parallel digital world. Technology of augmented reality is based on tracking and tracing observer and subsequently projecting image of the digital model. The imaging system allows to transfer 3D digital models of the production system to the real space scanned by digital technology. Thus obtained digital 3D model of the production system will be used as a support tool for production system design, to identify potential risks and will also be used in-depth analysis of the complex production system.

Advantages augmented reality:

- ✓ increases engagement and interaction and provides a richer user experience,
- ✓ personal experience,
- ✓ well implemented AR activity conveys innovation and responsiveness,
- ✓ research has shown that AR increases the perceived value of products and brands.

Fig.2. 3D model of the production layout

2. CONCLUSION

Now the issue of production systems design gets on a new level. Companies doing business in Slovakia gradually transfer to the sophisticated solutions that enable them to effectively plan new production in a virtual environment. These solutions have been progressively established not only in companies in the automotive industry but also in other sectors. Research and implementation of digital factory tools and technologies is crucial to increase competitiveness and ensure sustainable development of the Slovak economy.

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Bionic, Automation technology, Assembly, Handling

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BIONIC IN MANUFACTURING ENTERPRISE

Abstract

This paper deals with the implementation of bionic principles to manufacturing enterprises. Simultaneously indicating that bionics has a broad scope and innovations inspired by nature have application not only in various technological sectors, but also in management approaches and natural science.

1. INTRODUCTION

Bionics is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology. Innovations are necessary for success of the manufacturing enterprise and service companies. The extent of their success and implementation of innovations are more or less proportional. The strategic decision of innovation is proved to be crucial for achieving competitiveness.
Nowadays, it is necessary to focus on the process innovations which result in the efficient use of human, tangible, intangible and financial resources. Reducing resource consumption is a global issue, it is necessary to find alternative solutions to ensure better solutions providing lower consumption. Implementation of innovative approaches in the design of the assembly processes is desirable, because of rapid development of new customer requirements and organizational changes to achieve cost reductions. It is also developed a range of new technologies (e.g. bionic system), which enable the dynamic development of the new generation of quality production and assembly systems.

1.1. Bionic and bionic benefits

Bionics searches sustainable solutions imitating natural time proven models and strategies. In many manufacturing enterprises already work engineers. They cooperate in innovation of existing products or in development of new products.

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The main bionic benefits are:

- **Save energy:** Due to lack of power, nature has tended to organize extremely energy efficient structures, systems and to optimize energy consumption on every step. [1, 2]
- **They reduce the material cost**: bionics can help minimize the amount of material used, and thus to decrease the material costs, while maximizing the efficiency of their products to achieve the desired function. Imitation of these natural active strategies can reduce energy consumption in the enterprise. Energy efficiency translates into energy cost reduction and thus to higher profits.
- **Define and eliminate "waste":** organizing material flows in society, the same as in nature; it will be managed by the company's profitability through cost savings. It may be beneficial to the creation of new benefiting centers aimed at the sale of waste to firms with interest in the waste treatment as a raw material. [3]
- **Strengthen the existing product categories:** Bionics helps to see obsolete products in a radically different light and this new perspective creates opportunities for innovation.
- **Define new product categories and industries:** Bionics helps create advanced technologies that will transform the industry, or they can build a whole new industry. [4]
- **Lead to income:** Bionics can help create a whole new area of business that helps companies grow and restarted / or innovate / obsolete product categories and also attract new customers who are interested in innovation and sustainability, respectively competitiveness. [5]
- **Goodwill:** Creation of bionic products and processes, the company can become known as an innovative and also environmentally friendly company.

1.2. The future trends of manipulation

For example, the company Festo has a technique using superconductors, as well as bionic structure inspired by natural patterns. In these areas is currently ongoing intensive research.
Between superconductor and magnet remains stable air gap which can be used for contactless manipulation with objects of without friction losses, or for manipulation with objects in an enclosed area that is separated from superconductors by walls.
The successful application of bionics in technical practice is the adaptive gripper **DHDG** inspired by fishtail functions (Fig.1). They are able to create a surface by grasping surface and are thus suitable for gentle manipulation of objects that can be easily damaged.

Fig.1. The bionic adaptive gripper

Bionic Handling Assistant (Fig. 2) appears to be a resilient gripper arm whose structure and overall functional principle imitate an elephant's trunk. However, above and beyond its actual benefits, the Bionic Handling Assistant is a development platform combining a wide range of technologies and

components – from manufacturing concepts to series products like sensors and valves, actuators and grippers, to control technology and software for developing applications and products.

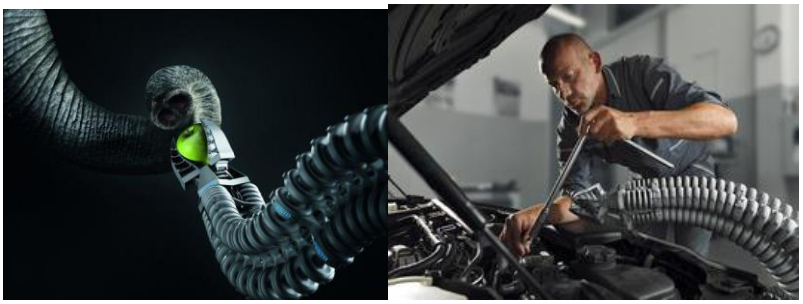

Fig.2. Bionic Handling Assistant

1.3. The future of automation technologies

Interesting is the line that the example of blue balls demonstrates various options handle using - for example Bionic Tripod, pneumatic muscles (Fig. 3), outside the box by "grass" - bionic structure biasing ball forward through each leaf curling "grass" (Fig. 4). Fluidic Muscle is a tensile actuator which mimics natural muscular movement. It consists of a contraction system and appropriate connectors. The contraction system is formed by a pressure-tight length of rubber hose, sheathed in high-strength fibres.
The fibres create a rhomboidal pattern with a three-dimensional grid structure. When internal pressure is applied, the hose expands in its peripheral direction, thus creating a tensile force and a contraction motion in the muscle's longitudinal direction. For example, a Fluidic Muscle with a 20-mm diameter develops as much force as a conventional cylinder with a 63-mm diameter at the same pressure. Both actuators develop a force of 1.5 kN at 6-bar, even though the cylinder has almost ten times the cross-sectional area and about eight times the weight. With the Bionic Tripod, Festo is adopting a new approach in handling technology as an alternative to the portal systems that are predominant in mechanical engineering. Sorting, palletizing and fitting: tripods are suitable for a wide variety of three-dimensional handling tasks, especially with small objects. This technology can be used wherever small masses are to be moved rapidly and flexibly. [6]

Fig.3. Tripod and Fluidic Muscle

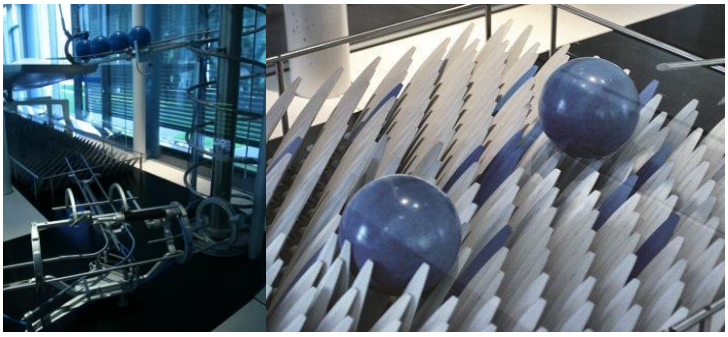

Fig.4. Bionic structure inspired by grass

2. CONCLUSION

People can always learn from nature. Nature often provides fresh impetus and new approaches to solutions for industrial applications and is the most natural source of inspiration and innovation. This situation is mainly conditioned by insufficient degree of development of materials and technologies. Many ideas from nature cannot therefore be implemented and the extent of mass production or the extent of the prototype. Research and development of materials and technology will progress and creates space for application of natural principles into technology. In the future it can be expected that intensive use of natural principles to solve engineering problems.

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Intelligence maintenance, Smart maintenance, Maintenance 4.0, Technical service, Improve workplace

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PRECONDITIONS OF IMPLEMENTATION OF SMART MAINTENANCE

Abstract

Maintenance nowadays needs to change to meet the requirements of Industry 4.0. Therefor processes and strategies need to be optimized and improve. To implement predictive maintenance improvement in knowledge and data management is necessary. The main goal of machine interconnection is to be able to forecast maintenance needs as exactly as possible in order to integrate them into the production planning process.

1. DATA COLLECTION

Basic data collection systems are commonly used as electronic and paper. Each of these systems has one´s advantages and disadvantages. At the present, it´s better to use an electronic system that allows you to work with data in real time. These systems can be divided into manual and automated data collections. [5]

The usage of maintenance systems in plants has many advantages. One of the biggest is the elimination of paperwork and manual tracking activities, leading to the already mentioned greater productivity and cost reduction. The functionality of these systems is to collect and store information. [2] The advantages in creating automated data collection systems, their transmission and processing are as follows:

- correctly data,
- clearly defined and readable,
- considerable time savings and costs,
- rapid ROI (return on investment),
- elimination of errors caused by human factor,
- clarity records.

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For systems of data collection is preferred to use complex systems for automated data collection. At that time, the maintenance is done better and faster with the aim of reducing costs and downtime and increasing availability of equipment. [8]

1.1. Today trends in companies

Today we meet a variety of equipment maintenance that are constantly improved. The goal is to introduce order in the operation and maintenance processes. [4] Expected benefits are to increase efficiency and reduce equipment repair costs and to create greater awareness of maintenance, rapid response to repair. For increase the efficiency using of electronic book of disorders. [3]
Electronic book of disorders (Fig.1.) is a solution that helps to communicate with current information in an interactive form. Solution is based on an industrial PC with a touch screen with application in a database. The electronic book will replace existing books of disorders in writing form. It is characterized by reliability and quality design. It is a modern information system with a modern design, functionality and flexible use. Electronic book fault is located directly in the production and workers in the register file their ID card (Fig.2.). This solution is very quickly, clear and transparent.

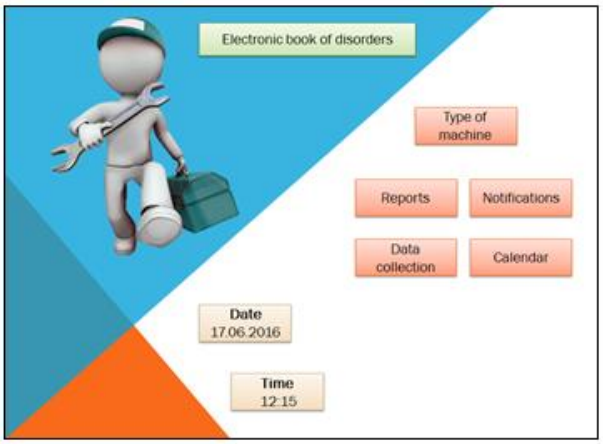

Fig.1. Electronic book of disorders

Fig.2. ID card and reader of ID cards

1.2. Improved CMMS integration

- **Focus on Maintenance Operations**
  Modern CMMS solutions are designed with maintenance people in mind for planning and managing maintenance and assets. If they easily share data with accounting and other applications, get the best of both worlds: happy maintenance engineers with usable software, and happy bean counters with data they can use. [7]
- **Compatibility with External Applications**
  Maintenance managers can easily share maintenance data with their organization's systems of record. They don't need to worry about manually reformatting volumes of data to just to satisfy the requirement of other systems. [1]
- **Data Collection from Multiple Sources**
  Improved integration with external data sources means CMMS software can collect data from building automation systems as well as from meters, PLCs, and gauges on the factory floor. In fact, a modern CMMS, properly integrated, can use data from virtually any source to feed its alerts, alarms, and reports. [6]

3. STEPS OF TRANSFORMATIONS

Industry 4.0 combines the efforts of scientists and industry into a integrated system. Becoming a Digital Factory is becoming increasingly important factor for the survival of the company, but the way forward is not always clear and simple. One of the basic requirements it will include education, training, skills, knowledges and equipment for technical service department. Assumptions to be taken into account for the factory of the future are types of machines, used FTS / AGV, construction of machinery and products. With the requirements and assumptions related steps and phase transformations which are describe in Fig. 3.

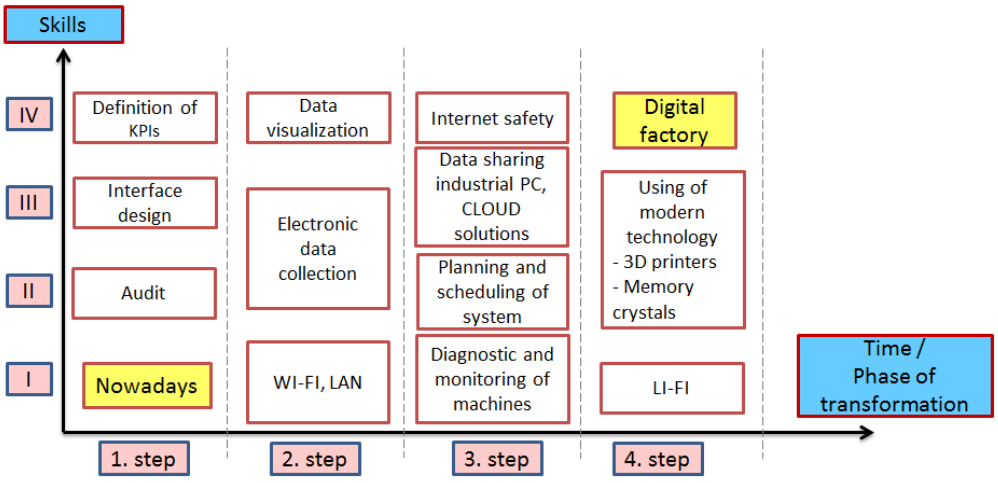

Fig.3. Transformation of technical services for digital factory

4. CONCLUSION

As can be seen, it is necessary to adapt the direction of the current maintenance, because Smart Things surround us already to a large extent. In the article is outlined the view of how the maintenance could include at this new change in industrial enterprises. On the based these premises, it is necessary solve and develop of technical services in the organization. As long as the companies introduced high-tech as production or logistics and technical services will not be developing, long-term sustainability of such systems will not be possible. It can be assumed that the development will go on and a few years will talk about Smart World. Already at present they are available and widely used by some elements. Maintenance or technical service certainly will not disappear, but will evolve into a sophisticated system.

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Preventive maintenance, Bill of material, Equipment list, Working instructions, Material forecast

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CONDITION BASED DECISION SUPPORT SYSTEM FOR PREVENTIVE MAINTENANCE

Abstract

Presented paper deals with the topic of preventive maintenance. The decision support system was designed, which includes the historical as well as forecast information to calculate weeks to preventive maintenance. The system optimizes costs of maintenance while no additional investment and running costs are needed.

1. INTRODUCTION AND PROBLEM STATEMENT

According to Ahmad and Kamaruddin (2012) maintenance strategies can be broadly classified into Corrective Maintenance (CM) and Preventive Maintenance (PM) strategies. Authors further report that the concept of PM involves the performance of maintenance activities prior to the failure of equipment. One of the main objectives of PM is to reduce the failure rate or failure frequency of the equipment. This strategy contributes to minimizing failure costs and machine downtime (production loss), and increasing product quality. The PM strategies can be based on Orginal Equipment Manufacturer (OEM) recommendation, which is however, not applicable in practical conditions. Other strategies are based on operational research and comprise strategies as Time-based (TM) and Condition Based Maintainane (CB). Time-based maintenance, also known as periodic-based maintenance is a traditional maintenance technique. In TBM, maintenance decisions (e.g., preventive repair times/intervals) are determined based on failure time analyses. In other words, the aging (expected lifetime), T, of some equipment is estimated based on failure time data or used-baseddata. TBM assumes that the failure behaviour (characteristic) of the equipment is predictable.

Condition-based maintenance, also known as predictive maintenance is the most modern and popular maintenance technique. CBM was introduced in 1975 in order to maximise the effectiveness of PM decision making. CBM is a maintenance program that recommends maintenance actions (decisions) based on the information collected through condition

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monitoring process. CBM is well discussed topic (Yam et al., 2001; Grall et al. 2002, Marseguerra et al., 2002).
It is a proactive process that requires the development of a predictive model that can trigger the alarm for corresponding maintenance (Peng et al., 2010). In CBM, the lifetime (age) of the equipment is monitored through its operating condition, which can be measured based on various monitoring parameters, such as vibration, temperature, lubricating oil, contaminants, and noise levels. The motivation of CBM is that 99 per cent of equipment failures are preceded by certain signs, conditions, or indications that a failure is going to occur. Therefore, CBM is needed for better equipment health management, lower life cycle cost, catastrophic failure avoidance etc (Ahmad and Kamaruddin, 2012). However, The introduction of CBM without managerial support at all levels, appropriate data and analysis, disciplined and knowledgeable maintenance staff is unlikely to achieve desired results (Ellis, 2008).

According to the ISO TS standard the producer has to use the preventive maintenance, based on time intervals, as well as "prediction" maintenance to ensure the continues improvement and quality assurance.
From practical point of view, acquisition of data needed for preventive maintenance is based on records of line operator, or different cycle counters. The downside of this method is, that data need to be imported into the available software manually.
The aim of this work was to design a decision support system suitable for company Hessel Slovakia s.r.o. which would enable an automatic software-based information flow pointing to maintain frequency of PM given by OEM of the tool instead of collecting data coming from cycle counters and/or other cycle records pending on operator's responsibility to bring the data into any maintenance software just in time.

2. DESIGN OF THE CONDITION BASED DECISION SUPPORT SYSTEM IN THE HESSEL SLOVAKIA

Aim of the work was to design system, which would determine the time till the next PM steps need to be taken. Resulting from literature review and practical applications, design of the DSS for PM was based on assumption:

- PM frequency pre-described by OEM is used,
- historical as well as forecast data are used,
- system has to be operator independent - with no need to use manually recorded data (due to the fact that no system based on manual data records is good enough to keep sufficient frequency and maintain equipment at its initial level of order)
- relationship among existing company parameters and process parameters generally available at most cases should be used - so no additional agenda is created.

The historical data are coming from existing company reports/documents. All sources of information are standard process documents. Firstly, bill of material of finished goods (BOM). According to final inspection records at production line, BOM always declares which number of raw materials was used – processed on the production line, thus on relevant equipment. On top of this parameter, an additional information coming from waste records is used as it may significantly influence this number. Working instructions (WI) are used as a second input. In general, this list describes number of production steps and its detailed manual for operator. Standard time of operation, which stands as an additional information in WI, was applied in our calculations. This number may appear either as a cycle, showing mostly frequency needed to

achieve the standard time per operation. This parameter is reflected by number of pieces per min, hour, shift. Second option may be describing operation standard time by time itself. In this case, equipment with versatile use pending on different set up for different products is usually defined by time of use. As a last source of historical data, so called equipment list (EL) is used. This may but must not be a part of WI. The EL comprises information on each operation as it ought to be performed at its assigned working place. By definition for using assigned working equipment, at its order of use, processing defined number of materials (based on BOM) EL covers a matrix of tools used vs. raw materials processed.

Proposed system uses relationship among all upper mentioned parameters/information. As it was described above, production line is predefined by EL and WI so the process flow is ensured. When assessing the equipment and other tools for PM, selected production steps and connected information are subtracted from these documents. Each operation runs different time and different number of cycles are needed to kick off final product at the end of the line. It has to be highlighted, that even in case of parallel production steps, which are used in order to increase the final efficiency of the line, the real time usage of the single tool does not decrease. Using this philosophy, it can be exactly calculated which share of preventive cycle time (given by OEM) is consumed per one semi-finished product or finished goods. All produced parts records, coming from final outgoing inspection were taken into consideration to get a result, which comprises number of processed raw materials quantified through BOM. Moreover, to get the real numbers, amount of raw material is increased by waste reports. Total number of cycles performed is generated than by confrontation of BOM quantification with EL matrix.

Production can vary at any time base, based on many factors. Therefore future is at this case as important as the history. The novelty of our system is based on the fact, that not only historical data of all consumed materials consequently cycles done, but also forecast information are used. Here, material request planning (MRP) calculator is used. MRP shows the future as long as customer planning covers its demands. Material usage applied as a cumulative parameter and MRP applied as an variable parameter shows us very precisely the material frequency at the production line.
When confronting materials and their usage as well as foreseen usage with the EL matrix, time, resp. cycles consumed and planned to be consumed per each tool, equipment are calculated. Equation 1 describes the above mentioned system.

Equation 1.

$$WTPM = \frac{n * (PM_F - (ICC - (PM_R * PM_F)))}{\sum_{i=0}^{n} MRP_i} \quad (1)$$

$$ICC = \sum_{1}^{n} M_c \quad * EL_t \quad (2)$$

Where:

WTPM - weeks to preventive maintenance
ICC - informative cycle counter
Mc - Cumulative material consumption per week
EL_t - equipment list defined time, or cycle
MRP - Material request planning - average material forecast per week

PM_R - records of preventive maintenance done per each operation of PM needed
PM_f - preventive maintenance frequency - frequency of either time, or cycles prescribed by equipment producer and/or an additional organizational set ups

3. CONCLUSION

Aim of the work was to design decision support system for preventive maintenance suitable for company Hessel Slovakia, s.r.o. Proposed system is based on historical as well as forecast data from the customer. It uses existing documents/reports of the company and does not lay any additional load on staff. It is a simple tool, which does not introduce investment costs and moreover optimizes the costs and efficiency of maintenance.

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Innovative potential, Innovation performance, Market

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INNOVATIVE POTENTIAL

Abstract

Globalization has confirmed that the competitive ability of organizations is conditioned by the successful development of innovations. Innovation management and development of innovative potential of organizations are becoming a scientific problem. The paper presents a new approach to identification of innovation potential. Knowledge of the innovative potential of organization is one of the premises for increasing its innovation performance.

1. INNOVATIVE POTENTIAL IN THE ORGANIZATION

Innovative organizational performance is contingent upon the development of its innovative potential. The significant problem in the organization is the question on how to identify it and subsequently quantify it. In general, the potential characterizes the extent of opportunities of the object under examination which are available to achieve the desired effect. We understand the desired effect as a transformation from the existing state to the target state. In relation to the need for creating and commercializing innovation it is necessary to distinguish:

1. Innovative potential of the product.
2. Innovative potential of people.
3. Innovative potential of the organization.

In the following sections are highlighted differences of innovative potential of the product, innovative potential of people forming those innovations and innovation potential of the organization.

1.1. Innovative potential of the product

Global markets require targeted creating of specific products. We are asking how the offered product suits the specific environment (customer) and what is expected of the product to succeed. Just to answer these questions, the innovative potential of the product (IP_{PR}) must be examined. From a systemic perspective, it is important to opt for such methodologies that continuously assess the potential, because it is a newly created tradable product, economically efficient, environmentally friendly, ready to be produced, corresponding to the legislation and

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acceptable for people. In connection to this, it is needed to parametrize these conditions for success.
During the innovation projects, innovator must maximize the innovation potential of the product offered by maximizing the following parameters: marketability (p_1), economic efficiency (p_2), environmental friendliness (p_3), technology (p_4), legislation (p_5), and culturalism (p_6).

$$\max IP_{PR} = \max f(p_1, p_2, p_3, p_4, p_5, p_6) \quad (1)$$

While: $p_1 > 0 \Lambda p_2 > 0 \Lambda p_3 > 0 \Lambda p_4 > 0 \Lambda p_5 > 0 \Lambda p_6 > 0$

By setting the evaluation criteria for $p_{1\text{-}6}$, it is possible to guide the decision already in solving the subtasks of the innovative project.
Innovative potential of the product is the characteristics of the product, which through these parameters expresses its possible commercialization. Innovative potential of the product can be increased by aligning its parameters with the anticipated market requirements. The condition is that none of the product's parameters is in a direct violation of the anticipated market requirements.
As we see, we can assess the potential success of innovation through the key parameters that affect the global market. It is fundamentally a new view eliminating subjective quantification of the strengths and weaknesses of the product.

1.2. Innovative potential of people

Innovative potential of **people** (individuals, groups, humankind) refers to the possibility to invent, develop and implement a product that succeeds with customers. The need to invent is associated with creativity. Creativity means a set of characteristics that gives humans the ability to create a new product or a new process due to changes in human consciousness. Knowledge of the development of creativity allows for the results of scientific investigations in the field of psychology, medicine and management. Knowledge, that every creative individual is a carrier of innovation potential, is essential for studying the innovation potential of people. Innovative potential of an individual can be expressed as a function of three parameters $i_{1\text{-}3}$.

$$IPI = f(i1,i2,i3) \quad (2)$$

While: $i_1 > 0 \Lambda i_2 > 0 \Lambda i_3 > 0$

Where:
IP_I innovative potential of individual,
i_1 motivation of the individual, his ability and willingness to cooperate, his personal interest for achieving the objective, courage and desire or need to create something new,
i_2 explicit and tacit knowledge of the individual,
i_3 working environment.

Innovative potential of defined group of people is formed by contributions of cooperating individuals. It can be expressed through the innovative potential of individual group members.

$$IPPE = f(IPI1, IPI2, ..., IPIn) \quad (3)$$

Where:
IP_{PE} innovative potential of people
IP_{Ix} innovative potential of x-th individual,
n number of group members

Stimulating element in maximizing the above parameters is the effective cooperation. Innovative potential of an individual lies mainly in its openness to adopt new knowledge and willingness to cooperate. Individual is the fountain of good ideas, but needs colleagues for his development and implementation of ideas.
By introducing appropriate forms of work organization (e.g. teamwork) we can achieve even greater increase in the synergistic effect of using the innovative potential of individuals.

1.3. Innovative potential of organization

To provide standard operation of the organization requires considerable effort and resources. However, if the organization has to develop, it is necessary to purposefully implement the development activities. To create and maintain an innovative organization is possible if significant support will be given to the use of existing innovative potential of individuals and groups. This means providing information, material and financial resources necessary to achieve the objectives set in relation to the use of the innovative potential of people.
Innovative potential of the organization is a function of all of its available resources. These resources can be divided into four basic groups, while the prerequisite for this process are sufficient funds. Innovative potential of organizations can be therefore expressed as follows:

$$IPO = f(r1, r2, r3, r4) \quad (4)$$

While: $z_1 > 0 \Lambda z_2 > 0 \Lambda z_3 > 0 \Lambda z_4 > 0$

Where:
IP_O innovative potential of organization
r_1 people (IP_P – innovative potential of people),
r_2 information (technology, licenses, patents, trade mark, trade secrets, know-how, codified knowledge,...),
r_3 material (tangible assets, technical equipment, materials, energy, ...)
r_4 funds

Innovation potential of organization refers to the ability of organization to coordinate the work of individuals, working groups and to develop links in the network of cooperating organizations in order to succeed with customers. To utilize the innovative potential of the organization it is also necessary to ensure the efficient organization and working environment.
Neither individual nor group or organization is able to exploit the potential of the knowledge contained in the global business environment by themselves. Wealth of the whole range of disciplines and knowledge potential hidden in the individual organizations cannot be used without networking and fellow innovators [2]. Networking and coordinated cooperation can strengthen the innovative potential of each of the organizations involved.

2. INTEGRATED INNOVATIVE POTENTIAL

It is possible to present an integrated innovative potential through schematic representation of integration of the individual innovative potentials. (Fig. 1.)

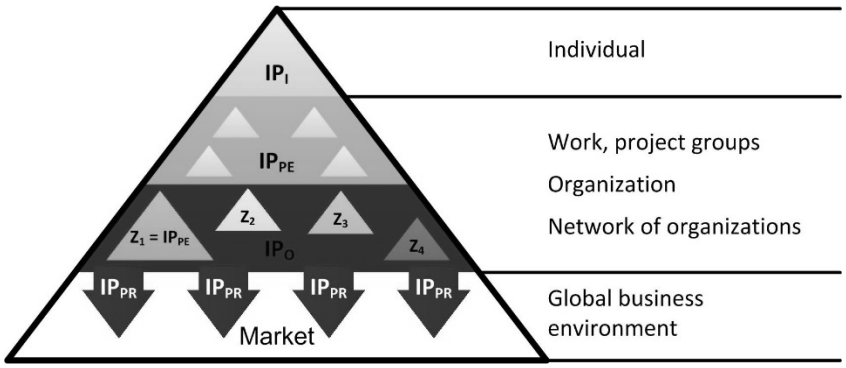

Fig.1. Integrated innovative potential

The individual plays a role of creativity bearer, generating good ideas (IP_I). The implementation of the idea generally requires not only resources but also colleagues (IP_{PE}). The organization enables efficient coordination of the work of individuals and groups, securing the necessary tangible and intangible resources (IP_O) and active involvement in networks of organizations. The size of the innovation potential of the organization always depends both on the availability of creative individuals willing to cooperate, as well as their ability to actively participate in organization's networks. Given this mechanism, organizations create products based on the new innovation potential (IP_{PR}) and place them on the market within the global business environment.

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Ergonomics, Screening assessment, Mobile application, Augmented reality

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SCREENING ASSESSMENT OF ASSEMBLY WORKPLACES BY MOBILE APPLICATION

Abstract

Ideal - „healthy workplace"– without risks, doesn´t exist. At every workplaces we can find smaller or bigger ergonomics risks. Mostly they are related with his design, work condition or work process. All interact and range of diverse factors then causes a risk to workers health, because of non-physiological working position, manual handling with load, repeated operations within a short cycle and so on. Then we speak about physical and mental load of workers.

1. MODERN ERGONOMICS

Modern ergonomics is dynamically progressing. It should be tailored to meet the needs of industry. New area is exploitation of mobile application for fast evaluation of risk workplaces. In simply electronic tools, called Quick risk assessment - „QRA tools", by mobile application, we see a way, how to help industry companies and other companies, but also experts who makes this evaluation (for example health services, consulting companies). Important is use the solutions with new approaches. Introduction ergonomics for companies means not only link of departments, human resources, but above all the use of new tools and methods. In modern ergonomics we use tools of Digital factory, Virtual and Augmented reality, but also ISO norms and European and Slovak legislation and relevant, valid European assessments.

2. CERAA - APPLICATION

CEIT Ergonomics Analysis Application, is user-friendly, fast mobile application, created on basis of law of Slovak no. 542/2007. It is used for screening assessment of space conditions and work position of workers on potential risk workplaces. It is product of Division of research and innovation (CEIT, a. s.). First version is now in process of testing. Users are industry companies. Thank this tool they can realize fast screening of ergonomics their workplaces.

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User doesn´t need to be ergonomist, knows based knowledges about ergonomics and designing of workplaces, as well.
The main goal is to verify if workplace is risky and if is needs a detailed evaluation and find a corrective actions and if is here threatens of risk to health workers, deterioration in the quality and work efficiency, productivity loss, consequential sanctions – as perhaps categorization of work and then associated costs of hazardous workplaces, worker's compensation and etc..

2.1. Background of CERAA

Evaluation passes through the spatial conditions and working position. Used the elements of Virtual and Augmented reality, above all evaluation is only in terms of valid Slovak legislation and technical standards as law of Slovak no. 542/2007, Government regulation of SR n. 391/2006, STN ISO 72550-1, TNI CEN ISO/TR 7250-2, STN EN ISO 14738, STN EN 547-3 + A1, STN EN 1005-5.

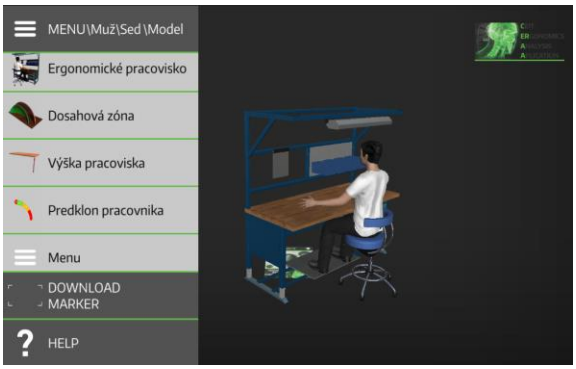

Fig.1. Illustration of specific virtual workplace (for man – sitting – height 1855mm)

Application is currently evaluating two areas. The first area is the evaluation of spatial conditions for workers – work position, based on Annex 1 of law of Slovak no. 542/2007. This evaluation includes a review of the movement area during working, sitting and standing, based on anthropometric calculations. We can find here basic principles under legislation, such as the free space for the legs, demands on the eyes, handling planes (space for frequent and occasional movement of the upper limbs), also calculated and visualized for different heights workers.
The second area is the evaluation of selected work postures (fig. 3a), based on Annex 1 of law of Slovak no. 542/2007. This evaluation includes such characteristics and criteria's for determining the admissibility of positions with respect to the position of the torso, head and neck posture, the position of the upper limbs, lower limbs and position of other parts of the human body, the hygiene limits with respect of time.
For effective evaluation were developed virtual models and centers optimized for the worker with respect of work position, gender, height, workers and the principle of design offices, as well as the method to check angles of selected parts of the body real worker using Virtual and Augmented reality and quick comparisons with legislation. Part of the application's menu buttons with labels that guide the evaluator and guide you through the entire score to exit the application.

Entry	TNI CEN ISO/TR 7250-2	Male			Female		
		P5	P50	P95	P5	P50	P95
a2	4.2.8	370	405	435	345	370	400
a17	4.2.11	350	375	420	360	390	460
b2	4.4.2	685	740	815	625	690	750
b15		197	258	330	193	278	347
b18			150	180	125	145	175
c1			610	655	545	590	640
c2			265	285	225	245	260
h1			1750	1855	1535	1625	1720
h4			1100	1175	960	1020	1080
h6			830	905	710	775	830
h11			910	965	810	860	910
h12			795	855	705	755	805
h13			625	670	540	590	630
h16	4.2.12		450	490	375	415	450
h17	50mm (for all P)	50	50	50	50	50	50
t2	4.4.3	325	350	390	295	315	350

h16 (P95) + b18 (P95) + x3
c1(P95) - b15(P5) + z1
a17(P95) +y
t2(P95) + a2(P95)
2t3(P95) .sin60 + a2(P95)
2t3(P95) .sin60 + a2(P95)
b2(P95) - 190mm
.....

Fig.2. Illustration of input dimensions for calculation ergonomic workplaces – according anthropometry (author)

Figure no. 2 show a sample from a table of input data – dimensions [mm] of parts of body, according TNI CEN ISO/TR 7250-2. These data were input to formulas for calculation the dimensions of work and handling surface. They were calculated information about height of space for lower limbs, adjustable seat height above the footrest, height of footrest, minimal space for lower limbs, width of space for lower limbs, optimal height of working surface, maximal height of working plane, maximal width of working surface, optimal depth of working surface, maximal depth of working surface and more information about working posture – standing.

2.2. Assessment of risky workplaces with CERAA

The user selects from the menu – ergonomic workplace, reach zones, working postures. He makes it based on the gender, height and working posture of worker.

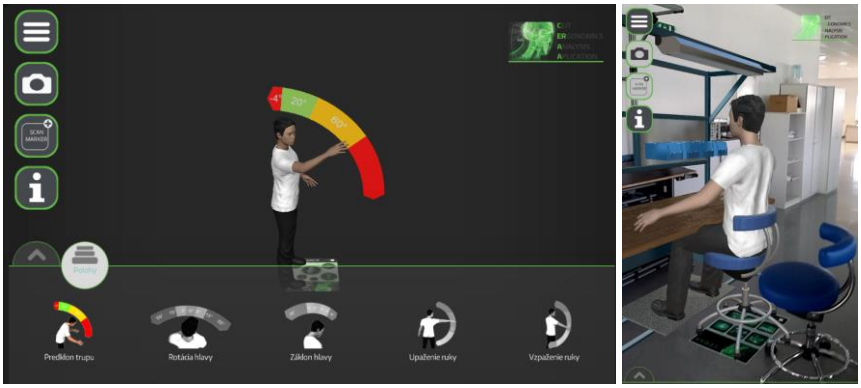

Fig.3. a,b. Illustrations of evaluation working posture (left – a) and virtual model of ergonomics workplace in real space –through Augmented reality (right - b)

After entering these parameters defined object is displayed in the middle of the tablet screen. With object (fig.1), we can move, rotate, zoom and we can select trigger labels – some information points.
In this information points we can find basic principles with regard to design workplaces – based on Slovak legislation.
After opening and running an application, opens a camera and after scanning the marker shows the object, which is assigned (fig.3b). It is for ideal comparison of virtual workplace and real industrial workplace and for risk searching. Thus the Augmented reality used for verification of ergonomics in the workplace.

3. CONCLUSION

This solution is a new approach to screening assessment of assembly workplaces. In a short time a lot of companies can verify ergonomics of workplaces and then make a decision about next steps they need realize. Goal is create this application, add new assessment methods to create a comprehensive solution based on a screening of legislation.

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Adaptive Logistics System, Mobile Robotic Systems, Smart Connected Product

Tomáš GREGOR*, Martin KRAJČOVIČ**

SMART CONNECTED MOBILE ROBOTIC SYSTEMS

Abstract

The paper introduces the information about Mobile Robotic Systems (MRS), working in the framework of adaptive logistics systems (ALS). It describes MRS as the Smart Connected Products whereas illustrates this concept on the case of Mobile Robotics Systems of CEIT Company.

1. INTRODUCTION

The standard internal logistics, which provides for transfer and handling of the material in the production process, is an area burdened with high demands for manual labour. The most commonly used logistic means are handcarts or motorized carts, with high energy consumption and usually also high environmental costs. Conventional internal logistics is usually an origin of injuries. Such a logistics system usually doesn't suffice to ensure the logistic requirements of modern, automated factories, which results in the formation of bottlenecks, occurrence of delays in deliveries and formation of unplanned, unnecessarily high stock.
One solution to this situation is the use of mobile robotic systems and automated logistics equipment for the reliable functioning of the internal logistics in the challenging conditions of factories of the future. Such solutions are referred to as Adaptive Logistics Systems (ALS). It is estimated that by 2030 up to a half of European factories will be able to operate its own internal logistics with the use of autonomous mobile robotic systems (MRS). [4]
MRS are becoming an inseparable part of advanced logistics concepts. Standard control methods of such advanced logistics systems are being gradually replaced by new systems based on emergent properties. Automatic decision making becomes a standard feature and it requires real data transfer between the system and its surroundings, a knowledge of the previous historical behaviour of the system and an ability to learn from the previous situations. These properties transform a simple piece of hardware into a smart product. [3]

1.1. Innovations of logistics solutions

A good example of an innovative applied research & development utilizing the latest IoT technologies is the autonomous logistics system, being developed in the context of ZIMS (Zilina Intelligent Manufacturing Systems) at the Central European Institute of Technology

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(CEIT) (Gregor, M., 2011). This system is built upon the autonomous Aurora logistic tractors shown in Fig.1 [2].

Fig.1. Aurora - Logistic Trucks

CEITs AGVs development resulted from the requirements of automotive industry and was carried out in cooperation with VW Group. The application of this logistics solution can be seen in Fig.1. As shown, the system uses automatic vehicle position identification and it also includes its own monitoring and control system, linked to the system of production planning and control [2]. Deployment of the current Aurora logistics system in the environment of automotive industry at SKODA Auto Mladá Boleslav production plant (CZ) is shown in Fig.2.

Fig.2. CEIT Logistics concept

1.2. MRS and the Convergence of Technologies

As shown in Fig.3 a rapid development of information and communication technologies has brought about technological convergence. This is also visible in the case of MRS. The classical technology, extended with the most recent components of automation and ICT solutions (sensors, effectors, artificial intelligence etc.) have converged and they are giving rise to new technologies – the so called converged technologies.

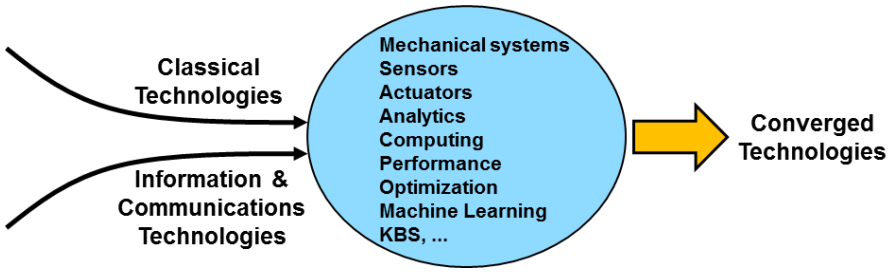

Fig.3. Technological convergence

Extending the basic mechanical and electronical functions of the MRS with components of "intelligence" leads to the creation of smart products. Utilization of smart products creates the conditions for the improvement of the entire logistic chain. The MRS, as a fully connected product, is thus becoming a part of larger systems. It therefore has to provide support for fast connection and immediate operation (plug and produce), rapid reconfiguration (change of capacity and functionality), the ability to directly communicate with the remaining entities of the logistic system and also the ability to make decisions and optimize its behaviour according to the immediate situation. [1]

1.3. MRS as a Smart Connected Product

Intelligent (smart), connected products are products whose basic hardware and software components are extended with components of "intelligence" and the ability to communicate. This new communication feature of MRS enables direct communication which can have two different forms, either machine to machine (M2M) or machine to man. [5]
Smart connected products must have a set of new features and functions, starting with the ability to monitor their own state, and to use this information to control their own actions and to optimize them. These extensions also include autonomous behaviour and the ability to quickly and easily change capacities and functionality (reconfiguration capabilities). This development is displayed in Fig.4.

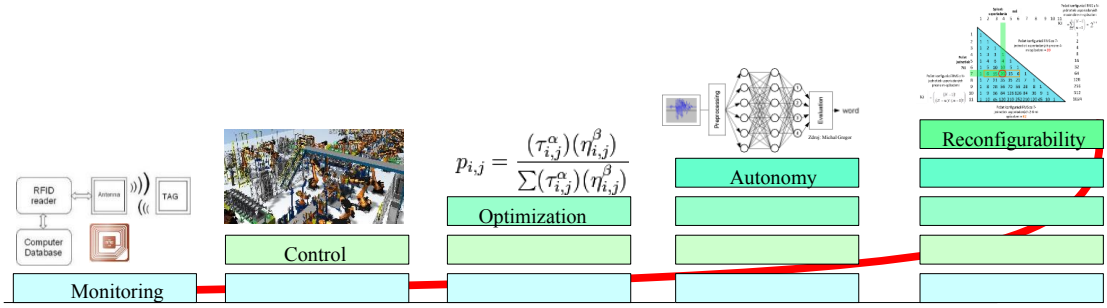

Fig.4. Development of new features associated with connected product

Autonomy requires the ability of an individual MRS to react to emergent requirements. This requires a different way of controlling the activities of the logistic system (in comparison to the traditional push system). The concept of agents and multi-agent systems (MAS) has emerged

as the most suitable alternative. A set of smart connected MRSs then enables the use of multi-agent control system.

1.4. Product Cloud MRS

The development in the area of ICT has brought significant, positive changes to the field of MRS in recent years. All data on the deployment of MRS now exists in digital form (birth certificate of the product, product card, service book, etc.). Cloud technology allows for sharing of the information with all the other elements of the logistics system, production management system or ERP system.

2. CONCLUSION

Adaptive logistics systems are an irredeemable part of the factory of the future environment. Mobile robotic systems, as one of its most important subsystems, becomes the pressure point for competitiveness and thus also innovations. The evolution is heading towards autonomous, intelligent solutions with agent control, interconnection via the internet of things (IoT) and cloud services. Such development and applied research is currently being carried out in Slovakia by CEIT Company in cooperation with automobile industry, the University of Zilina and the Technical University of Košice.
The CEIT solutions for internal logistics are a great example of continuous creation of innovations and their immediate implementation in the industry. The rapid development changes not only the products themselves or their functionality, but it also brings a whole new qualitative level of communication, control and optimization to all the logistics operations.

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Knowledge base, Experiment, Simulation

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SIMULATION OF DECISION-MAKING PROCESSES

Abstract

The article deals with the problem of simulation of decision-making processes. It represents a behavioral experiments as one of the solutions to this issue. Article also discusses the connection of experiment sphere with the creation of a knowledge base. It points out various instruments to establish a knowledge base that includes a simulation of decision-making processes.

1. INTRODUCTION

Today, it is nothing special to supplement or to replace human activity by outputs of technical development and elements of artificial intelligence. Current technical progress came into a state in which human work can be in certain fields fully replaced by the machine. This happens in several areas because man as himself and the human factor is the set of characteristics and properties that are influenced by and the degree of reliability compared with the conveniences of today is incomparable. Using elements of artificial intelligence in manufacturing, logistics, warehousing, planning is currently not newsworthy. Even this sphere has no boundaries and activities which we might think are strictly "human" will evolve and create even in virtual form - simulation of many states etc. Strategic decisions in the conditions of global change has shifted from forecasting the future state to finding adaptation scenarios and navigation changes. In real terms, this process takes place in an environment of a large number of factors and high uncertainty of information.

2. EXPERIMENT

The term experiment or attempt is the intentionally induced process in relatively precisely controlled conditions used for the generation and verification of experience, knowledge, scientific theories and hypotheses.

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The aim of the experiment is to find previously unknown phenomenon or regularity or verify deductive discovered regularity. The experiment is a research method that is used in many sciences.
The difference between attempts and experiments is that the attempt is an asked questions, by which we are looking for some patterns. In a certain sense, each of our action is an attempt until we see its effects. However, we are talking about scientific experiments only when the review may take place continuously and with the conscious aim.
Experiment is used for seeing the effect of the variables intentionally induced by experimenter (the man who carried out the experiment). Under the variable (or parameter) is generally thought such a property that can have different values (either quantitative or qualitative).
Hypotheses give observation certain. They allow to carry out a planned observation by creating conditions that are necessary in terms of hypotheses. So experiment takes place: we see what happens for quite some assumptions.
Computer simulation is an imitation of real process by computer.
Simulation is often confused with modeling. Creating a real, or close reality model represents the basics of simulation, but cannot be equated. The same real model can be simulated in several ways.
The simulation is an experimental method by which the real system is replaced by the computer model, this model is used for the experiments, which are then evaluated, and the results of optimizing are then re-applied to the real system. [4]

3. SIMULATION OF DECISION-MAKING PROCESSES

Experimental approaches can be used for simulating the decision-making process under controlled conditions, thus reducing incompleteness of information. Decision-making in real terms is today taking place in a complex environment, with the participation of a large number of actors and high uncertainty of information. With the technological development, we can predict many things, but we can not entirely accurately predict their impact. It also demonstrate the fact that human error has a wider dimension, like the anonymity of collective decision-making. [5]
Traditional forecasting approaches often fail to predict or to analyze changes in conditions of complexity. Experimental approaches allow to simulate the decision-making process under controlled conditions, thus reducing uncertainty of information. At the same time they take into account the complexity of socio-economic, technological and biological factors and motivations that may affect human behavior and decision making, for example, in situations in which individual interests are in conflict with societal. They also allow testing of new alternative policies and decision-making tools, such as the protection of health, natural resources, the introduction of technological and organizational innovation.
The experiment simulates the decision making process of individuals as well as teams in the laboratory and in real decision-making environment. The validity of the results comes from multiple replication under controlled conditions and with the exclusion of incidental changes.

3.1 Experiments and acquisition of knowledge

Behavioral experiment, just like any other experiment, means to approach the reality. Therefore, experimental methods combined with modeling of multiple decision-making agents with participatory multi-criteria decision or the decision-games. A special feature of this approach is the acceptance of the conditions of imperfect information, that these approaches

are based on. Decision-making games, for example, simulate the conditions of decision-making in uncertainty and offer individual player positions with certain obligations and motivation to be monitored. It simulates the coexistence of individual and collective decision-making strategies. [4]
Among knowledge acquisition methods that are closest to the experimental techniques for obtaining answers to specific patterns belong selected techniques for acquiring knowledge based on the manual knowledge acquisition. This is the same kind of conditions simulated situation in deciding when an expert as part of a team represents a person for resolving a particular problem. Based on its knowledge the procedure of dealing with the situation is recorded.
Here, we can include these two kinds of knowledge acquisition involving the simulation of decision-making activity:

- **Free association** - the initial stimulus are entered to the expert, and he responds to it through associations that raise him. These associations can become new stimuli, which then creates a whole association network. A variation of this technique is organizing concepts (expert mostly through cards organizes various concepts into a hierarchy, this process is repeated for prompted accuracy of addressing the issues).
- **Monitoring** - Experts is asked a question that is answered by "thinking out loud". He suggests and explains solutions. Monitoring is often associated with the indicative interview, but the description does not interfere with the expert. The monitoring uses a number of specific strategies:
    - a retrospective description of solving the problem,
    - simulation of a hypothetical solution to the problem,
    - strategy of critical issues. [2]

3.2 Problems vs. challenge

Rather than a disadvantage, we would call it a challenge. Teams of researchers engaged in the creation of systems to support human decision-making are teams composed of experts from several interdisciplinary areas. The scientific teams of social science experiments are composed from analysts, managers, mathematicians, programmers, psychologists, experts, knowledge engineers and specialized technicians. In addition, they must all adopt interdisciplinary approaches and principles of collective cooperation, such as substitution. During the experiment running it is important to maintain standard conditions. Therefore, if the leader of the experiment reveal that a player does not have a pen or his software falls down, he must substitute colleague. [3]

4. CONCLUSION

In this post we would like to point out that part of the creation of a knowledge base, which focuses on working with people. Remelting of human activity and the actual decision-making in any conditions is very difficult in any other form. Artificial intelligence is an area that is not new, but it is expanding scientific discipline focusing on everything. Correct processing of all factors that affect human decision making under defined conditions in order to enter the previously gained experience, knowledge, information, is not easy. This includes the work of a group of people whose processing constitutes another entry in simulations of these activities and the creation of something autonomous and revised so it can replace human activity.

We want to say, that it is impossible to form a knowledge base without people, people whose knowledge we gain, and above all they want to share them. Although we try to relieve a person from certain activities, in the final analysis it is in my opinion one indispensable part of any system.

This paper was made about research work support: KEGA 064ŽU-4/2014.

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Evolutionary algorithms, Genetic algorithm, Plant layout

Viktor HANČINSKÝ[*] , Martin KRAJČOVIČ[**]

GENETIC ALGORITHM LAYOUT PLANNER

Abstract

The article is focused on the presentation of plant layout design method, utilizing genetic algorithms. Within the article, the basic operation of genetic algorithm is presented, followed by presentation of the proposed solution, developed within dissertation thesis solved at the Department of Industrial Engineering.

1. INTRODUCTION

Within the design of production layout, the planners are often confronted with complex, sometimes conflicting demands and a number of restrictive conditions, which encourages their efforts to develop new, progressive approaches to the development of production layouts. The purpose of the innovative approaches in this field is to provide users with better, elaborated designs in less time, while they are able to implement various restrictive conditions and company priorities to the design. The trend of todays advanced times is evolutionary algorithms that use mechanisms inspired by biological evolution, to evolve solution. These algorithms are heuristic in nature and show good results for complex optimization problems.
The combination of these two technical fields offers the opportunity to exploit the available potential of evolutionary algorithms for the development of production layout, so that quality solutions within a reasonable time can be achieved.

2. PROPOSED SOLUTION

In general, we can define the facility layout problem as the search for the best arrangement of physical objects, which ensures the most effective operation of these facilities. Within solved dissertation thesis, an extensive study was dedicated in this field, and a solution was developed using software solutions available on the Department of Industrial Engineering at University of Zilina – Matlab, where the genetic algorithm core was programmed and FactoryCAD / FactoryFLOW pack developed by the company Tecnomatix, which was developed for the 3D production system design and also for static evaluation of these systems. We can also export this data in a SDX format (Simulation Data Exchange). The control is made through a user interface

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created in MS Excel. Connection diagram of the processed solution, which was called GALP (genetic algorithm layout planner) can be seen in Figure 1.

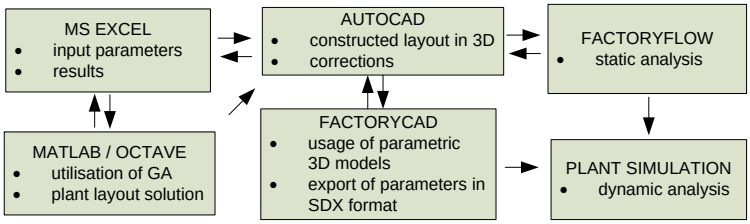

Fig.1. Interconnection of processed solution modules

The genetic algorithm core, programmed in Matlab consists of several steps:

- Generation of the initial population
- Evaluation of individuals by fitness function
- Decision blocks
- CAD system processing
- Static verification
- Dynamic verification

The first step is to create an initial population, which is a set of solutions that will be further evolved. In our solution, every individual is composed of genes in the number count value equal to the number of placed machines. These can take the values from 1 to n, where n is the number of machines that are being placed. The order of individual genes is corresponding to the order in which the machines will be placed into the layout. The starting solution is formed by random generation. Following the creation of the population it is necessary to evaluate it by the fitness function that consists of two weighting components - evaluation according to the intensity and distance (f_{ID}) and by relationships and distance (f_V).
Calculation of f_{ID}:

$$f_{ID} = \sum_{i,j=1}^{i,j=n} D_{ij} * I_{ij} \tag{1}$$

Calculation of f_v:

$$f_V = \sum_{i,j=1}^{i,j=n} V_{ij} * D_{ij} \quad \text{for } V_{ij} \geq 0 \; f_V \qquad \sum_{i,j=1}^{i,j=n} \frac{V_{ij}^2}{D_{ij}} \quad \text{for } V_{ij} < 0 \tag{2}$$

Where: n – the number of placed workplaces
D – rectilinear distance between workplaces i-j ($D_{ij} = |x_i - x_j| + |y_i - y_j|$)
I – intensity between workplaces i-j
V – coefficient value of relationship between workplaces i-j (AEIOUX)

The resulting value of the fitness function is defined as:

$$min:\ f = \alpha * f_{ID} + (1 - \alpha) * f_V \tag{3}$$

Where: α – ratio coefficient between f_{ID} and f_V (α ∈<0;1>)
After evaluation of all individuals by the fitness function, the best solution in generation is saved as the elite individual. In the next step it is necessary to make comparison of the termination criteria of the algorithm with the current solution status in four decision blocks.
The first condition is to achieve the maximum number of generations (iterations) - G_{max}. The second condition is the achievement, or exceeding the maximum allowable fitness value - f_p. The third condition is to achieve maximum specified solution time - t_{max}. The last condition is exceeding a defined number of iterations (I_{max}) without the improvement of reached solution.
In the case, that neither of the termination criteria has been met, the algorithm continues with selection of individuals to be crossed with each other and subsequently mutated. For developed solution we chose a roulette-wheel mechanism with fitness-proportionate selection. Also, the option to enable stochastic universal sampling has been programmed. Pseudocodes or both methods are:

Roulette wheel mechanism:

1. Generate random number on interval <0;1>
2. Get parent
3. Achieved desired number of parents?
4. False – go to step 1. True – continue with the next step of algorithm.

Stochastic universal sampling:

1. Generate random number – the first pointer U_1 – start at interval <0;F/n>
2. Generate the rest of uniformly distributed pointers

After selection, genetic operators crossover and mutation take place. For more efficient crossover process, we incorporated partially matched crossover (PMX), which has implemented measures to ensure that within the solution, each encoded machine occurs just once within its steps. Example of partially matched crossover can be seen in Figure 2.

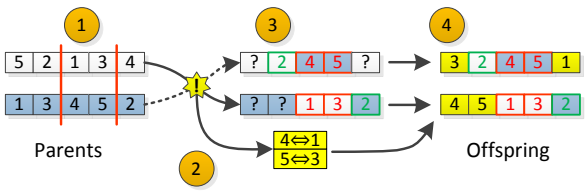

Fig.2. Partially matched crossover

Following the actions of genetic operators are parents replaced by the offspring. After this step, the algorithm returns to evaluation, to assess new individuals through fitness function. The cycle is repeated until one of the termination criteria is fulfilled.
After obtaining solution, GALP automatically generates a script that transfers the entire solution into the AutoCAD environment. Using Siemens Tecnomatix FactoryCAD, 2D objects with rounded dimension are replaced with 3D models of machinery and equipment with their exact dimensions. The proposal is additionally modified this way, to better correspond to the real

possible state of the production system. In addition to machine models, the user can also use an extensive library to design warehouses, offices, workplaces or the building itself.
After the creation of 3d plant environment, we use FactoryFLOW to verify by static analysis such as D-I diagram, Sankey diagram, aisle congestion analysis and many others.
Within the analysis it is necessary to define individual products, their bill of materials, production volumes, activity points (machines, warehouses, and other workplaces through which the product passes) and shipping and handling information. The purpose is to examine the factors affecting the quality of the proposal, which are not taken into account by the genetic algorithm, such as planned transport network, intersecting material flows, insufficient number of transport equipment, or aisle congestion. The last step is the dynamic verification. Here, the aim is to back the results of the static analysis by simulation of the proposed production system, examining the impact of random or dynamically changing factors, such as machine failures, changes in production volumes, delayed delivery of materials, storage capacity, and more. The aim is that the proposed solution will be flexible enough to adapt in rapidly changing circumstances. Within the developed solution, we propose the use of software Plant Simulation. Tools FactoryCAD/FLOW, mentioned above, allow using SDX format to export parameters of the production system to the other tools of Tecnomatix portfolio – which Plant Simulation is a part of.

3. CONCLUSION

The aim of this paper was to present solution developed within dissertation thesis, which utilizes genetic algorithms within plant layout design. The proposed solution (GALP) generates layout based on user-defined attributes, such as intensities and relationships between machines/workstations, their dimensions (in 3D) and also parameters of the genetic algorithm itself. After finding the solution, results are transferred back to Excel, and also a script is generated to construct the solution in AutoCAD environment with Tecnomatix FactoryCAD/FLOW extensions, enabling the user to verify proposed layout statically, and with the help of SDX format also export data to Plant Simulation Software for dynamic verification.

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TECHNOLOGY TRENDS FOR DEVELOPMENT OF FACTORIES OF THE FUTURE

Abstract

The economic crisis and global megatrends in the past decade have caused significant declines performance of the industry. Many countries have responded to support the industry rebounding by creating initiatives at national and regional level. At the same time it responded to the European Commission an initiative called 'Future of the Future', which aims to increase the use of technologies in industry.

1. CREATION OF FACTORIES OF THE FUTURE

Historical development, impact of globalization and global megatrends bring changes in the industry. Many countries and groups of countries prepared their initiatives to improve the state of the industry and industrial production. One of the most important initiatives is Factories of the Future). Other known approaches include German Industrie 4.0 platform or the Dutch initiative Smart Industry. The common denominator of all initiatives is restarted industry and industrial production in order to achieve the previous position while responding to growing production volumes from Asian countries, particularly China.

The European Commission led by José Manuel Barroso in November 2008 prepared 'A European Economic Recovery Plan'. It is a direct response to the European Commission on the situation of the crisis. One of the key aspects of the plan was to create a uniform approach throughout the European Union, which will increase the synergy effect of the measures. This plan was based on 10 key actions including Research and Innovation. To increase of use of technology and to support industry was created 'Developing clean technologies for cars and construction' action. This action was addressed to support innovation in manufacturing, in particular in the construction industry and the automobile sector which have recently seen demand plummet as a result of the crisis and which also face significant challenges in the transition to the green economy, the Commission proposes to launch 3 major partnerships between the public and private sectors: [1]

- In the automobile sector, a 'European green cars initiative', involving research on a broad range of technologies and smart energy infrastructures essential to achieve a

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breakth0rough in the use of renewable and non-polluting energy sources, safety and traffic fluidity.;

- In the construction sector, a 'European energy-efficient buildings' initiative, to promote green technologies and the development of energy-efficient systems and materials in new and renovated buildings with a view to reducing radically their energy consumption and CO2 emissions;
- To increase the use of technology in manufacturing, "a factories of the future initiative": The objective is to help EU manufacturers across sectors, in particular SMEs, to adapt to global competitive pressures by increasing the technological base of EU manufacturing through the development and integration the enabling technologies of the future, such as engineering technologies for adaptable machines and industrial processes, ICT, and advanced materials.

European Commission based on this Plan created this initiative and allocated mentioned money for they activation. This Actions are closely related with European program for support of research and Innovation called Horizon 2020.

2. FACTORIES OF THE FUTURE

After creation of 'a Factories of the Future' initiative was formed European Factories of the Future Research Association. This organization associate more than 130 companies, universities and research organizations with ambition to cooperate activities in field of Factories of the Future research. Stakeholders from member organizations of EFFRA together created Multi‑annual roadmap for the contractual PPP under Horizon 2020. [2] This document define factories of the future as factories based on 4 challenges & opportunities:

- Manufacturing future products,
- economic sustainability,
- social sustainability,
- environmental sustainability.

This challenges and opportunities should be reached with high involvement of technologies and use of knowledge worker. Factories of the Future are forward-looking manufacturers who systematically take up the challenges of the fourth industrial revolution. They supply products with high value added and are flexible enough to respond to swiftly changing market demand. This also enables them to continue playing a major role in a dynamic worldwide manufacturing network. Factories of the Future fully embrace digitized production processes. They take care how they carefully handle energy and materials and maximally exploit the potential of modern production technologies. Besides technological innovation, social innovation is also high on the agenda, with special attention paid to staff involvement, creativity and autonomy in a human-oriented approach.

3. TECHNOLOGY TRENDS

Technology is constantly evolving and maturing. It moves from a nascent, undefined entity to one that is widely accepted and becomes so commonplace that we wonder how we ever functioned without it. Authors of 'An OECD horizon scan of megatrends and technology trends in the context of future research policy identified 40 technology trends, which should bring to life new dimensions. [3] This dimensions will be faced new opportunities to make life better in all spheres

– from working life to private life. All this technologies need to be used for improving of quality of life, improve of productivity and make "life easier".

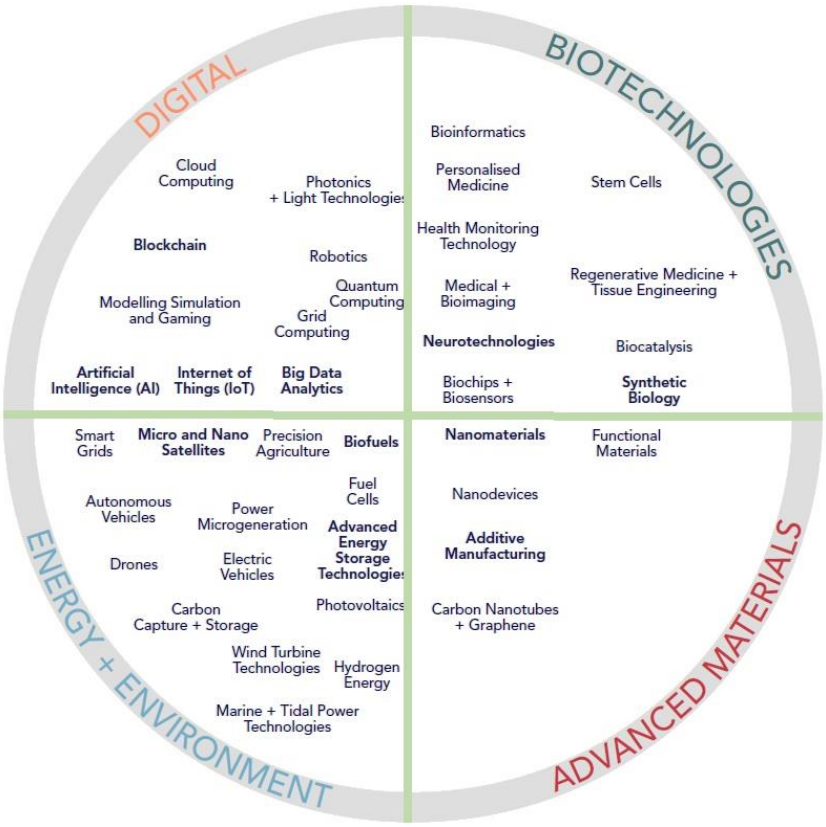

Fig.1. Technology Trends [3]

From industrial point of view are most important technologies selected to digital and energy + environmental section. Most of this technologies is actually used in industry. Higher potential for implementation to industry have got combination of technologies, for example Internet of Things (IoT) in combination with cloud computing offer opportunity to monitor production real time from all over the world. [4]

An important component of Factories of the Future is a combination of physical and virtual world, this connection is made possible by the creation of the so-called cyber-physical system (CPS). Cyber-physical systems are integrating computational and physical processes, embedded computer and management processes retrospectively when serious physical processes complement of computer and vice versa. The integration of the Internet of Things and Internet of service in the manufacturing process initiated by the fourth industrial revolution. Internet of Things allows "things" and "object" as RFID, sensors, mobile phones integrate into unique links, which can work together with other objects to achieve a common goal. CPS granted under the definition given above, it is possible these "things" and "objects" deemed CPS. On this basis, the Internet of Things can be defined as a network in which CPS collaborate through unique links. Use of the Internet of

things can be, for example, the Smart factories, homes or networks. [5][6] Cloud can be simplistically defined as a repository of data on which is placed a lot of data, you can access it from any site using an Internet connection. Digital Factory is a virtual image of real production, which shows manufacturing processes in the virtual environment. It is mainly used for planning, simulating and optimizing the manufacture of complex products. To verify and optimize all parts of the production system in the planning phase, which will ensure that the next real production products already will be provided in terms of quality, time and cost. It is also possible to significantly reduce the cost of the necessary changes being made to grow disproportionately with the approaching date for the beginning of real production. [7]

Conclusion

Factories of the Future give opportunity for industry to reach lost positions before crisis and react on megatrends. Technologies implemented into Factories of the Future mean increase of productivity, make better condition for employees and respect environmental aspect of manufacturing. Technologies are very fast changing and reaction on this change from manufacturing site is potential to be competitiveness in the future.

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Improvement, Healthcare, 7 Wastes

Jozef HNÁT, * Libor KUBINEC**, Branislav MIČIETA***

SEVEN TYPES OF WASTES IN HEALTHCARE

Abstract

This paper deals with implementation Lean method which are knows from industry to non industrial area. 7 wastes are described for especially in healthcare - Overproduction, waiting, overprocessing, Inventory, Motion, Defects, Transportation, Unused Human capital and waste of organizational design.

1. SEVEN WASTES

Nonvalue-added activity and waste mean the same thing. The early founders of the Toyota Production System spent a lot of time observing waste. Because of the repetition of certain forms of waste, it proved helpful to put the wastes into several different categories. The major forms of wastes found in operations became known as the seven operational wastes. [1]

2. OVERPRODUCTION

Overproduction is producing too much stuff, or producing stuff too early. Let's say we were unable to use a premix IV (intravenous) and had to mix IV solution in the pharmacy. Subsequently, we delivered two days' worth of this mixture to the unit where the patient was being treated. At the end of the first day, following the delivery of this solution, the patient was discharged and sent home. The remaining solution would need to be returned to the pharmacy and likely disposed of properly.

3. WAITING

Waiting causes a disruption of workflow. This disruption can result in idle resources, stopping and starting, and time delays to our customers (patients or staff). Within healthcare, we can experience waiting for service providers, diagnostics, information, equipment, and materials. I typically find waiting as the largest single waste within healthcare. For service providers that

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work in the emergency department or a clinic, I'm sure you can recall an occasion where a patient or family member verbally expressed disappointment with the time they were spending in the waiting room. Staff members do not always see waiting as a waste. If a therapist walks to a patient's room to provide some therapy and the patient is not present, then the therapist likely would not wait. The therapist would simply go to their next patient. So, since the therapist is not idle and is now adding-value (providing therapy) to a different patient, the waiting was not considered wasteful. I would like to point out that this argument is flawed on two fronts. First, waste was created when the therapist walked to the patient's room only to find out the patient was not present. This walking to a missed appointment would be the waste of motion. However, more importantly, remember that waste is always viewed from the customer's perspective. For the therapist to not see the missed therapy session as wasteful is looking at the waste from the wrong pair of eyes. The patient is the customer and it is that customer that is waiting for his/her therapy. Even though 95% of the activities going on around us are nonvalue-added, it still takes time and practice to be able to see waste. Understanding the seven key wastes is a good start to being able to identify waste in your organization. [2]

3. OVERPROCESSING

Overprocessing is a waste generated by performing work in excess of value. While this may be hard to believe, it is possible to do more work than the customer values. For example, many of us use spreadsheet solutions on a daily basis. Software solutions are invaluable; they enable us to sort numerical data, determine averages, sum column totals, and quickly build charts ands graphs. Have any of you ever considered the work that went into the engineering process of these solutions? You have the ability to do conditional formatting, data validation, pivot tables, and logical formulas in a matter of moments. It is my belief that you could spend years trying to learn all the functionality of this type of software, but 99.9% of us will never use greater than 10% of this capability. [3] For many customers, the product is overengineered; the use of this product can easily create overprocessing. It is important to note, however, that other people may find these many features beneficial. Thus, from their perspective, the product does not appear to be overprocessed. As an example of overprocessing within healthcare, we might consider inter-professional assessment. A complex patient might get assessed by multiple nurses, multiple physicians, and several members of the allied health team. While each team member is looking for different pieces of information to provide the best possible care, a patient might be asked the same question by two or more people. Do you people not talk to one another?" Again, from the patient's perspective, as an organization, you have overprocessed. The redundancy in questioning creates work in excess of value. Another example of the waste of overprocessing within healthcare: Are all tests ordered really necessary?

4. INVENTORY

When we think of inventory, we think of supplies. It is my belief that everyone, whether in a production environment or a service environment, can relate to the disruption in work when we run out of materials and supplies. The opposite is also true; when we have too many supplies. Excess supplies can lead to damaged product, obsolescence, and time wasted on inventory management. None of these activities meet the need of the customer. In healthcare, however, there are other forms of inventory present. One inventory that we do not frequently think about is patients waiting for services. Patients could be waiting for an admission, waiting for an

inpatient bed, waiting for test results, etc., but the collection of these patients is inventory as they are queuing up and occupying space. A simple definition of inventory is "things" (people, items, information) waiting to be worked on. Another form of inventory is things waiting in your inbox. Within administration, there are lots of places where work queues up. Bills waiting to be paid, charts waiting to be coded, invoices waiting to be processed and mailed, e-mails waiting to be answered, performance appraisals waiting to be completed, payroll waiting to be processed, supplies waiting to be ordered, financial reports waiting to be generated. The backlog of these items is inventory.

5. MOTION

When we speak of the waste of motion, we are talking about movement in excess of that required to create value; this movement is from the staff and providers. One form of motion is present when we walk from one area to the next looking for supplies and equipment. A simple example of wasted motion occurs when we have to walk an extra ten steps to get to the sanitizer because the dispenser is not located at the point of use. I often hear the argument that it is "healthy" for the staff to be active. I agree that it is healthy to have an active lifestyle, but unnecessary movement in the workplace is wasteful. The following example demonstrates how easily wasted motion accumulates in the workplace. One organization (I'll call it XYZ) did an extensive study of the waste of motion for their inpatient nursing staff. They used a stopwatch to record the percentage of time that nurses spent walking during their 12-hour shift. The results of the study revealed that 53% of the time a nurse was simply walking from one place to the next. More than half of their time working was spent walking. This organization had over 800 full-time nurses on their staff across the hospital. After some simple mathematical calculations, it was deduced that over 400 nurses were being paid throughout the week to walk from one point to the next. If this organization could reduce the nurse walking time across the organization by 25%, that would be the equivalent of getting an additional 100 nurses (25% of 400 nurses = 100 nurses). Could any of your organizations use 100 nurses? For free?

5. DEFECTS

Defects create waste because they result in work needing to be completely redone or corrected. Before we get too far into the waste of defects, we need to differentiate between a defect and an error. Work that is completed by humans is subject to errors; an error is a mistake in the execution of a task. An example of an error is a physician order for a medication that was inadvertently not signed. Regardless of how well trained people are, how often they complete a given task, or how diligent/conscientious they are, errors will be made. However, an error need not turn into a defect. A defect is an error that makes its way to the customer and results in work needing to be redone, corrected, or clarified. In healthcare, defects frequently appear in the form of missing information, incorrect information, or information received in the wrong format. However, defects also can be clinical in nature and appear in the following ways:

- The wrong test could be ordered
- The wrong diagnosis could be made
- Patients can be harmed through infections acquired at the hospital

6. TRANSPORTATION

Transportation is the conveyance of materials, equipment, information, and patients through an organization. From the patient's perspective, the movement of items or information doesn't create value, thus transportation is considered a waste. Transportation consumes staff resources and also takes time, while failing to directly meeting the needs of the customer. Motion is different from transportation in that motion involves the movement of staff, while transportation is the movement of items. Consider a patient that shows up for a surgical preadmission visit. This patient must first be registered. Next, the patient has to go to the lab for a blood test, followed by walking to diagnostic imaging for a chest x-ray. Finally, the patient returns to the clinic for a nursing screen and pre- and post- surgical education, followed by a trip to a different office for a meeting with the anesthesiologist. While we have optimized the utilization of the staff and leveraged the footprint of the facility, we have created a lot of transportation for the patient. Consequently, the customer perceives the visit as a nuisance rather than as an efficient process engineered to benefit the customer.

7. CONCLUSION

There are two other types of waste that show up within organizations that are not operational in nature: the waste of unused human capital (creativity) and the waste of organizational design. From an improvement perspective, the focus is generally on process and the seven wastes will show up when we study the process in detail through either direct observation or time observation. The waste of unused human capital and the waste of organizational design do not generally present themselves when studying a process, but they can be present and do generate some of the seven common wastes.

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SPC, Statistical process control, Management

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THE CAPABILITY OF MACHINES

Abstract

Today's customers expect high quality products for a low price. The cost of 100% quality control is really high. This the reason why companies use statistical control to verify their product. This article show SPC method which can be used to verify quality of process and machines.

1. SPC

The term "quality" is expressed by the ISO definition: "The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs". [2] It means that product has good quality when it meets requirements specified by the client.
Statistical quality control developed in fourties in last century, when statistical method were main quality control tool in companies delivered products in mass scale for army. [1]
In present days, there is used SPC method, called Statistical Process Control. The main approach of this tool is introducing preventive strategy in process. Applying SPC should be accompanied by active involvement with a view to removing the causes of the deterioration of the quality of production.
SPC is the most effective in the area of planning and implementation process. SPC is useful when it is the first stage is run production of statistical methods allow you to evaluate the accuracy of the work of production equipment, which gives the capability for selection of the most appropriate places for the most accurate technological operations. Additionally SPC provides the opportunity to evaluate suppliers and supply and it reduces quality costs and thus increase profits. [1, 3]
Using SPC, it is possible to track the process in terms of the place and the time. Because of this, it is easily follow and track the process and interfere when the process is disrupted.
The basic procedure in SPC is using the control cards with the control charts invented by Shewart. Production process control using control cards consist of taking samples from the production process, measure them and then analyze results. There are established limits for each process. The

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received results and limits should be plotted on chart. If results are below the lower limit or above higher limit or results totally different, it is necessary introduce actions to improve the process.
Depends on kind of card there different type of analyzes and charts. Indicators C_m and C_{mk} shows the capability of machine.
Cm is machine capability. The Cm index describes machine capability; it is the number of times the spread of the machine fits into the tolerance width. The higher the value of Cm, the better the machine. Note that even if the spread is off-centre, it is still the same size (Cm index). The figure takes no account of where the spread is positioned in relation to the upper and lower tolerance limits, but simply expresses the relationship between the width of the spread and the tolerance width.
Cmk is capability machine index. If you also want to study the position of the machine's capability in relation to the tolerance limits, you use the Cmk index, which describes the capability corrected for position. It is not much use having a high Cm index if the machine setting is way off centre in relation to the middle of the tolerance range. A high Cmk index means, then, that you have a good machine with a small spread in relation to the tolerance width, and also that it is well centred within that width. If Cmk is equal to Cm, the machine is set to produce exactly in the middle of the tolerance range. A normal requirement is that Cmk should be at least 1.67. [4]
Practical example is showed below. MiniTab presents C_p and C_{pk}, but these indexes confirm the capability of machines.

2. SPC IN PRACTICE

Statistical control is essential to analyze the quality of process. Analyzed process is an example in automotive industry, where quality of products must be on the highest level to eliminate any problems with car user safety.
The company which produce mechanical steering gears has a lot processes with critical characteristic. If some process has critical characteristic means that the process has influence on the safety of end user (the driver). This kind of process must be on the highest quality, must be verified and capable.
One of the critical process is tightening the inner tie rods to the rack. If inner tie rod will not be tighten correctly (with proper torque) there is high risk of driver life.
To verify the capability of process or machine, it is necessary to take from the process 25 samples (25 mechanical steering gear) and measure control torque with special torque wrench. The control torque limits are 90 N*m – 105 N*m. The person from special quality department (who has proper skills) measures tightening torques of left and right sides.
The table 1 presents the results from the measurements.
When all data are collected, there is prepared report with MiniTab. The report include visualization of capability and its final results. After introducing the data, we need to check if these data have normal distribution. The basic visualization is chart – generally it is used histogram. In this case, we have two reports showed at Fig.1 and Fig.2.

Tab.1. Collected data from tightening torque measurement

The number of the part	The measurement left side [N*m]	The measurement right side [N*m]
1	97,0	98,0
2	97,0	98,0
3	99,0	97,0
4	98,0	100,0
5	96,0	100,0
6	101,0	98,0
7	100,0	97,0
8	97,0	98,0
9	100,0	98,0
10	99,0	101,0
11	97,0	98,0
12	98,0	96,0
13	100,0	97,0

The number of the part	The measurement left side [N*m]	The measurement right side [N*m]
14	101,0	96,0
15	99,0	98,0
16	96,0	98,0
17	98,0	99,0
18	95,0	99,0
19	99,0	96,0
20	95,0	98,0
21	99,0	97,0
22	97,0	99,0
23	97,0	99,0
24	96,0	100,0
25	98,0	101,0

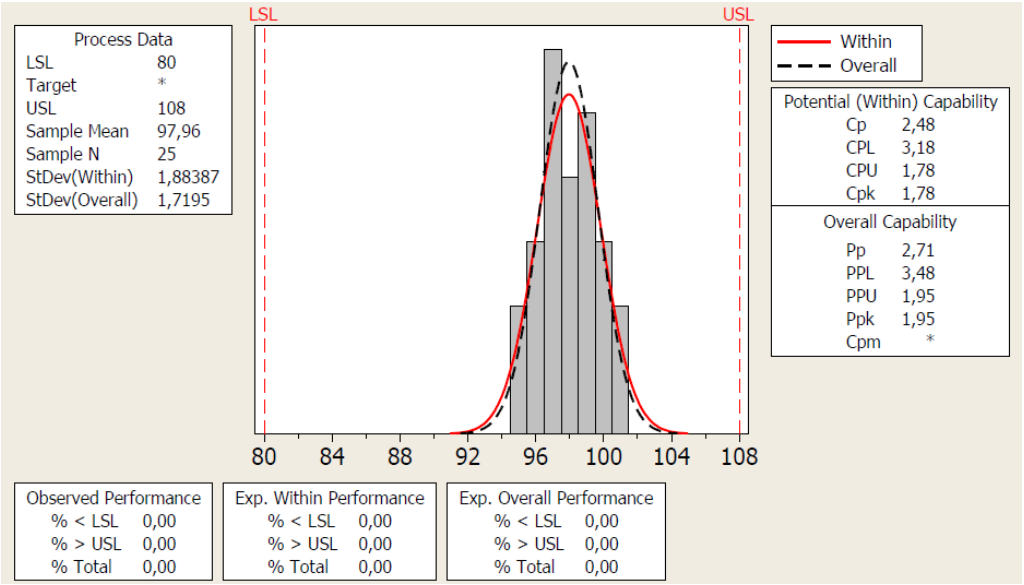

Fig.1. Report of process capability of left side

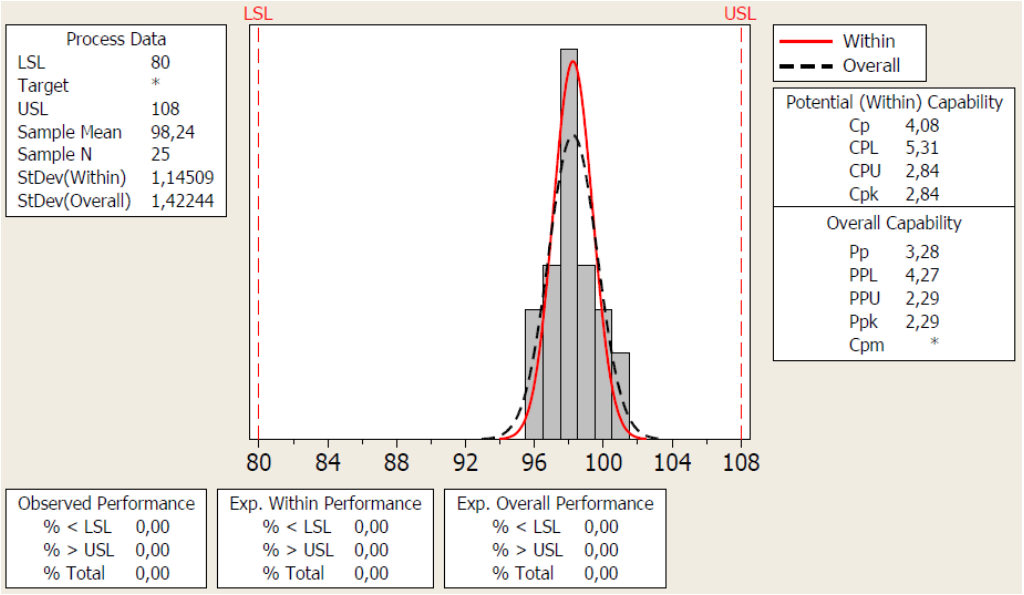

Fig.2. Report of process capability of right side

For this critical process, the capability indexes (Cp, Cpk, Cm, Cmk) must be over 1,33. The report show that these indexes meet the target.

3. CONCLUSION

When any statistical index is below 1,33, there is immediately stop production. Then, there are analysis to find causes of unstable process. Because of particular process there are some introduced activities to keep capable process, for example TPM activities (cleaning the heads and periodically changing). The cost of any introduced activities is non-countable, because this specific process has huge influence on drivers life.

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ABC method, Management

Monika BANACH*, Elżbieta ŚMIAŁOGÓRSKA**

ABC ANALYSIS IN PRACTICE

Abstract

Present days are difficult for companies because of high level of competition in the market. This is the reason to increase awareness of all people working in the companies. The heads of companies should lay stress on introducing new engineering and managing methods. One of this tool is inventory ABC analysis which is described in this article. This method allows to focus on proper problem, cause or the most profitable product.

1. INVENTORY ABC ANALYSIS

The source of this method we can find in researches made by Vilfredo Pareto. Hence, this method is called Pareto analysis. During years, he was making researches about some regularity. Pareto was creating cumulative interval series based on some statistical data [2, 3]. He provided the 20 – 80 rule'. It means that 20% of elements in heterogeneous community represents 80% of cumulated value of features. This rule should be treated conventionally. In the practice, the differences can be quite substantial, but the main idea '20 – 80 rule' is unchanged. ABC method is based on this rule. The proper procedure of ABC method can be presented graphically (Fig.1.) [1, 4]. The cumulative percentage of elements (due to which elements are considered) is presented on axis of abscissa. This data have to sorted descending. While, the cumulative percentage value of feature attributable to each considered elements. Having these data, it is necessary to set points and they are combined in line. The result is a curve. The distinctive shape of curve allows to divide into areas.

There are three areas [4]:

A about 20% elements represent about 80% the cumulative value of features,

B about 30% elements represent about 10% the cumulative value of features,

C about 50% elements are about 10% the cumulative value of features.

The next step is to classify data which were collected. It is necessary to sort elements in decreasing order. Afterwards, Then creates a sequence of increasing through the accumulation of previously ordered. Continues to set the scale of accumulating the number of elements and features of the cumulative values. The total number of elements equals 100% on axis of abscissa and the maximum cumulated value on axis of ordinates.

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In the last step, the coordinate system is appointed with percentage scale and then successive points corresponding to the coordinates of the number of elements and their corresponding feature value. Through the points marked on the coordinate system we can cross out the curve. Then we cross the lines perpendicular to the axis of abscissa which show 20% and 50% of values to get 3 areas: A, B and C. [4]

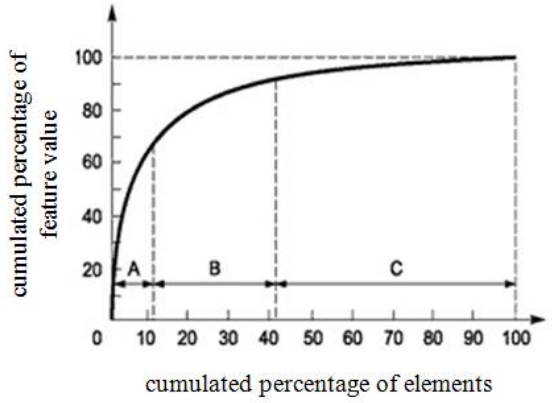

Fig.1. ABC curve

2. ABC METHOD IN PRACTICE

The analyzed company offers furniture. The problem which was defined in this company is that there are a lot of types of furniture in many different colors, eg. chairs, armchairs, sofas, corner sofas, beds. The furniture was divided into groups in view of colors. Taking into account the present trend the users are focused on colors. The furniture which are grey, grey and black, grey and white, grey and red are about 40% income from the sale. This products belong to group 1 and they are analyzed in the first way. Using ABC method and taking into account the color and income from the sale, the furniture were divided into three groups: A, B and C (Tab. 1.). Group A includes items which are sold to the customer and it is 80% of whole sale and while this group covers only 20% of all pending items. Group B includes 35% of items, which sum of sale amounts to 17,5%. Group C includes 45% of items, which value of sale equal only about 2,5%.

Analysis of group sales of goods A indicates that 20% of product items is responsible for 80% release of the finished goods warehouse (Fig.2.). In accordance with the principle of the ABC method it can be assumed that attention should be paid and have the inventory in the company through a precise setting: inventory levels, replenishment level, the size and timing of production start-up and should be carefully analyzed: market prices and manufacturing technologies.
In turn, the products of the C because of the amount while small share of the sales volume, the use of precise and expensive management of supply would not be efficient. For this group of goods, use simplified: procedures for the preparation of production orders, records storage and inventory control in order to reduce costs and resources involved in their operation.

Tab. 1. The furniture divided into groups

Name of product	Color of product	The percentage from the total sale	The group of product (A, B or C)
corner sofa	grey	20%	A
corner sofa	grey and black	2,5%	B
corner sofa	gray and white	20%	A
corner sofa	grey and red	2,5%	B
corner sofa	black and red	0,5%	C
corner sofa	brown	0,5%	C
corner sofa	brown and green	0,5 %	C
sofa	grey	15 %	A
sofa	grey and black	2,5 %	B
sofa	grey and white	25 %	A
sofa	grey and red	2,5 %	B
sofa	black and red	0,5 %	C
sofa	brown	0,1 %	C
sofa	brown and green	0,1 %	C
armchair	grey	2,5 %	B
armchair	black	2,5 %	B
armchair	white	0,1 %	C
armchair	red	2,5 %	B
armchair	brown	0,1 %	C
armchair	green	0,1 %	C

For products from group B to select indirect approach depending on their relevance to the activities of the company

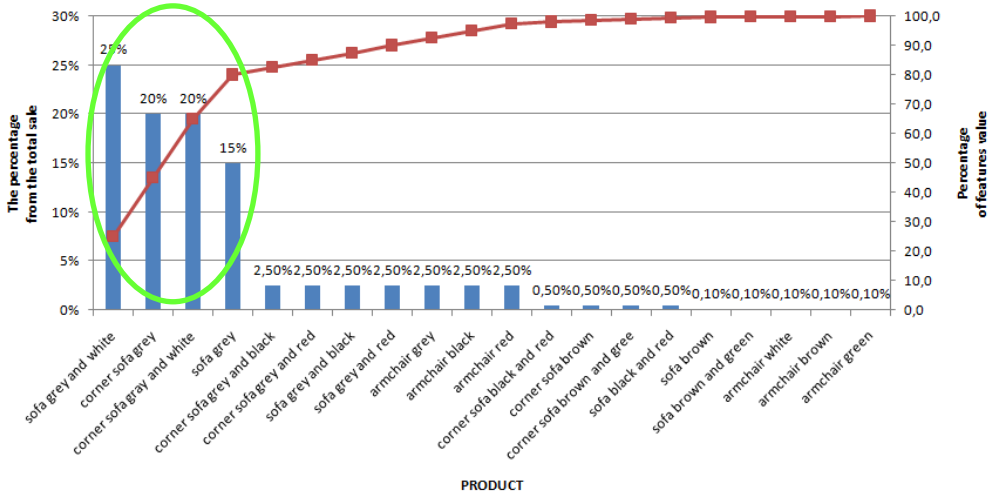

Fig.2. ABC analyze of furniture

3. CONCLUSION

Analysis of sales companies furniture products using the ABC method made it possible to differentiate these products in terms of flow rate at the outlet of the magazine in connection with the results of the analysis can be used to determine the location of finished goods inventory in the warehouse. Furniture from group A should be placed as close to the release area and the furniture of group C can be placed as far as the area release.

ABC method is a practical tool for the classification of stocks in the company, which provides information on the importance of individual stocks in terms of the size and nature of the release of goods, thanks to this method is a method of planning the location of inventory in stock

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Update inventory, Warehouse management, RFID

Elżbieta ŚMIAŁOGÓRSKA[*], Robert DROBINA[**]

RFID IN INVENTORY UPDATE

Abstract

Technology of XXI century is on the high level. Because of this, mangers try to introduce practical solution. One of this is RFID, which helps to manage the inventory in proper way. The article presents the basics of RFID technology and is an example of the use of RFID automatic identification when updating the data warehouse.

1. INTRODUCTION

Updating the inventory is a term that is often associated with work for several days or even weeks spent with sheets census [1]. You can update inventory using computer programs that store eg. Filing an inventory of fixed assets. List computer and the ability to print sheets of clear physical inventory is inventory committee's work is very handy. The first time to automate the process of updating inventory put barcodes. Equipped with a mobile operator reader scans the assets marked with a bar code printed on a special adhesive labels. This method quickly became popular because investment translated into immediate profit. In updating the inventory is becoming more and more popular, however, RFID technology [2].

2. RFID - BASIC CONCEPTS

RFID is a technology to identify objects marked code EPC (Electronic Product Code) using radio waves without direct visibility between the reader and the tag. This technology consists of: antenna, RFID reader and RFID tag. To read encoded data RFID tags used in antenna transceiver, whose task is the emission of radio waves that activate the passive tag, while it will be in range of its activities. RFID tag passing the antenna field detects the activation signal and transmits through its microchip information that may be received by the antenna scanning [3]. RFID readers can simultaneously read and process hundreds of labels that are within their reach [4]. An RFID system consists of: reading devices, software, and label printers also allows programming of RFID tags [3].

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The identification process by the RFID as follows:

- The reader with a transmitter generates an alternating magnetic field around the antenna,
- The reader can generate electromagnetic fields in a continuous manner or may be activated upon detection by the sensor moving nearby,
- RFID tags send information to the reader,
- RFID tags can be passive (excited and energized from a reader) or active (self-powered and usable signal of a certain frequency),
- The reader decodes the response tags,
- The answers are transmitted to the system [3].

3. RFID INVENTORY UPDATE

In updating the inventory, RFID technology is becoming increasingly popular. Depending on the substrate an RFID tag of the marked object are selected and secured by means of: an adhesive, pressure sensitive adhesive layer, rivets or screws. With chip RFID saves up to 90% of the time previously allocated to the monotonous inventory. The difference between the RFID and a standard list of stock is that the RFID tag need not be in the field of view of the reader, which disappears arduous location of numbers on each subject. The operator does not have to seek out the bar code on the surface of the object, you only need to get close to, the RFID reader. RFID tag can be read well both when it is clean and new, as well as after several years even if you have accumulated on the surface scratches, dust and dirt [4].

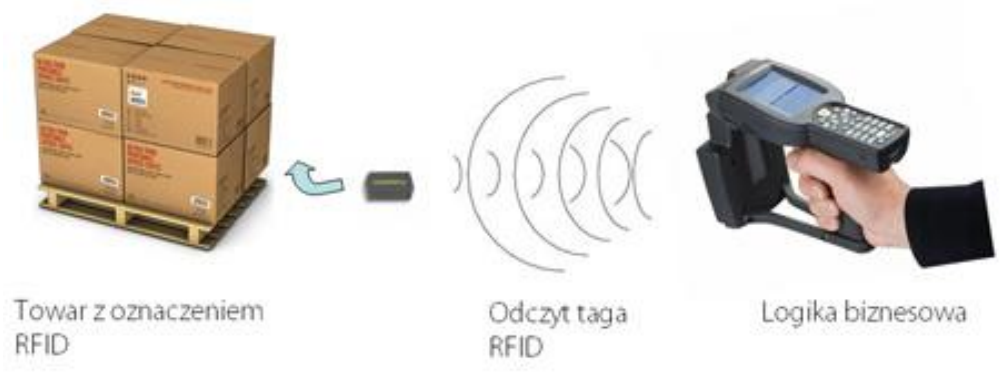

Fig. 4. Scheme of RFID applications [9]

Easier operation while updating inventory can be not only in the case of large quantities of small parts but also to the large amount of large-size elements. Inventory carried out the traditional method of counting components magazine by reading the manual of each label is associated not only with the long duration of the census but also the additional costs of a transport bulky assets magazine. An example of companies that incur additional costs during the inventory process is an enterprise which produces building materials.
Conducting an inventory of high-storage warehouse was connected a cost of preparing the inventory in the form of unloading materials with shelves and re-loading at the end of the list.

The use of bar codes for marking various materials hastened same process to update inventory, but did not solve the problem of the cost of unloading and reloading materials.

Fig. 5. An example of the high bay warehouse [10]

The use of RFID in the warehouse of goods, although the company was associated with incurring the costs of implementation, and solved the problem of loading and unloading of goods on shelves and significantly accelerated the process of updating the inventory. Other benefits of using technology company gained by additional attributes technologies, such as information about the availability of space in the warehouse (space available without the use of warehouse equipment or a place accessible only with a fork lift), and class space, which in conjunction with the classification of the ABC index was used to determine the default location of the index and the assignment of storage indexes in case the default place is occupied or not is determined.

4. CONCLUSIONS

RFID technology makes it easier to update the inventory as goods on shelves and packaging can be scanned in bulk; It brings real benefits wherever it is not possible to access the bar code in order to read [6] and improves the storage of goods that require special storage conditions, because tags can control the humidity and temperature [11]. Given the fact that the RFID tags are used repeatedly, they do not require "eye contact" the reader, can be read and written, in many cases turn out to be cheaper than barcode technology, because it is limited by the amount of work and the consumption of materials used to label [5].

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TBC, Europium zirconates, Pyrochlores

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INFLUENCE OF THE SINTERING METHOD FOR THE SYNTHESIS OF THE NEW TBC MATERIALS

Abstract

Gas turbines, working both in airplane engines as well as those used in the energy industry are exposed to the work in very aggressive environment. These parts operate in high mechanical stresses and in very high temperatures in the environment of the erosion and corrosive media. In order continuously increased work performance, it is necessary to conducting research on the modernize and improve the material and technological solutions.

1. INTRODUCTION

In recent years, widely studied are the new material solutions in the application for the thermal barrier coating (TBC) systems, based on ceramic materials with structure of pyrochlore type. Pyrochlore unit cell can be perceived as eight elementary cells of fluorite, each of which comprises, on average, a single oxygen vacancy (Fig. 1.). The most promising materials in this group proved to be zirconates of La, Gd, Nd, Sm and Eu [1-3].

The TBC material have to meet the strict requirements, these are among others: ability to experiencing deformation, "compatibility deformation", no phase transition in the operating temperature range, ability to withstand repeated thermal cycling, very good erosion resistance and high temperature oxidation resistance as well as a thermal compatibility with the oxide formed by oxidation of the BC (bond coat) [3].

Compounds of the pyrochlore structure $RE_2Zr_2O_7$ are characterized by a lot of desirable properties, among others: very low coefficient of thermal conductivity, below 2,0 W/mK; high coefficient of thermal expansion above 10^{-5} $°C^{-1}$ and working temperature up to 1600°C [3,4]. Currently the temperature of exhaust gases in a turbine, may reach a value of 1500°C directly on the surface of the wall the combustion chamber. The application of the TBC-type layers could reduce the temperature up to 200°C [5].

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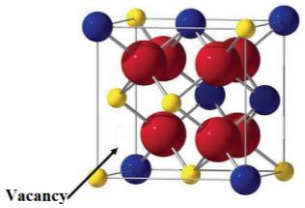

Fig.1. One-eighth of the unit cell of pyrochlore [3].

This paper presents the investigated the influence of the sintering methods for the synthesis of europium zirconate (Eu2Zr2O7 type) with the pyrochlore structure.

2. RESEARCH METHODOLOGY

The studies were used nanocrystalline powders of zirconium oxide ZrO2 provided by (Hefei Ev-Nano Technology Co., Ltd.), and europium oxide Eu2O3 (Inframat Advanced Materials, LLC). The powders were weighed in the weight ratio of 1:1, which gives the mole ratio of ZrO2 to Eu2O3 as 74% to 26%, with an excess of zirconium oxide as to the stoichiometric pyrochlore structure, which mole ratio is 67% to 33%. The aim of such selection the composition was to get acquainted with the mechanism of synthesis and identification of intermediate phases.
After weighing the powders, they were subjected to mechanical mixing in ethanol by 15 min. The next step was to make sinter, which was carried out by four methods, labeled in sequence as:

- **HTSP** – High temperature sintering under pressure. The sintering temperature was 1350^0C with time of process – 2h. The compaction pressure was 15 MPa and whole sintering process was made in a vacuum on level of 10^{-2}Tr.
- **HTSPA** – High temperature sintering under pressure with additional annealing. The sintering temperature was 1350^0C with time of process – 2h. The compaction pressure was 15 MPa and whole sintering process was made in a vacuum on level of 10^{-2}Tr. Than an additionally heat treatment in 1450°C during 5h.
- **FS1350** – Freestanding sintering in temperature 1350°C during 24h.
- **FS1450** – Freestanding sintering in temperature 1450°C during 24h.

Furthermore, X-ray phase analysis by XRD method (X-ray diffraction, Jeol JDX-7S) was also carried out both on starting oxides and in all final sintered materials. On this basis, the analysis of homogeneity of obtained compound Eu2Zr2O7 was made. The study of thermal diffusivity was performed on the device type LFA 427/4/G by Netzsch.

3. RESULTS

In the first step of investigation it was made the analysis of the phase composition the initial powders. Fig. 2. Shows the XRD patterns of ZrO2 where only zirconia with monoclinic (M) crystal system was detected and the XRD pattern of Eu2O3 with dominated cubic crystal system (C) and the residue of monoclinic phase (M).

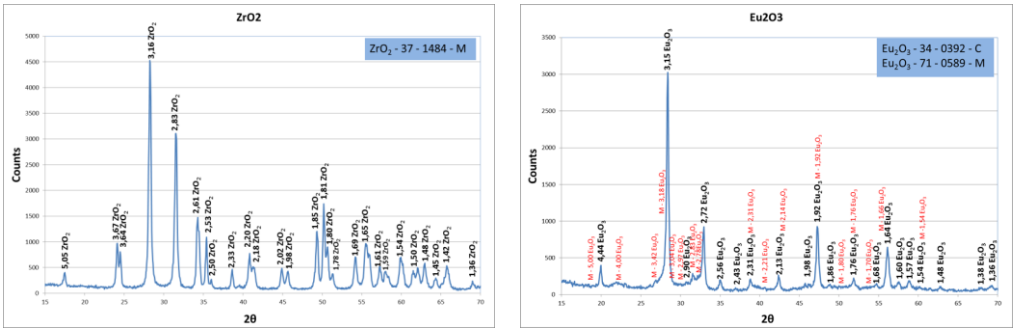

Fig. 2. XRD pattern of based ZrO2 and Eu2O3 oxides

Method of sintering also has an effects on the homogeneity of the phase, the main factors are temperature and time of process. The XRD patterns with identification of the phases are shown in the Fig. 3.

The XRD investigation show the difference in the synthesis of the compounds obtained by various method of sintering. The most homogenous final sinter based on europium zirconate phase with overall formula $Eu_2Zr_2O_7$ was obtained after sintering by HTSPA method and FS1450 method. In the last case it can be seen the strongest reflections coming from super-structure (marked by yellow color on the charts). The diffusion process occur the worst in the case sinter obtain by FS1350 method, visible are peaks not only from ZrO_2 but also strong peaks come from unreacted Eu_2O_3.

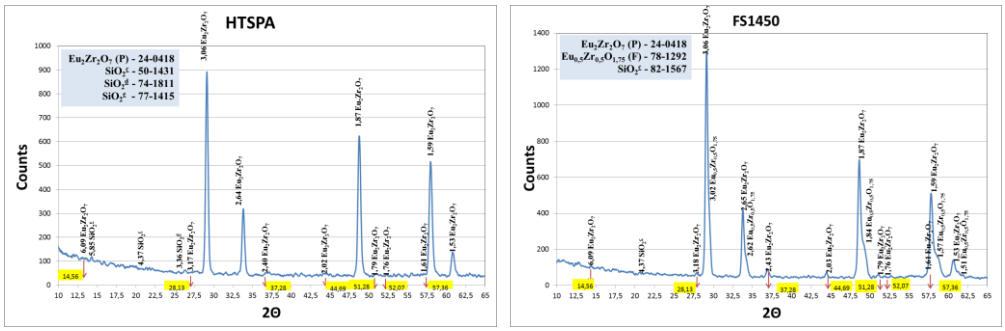

Fig. 3. Diffraction patterns of final materials obtained by HTSPA and FS1450 methods

The final data and basic goal of presented investigation was related to characterization of thermal insulation properties of synthesized materials, and comparison them to data for usually used in TBC systems yttria stabilized zirconia with addition of 8 % wt. of yttria (8YSZ – ZrO_2×8 Y_2O_3) sintered by the same method. For this analysis the laser flash method was used and thermal diffusivity of sintered materials at temperature range from 25 to 700°C was analyzed (fig. 4.). This investigation was carried out only in the case of material obtained by HTSPA method as a material with the most desirable phase constituents. Laser flash analysis revealed that sintered material based on europium zirconate has a lower thermal diffusivity coefficient in comparison with standard 8YSZ ceramic material in the whole temperature range

of investigation. This results suggests that it may be a good material for the application of the TBC.

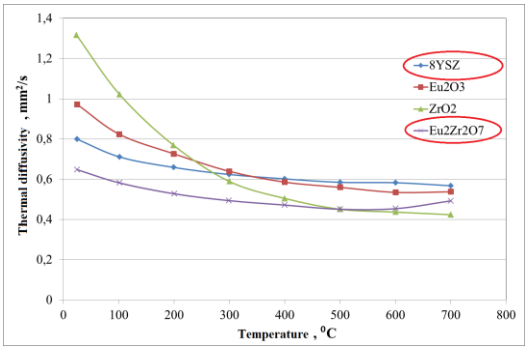

Fig. 4. The thermal diffusivity of $Eu_2Zr_2O_7$ based material in comparison to referential 8YSZ sinter obtained by the same technique.

4. SUMMARY AND CONCLUSIONS

The selection of sintering method has a significant impact on the process of synthesis. Each of the methods let obtain a pyrochlore structure $Eu_2Zr_2O_7$, however, they differ in the uniformity of the resulting phase. Undoubtedly a large impact on the degree of synthesis process of the compound is both time and temperature of the sintering process. Sinters prepared by FS1450 method and by HTSPA method, characterized by the highest homogeneity of structure
Application HTSPA sintering method, get the possibility of good quality final sintered material on the base of europium zirconate, which was characterized by lower thermal diffusivity, approx. 20% lower than the usually used 8YSZ oxide. This result suggests that it may be a good material for the application of the TBC.

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Learning curve, HR, Testing kit

Jaroslava KÁDÁDOVÁ*, Michal DEMEČKO**, Ján KOBULNICKÝ***

THEORY OF LEARNING CURVE

Abstract

This papers deals with theory of learning curve. It is theoretical base to future research of its implementation in HR. In first parts it describes two basic models for predicting learning, the volume-based and time-based learning models. In last part it describes how learning curve is described in detail. It shows us that learning curve can be also used not only in predicting costs but also in predicting human learning.

1. LEARNING CURVE

The concept of learning curve model has been used in industry since the late of 1930s. The study about learning curve model was firstly reported by Wright (1936) in aircraft industry. Wrights model known as log-linear learning curve model as expressed in equation [1].
In common use there are two basic models for predicting learning:

- **The volume-based learning model**

The mathematical model for learning assumes learning is a function of the cumulative production volume in units. Learning curve is used primarily for direct cost. Experience curve is used for total cost. Both models are mathematically identical

- **The time-based learning model**

This approach assumes that learning is a function of time rather than volume and models learning as exponential decay over time. Moore´s Law is known as time-based learning exponential growth model [3].
In this article, for further calculations will be used volume-based learning model.

Figure 1 shows log linear learning curve with 80% learning rate; means that each doubling of cumulative production leads to 20% reduction in unit cost (time). The area below the curve can be divided into two zones i.e. learning and standard time zone. These zones indicate the learning stage of organization [1].

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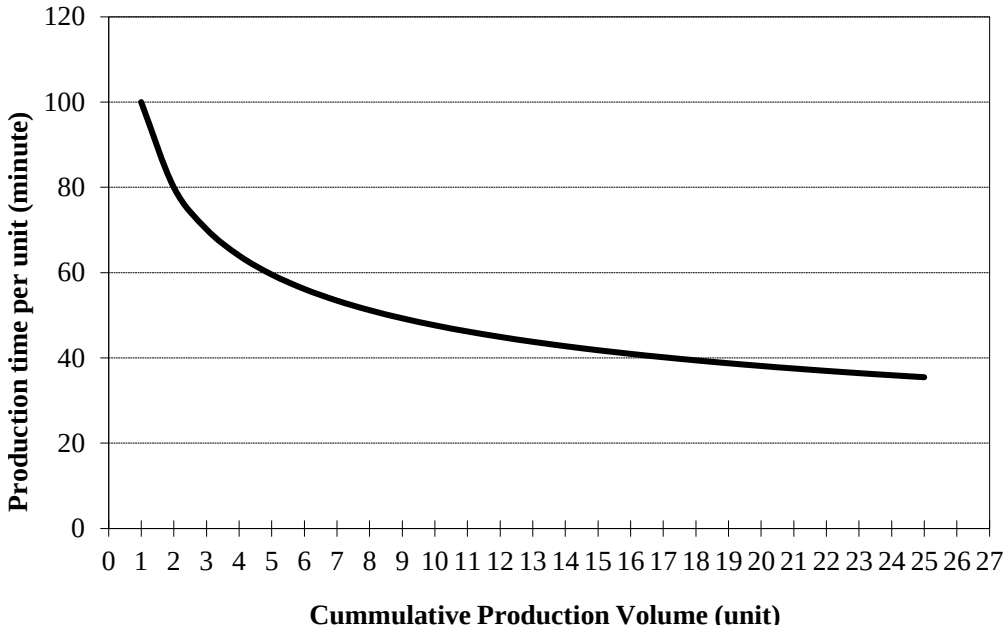

Fig.1. Learning Curve with 80% Learning Rate

The example, for an 80% learning curve:

- If cumulative production doubles from 100 to 200 units, then the hours required to produce the 200-th unit is 80% of that for 100-th unit.

Unit *n*	Production Time y_n
1	100
2	80
3	70
4	64
5	59
6	56
7	56
8	51
9	49
10	47

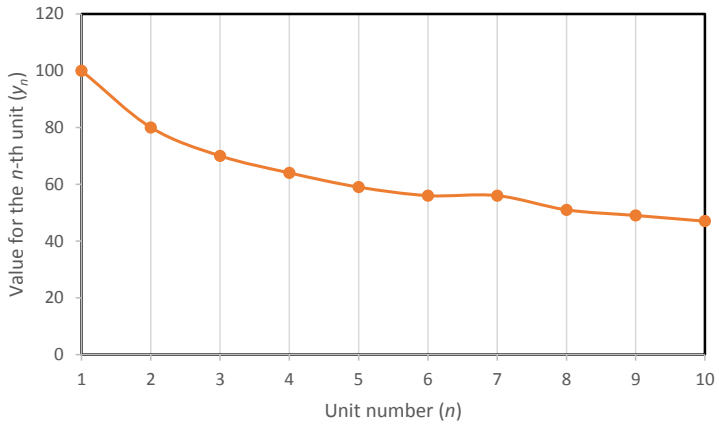

Fig.2. Raw data for the simple example

The basic equation for the learning curve model is:

$$y_n = y_1 n^{-b} \tag{1}$$

Where n is the unit number, y_n is the performance variable (cost, time, etc.) for the n-th unit, y_1 is the value for the first unit, and $b \geq 0$ is the learning parameter, rate.
Taking the natural log of both sides of the equation (1) yields:

$$\ln(y_n) = \ln(y_1) - b\ln(n) \tag{2}$$

which is linear equation with intercept (constant) $\ln(y_1)$ and slope b. We can then use linear regression to find the intercept and slope parameter. The value for the intercept $\ln(y_1)$ can be calculated as $y_1=\exp(\ln(y_1))$. Figure 3 shows the graph for this line.

Unit *n*	Production Time y_n	ln(n)	$\ln(y_n)$
1	100	0,00	4,61
2	80	0,69	4,38
3	70	1,10	4,25
4	64	1,39	4,16
5	59	1,61	4,08
6	56	1,79	4,03
7	56	1,95	4,03
8	51	2,08	3,93
9	49	2,20	3,89
10	47	2,30	3,85

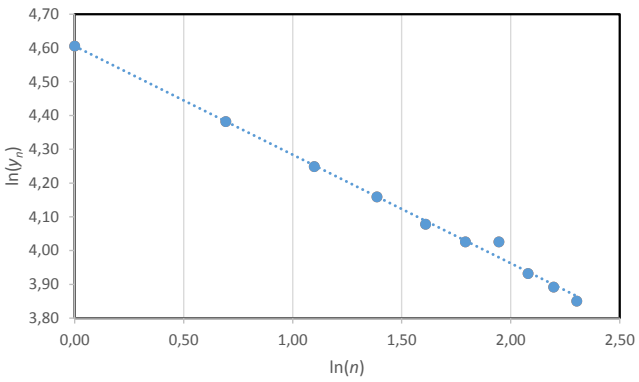

Fig.3. Graph of the line made with the natural log transformation

Simple linear regression for this example problem found that the intercept for the line is $\ln(y_1)$=4.605, which means that $y_1 = \exp(4.605) = 99.996$. The slope of the line is -0.321, which means that $b = 0.321$ and the learning rate is $k = 2^{-b} \approx 0.800 = 80\%$. The learning curve model for this example, therefore, is $y_n = 99.996n^{-0.321}$. If we know the learning rate parameter, we can compute the learning parameter using $b = -\ln(k) / \ln(2)$. For 80% learning curve, $k = 0.8$ and $b = 0.322$. Conversely, if we know the learning parameter (b), we can compute the learning rate parameter with $k = 2^{-b}$. The relation between exponent b and k, the percentage associated with the Learning curve is shown in Table 1.

Tab. 1. Relation between b and k

b	**0,000**	**0,074**	**0,152**	**0,234**	**0,322**	**0,415**	**0,515**	**0,621**
k	100%	95%	90%	85%	80%	75%	70%	65%
b	**0,737**	**0,862**	**1**	**1,322**	**1,737**	**2,322**	**3,322**	
k	60%	55%	50%	40%	30%	20%	10%	

2. CONCLUSION

This article shows how can be learning curve used not just for planning capacity, budget and establish proper goals, but also for hiring people. It is theoretical base on creating test kit for testing candidates for assembly line. With this testing kit we will be able to set up a standard for hiring employees for assembling.

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Performance, Metering, Management,corporation

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PERFORMANCE OF THE COMPANY

Abstract

This paper describes a well-known model of enterprise performance metering and management. The concepts of monitoring business performance, introduced and analyzed further, enables organizations to track not only financial aspects, but the depiction of management can also integrate Key Performance Indicators such as satisfaction of employees, suppliers, customers' profitability. The results of such measurements allow businesses to take decisions based on factual data.

1. INTRODUCTION

Every producer tries to find answers for the question how to obtain competitive advantages in a global environment. In recent decades the world market has been significantly globalised, the pressure of competition has grown significantly even on markets formerly developing in separation. Global competitors use various marketing tools to achieve the maximum market share, reduce the local producers´ impact and thus to control the market. [1]

1.1. Corporate performance

The main factor determining corporate competitiveness is its performance. The performance – generally stated – is the company´s ability to achieve required outputs and effects, if possible in measurable units [2] or its ability to achieve set goals, improve the value of input sources by its work, produce profit, improve the corporate value and at the same time to provide for future development. [3] The performance as a term – from the point of individual involved groups in a company and outside it – may be defined also as:

- Owners: ability to improve the value of input capital by means of dividends and/or growth of company´s market value
- Management: achieving profit, growth of market share, ability to win new customers, ability to respond quickly to the market environment changes
- Customers: offer and supplies of products meeting the required parameters of quality, price, deadlines, providing service in respect to other needs in addition to direct product

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supply, offer of development impulses linked to the product and service
- Suppliers: stabile financial flows for products supplies, increasing the orders volume, foreseeable business relations
- Employees: company´s stability and development, surety of future, wages growth

Terms such as efficiency and competitiveness are often linked to corporate performance. [3] The efficiency is the ratio between the final effect (output) and the sources used to create it (inputs).
Competitiveness may be defined as ability to achieve profit, extend the market share, whereas it is directly related to a company´s ability to offer adequate return per unit of sources used [4] A possibility to assess corporate performance is its value, whereas it is determined inter alia by its performance and its processes efficiency. [3]

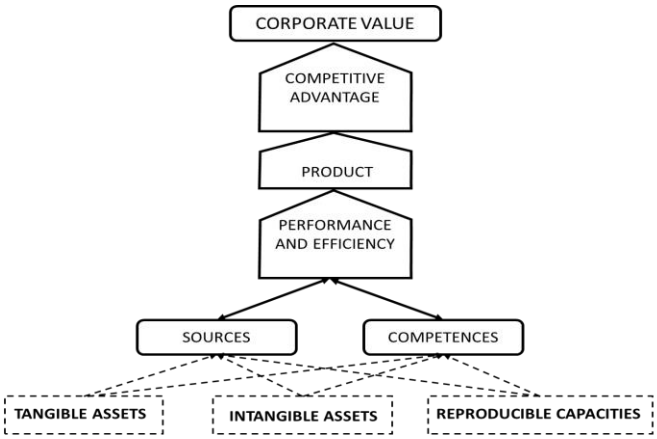

Fig.1: Competitive advantage and a corporate value creation

2. PERFORMANCE METERING AND MANAGEMENT

For the possibility to manage there is a general presumption that only what can be metered and assessed may be managed. It is obvious from the above stated that corporate performance is quite a wide term, which may be described by both financial and non-financial indicators. Financial indicators are traditional tools of evaluating corporate performance. These traditional financial performance indicators include mainly:

- evaluation of profit/loss by means of a profit and loss statement or a balance sheet
- cash flows evaluation
- indicators arising from the company´s financial statements:
  - activity indicators: period of stock turnover, period of receivables collection, period of liabilities maturity, overall turnover of assets
  - liquidity indicators: immediate liquidity, usual liquidity, total liquidity
  - indebtedness indicators: overall indebtedness, self-financing coefficient, credits
  - return: return on overall assets (ROA), return on equity (ROE), return on revenues, return on costs, return on investments (ROI)

- market value indicators: profit per share, revenue per dividend
- cost indicators: total costs, personal costs

The disadvantage of traditional financial indicators is especially the fact that they provide the view of the past and based on them it is not possible to speak sufficiently correctly about a company´s prospects. That is the reason why many companies gradually started to abandon the traditional accounting view of performance and ceased taking the accounting as the only basis for metering of performance and they see the finance as one of many indicators. [5]
At present, to meter corporate performance and processes in it monitoring of key performance indicators (KPI) that are interrelated and linked to the outputs monitored is also applied. The selection of suitable key indicators should be based on the so-called strategic map of processes, because the selection of proper KPI and their quantity are important for the successful use of them at corporate performance management. A very important fact is determining a clear methodology of calculation and determination of data sources to be followed at the indicators value determination.
To evaluate the future success of a company it is possible to use indicators for corporate performance metering from the point of value improvement for the stakeholders. The most popular include: EVA (economic value added), MVA (market value added), SVA (Shareholder value added), RONA (Return of net assets).
To meter and manage the corporate performance the models including inter alia the below listed are used in addition to the standard model of management based on financial indicators: CPM (Corporate Performance Management), BSC (Balanced Scorecard), MBO (Management by Objectives).

2.1 BSC - Balanced Scorecard

BCS provides a progressive vision and corporate strategy by means of an understandable set of metrics of both financial and non-financial performance. It is one of the most respected approaches at linking the corporate visions, strategic objectives up to operative planning and decision-making. BSC meters the corporate performance by means of four balanced areas:

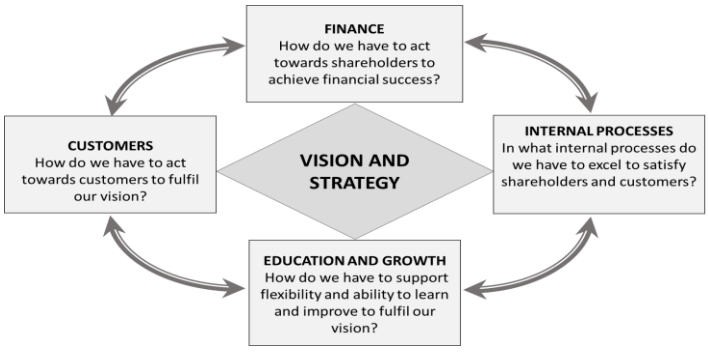

Fig. 3. Basic BSC diagram

According to the above diagram in BSC the vision and strategy must be reflected in all corporate areas. Based on responses to the questions in individual areas a company can formulate its appropriate strategy. If the strategy and vision change, it must again be reflected

in all areas. The arrows in the diagram also represent constant circulation of all areas balancing to avoid preferring any single of them. [6] BSC represents a strategic system of corporate performance metering.

3. CONCLUSION

Constantly changing conditions and competition growth result in growing pressure on corporate competitiveness increase, improving the efficiency for the ability to achieve profit at the company management. The management´s knowledge and ability to use modern methods at the corporate management at metering and managing the efficiency of processes and of company as a whole creates the basic space for successful development of the business entity thus improving its value for shareholders and creation of stabile environment for employees.

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Maintenance, Production scheduling, Dynamic simulation

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A CONCEPT OF INTEGRATION OF MAINTENANCE ACTIVITIES AND PRODUCTION SCHEDULING THROUGH DYNAMIC SIMULATION

Abstract

This paper describes integration of scheduling of maintenance activities into planning of production tasks at the operational level of decision making. The paper offers an account of maintenance tasks and starting points for maintenance planning by effectively using data collected through monitoring production machinery and equipment.

1. USE OF SIMULATION IN PLANNING MAINTENANCE

Maintenance planning is a process the outcome of which is a maintenance plan for a specific period of time. A successful managing plan for maintenance department counts on availability of a database of input or calculated data [1].

With operational planning, the aim is to set production and maintenance goals for the period of one to several weeks. In this kind of planning time frame a maintenance system takes into account partial features such as no-failure operation, continuity, maintenance and preparedness that are described by indices based on the study and description of random values [1].

To simplify calculations of reliability indices, we employ a mathematical model of simple alternating renewal processes for units to be repaired with non-zero time remaining to renewal. Input data fed into the selected mathematical model are collected from historical records of failures in the parts of equipment under our scrutiny. The input data will be updated over a one-month period. The reliability indices calculations will draw on:

- number of standard hours worked,
- time necessary to mend the failure,
- failure frequency.

These input data will be the basis for a simulation model, in which the processed data will be evaluated in the following manner [1]:

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Calculation of **probability of a non-failure operation** R (t_1,t_2) can be expressed as:

$$R(t_1,t_2) = \frac{n_s(t_1,t_2)}{n} \tag{1}$$

Where: $n_s(t_1,t_2)$ – is the number of machinery units operating in the moment t_1 over the interval (t_1, t_2), failure free.

Calculation of **an instant parameter of failure flow** z(t):

$$z(t) = \frac{n_F(t,t+\Delta t)}{n\Delta t} \tag{2}$$

Where: $n_F(t,t+\Delta t)$ is the number of failures observed over the interval $(t,t+\Delta t)$, while the time axis takes into account both, the periods of usable condition and the periods of non-usable condition.

Calculation of **mean time to failure** MTTF:

$$MTTF = \frac{total\ operation\ time}{k_o} \tag{3}$$

Where: total operation time is the aggregate operation time of all units n during a given period of time.
k_o is the total number of failures observed in course of operation during a given period of time.

Calculation of the **mean time to repair** MTTR:

$$MTTR = \frac{n_D(t)}{k_o} \tag{4}$$

Calculation of the **asymptotic readiness coefficient A**:

$$A = \frac{MTTF}{MTTF + MTTR} \tag{5}$$

Calculation of the **asymptotic non-readiness coefficient** U:

$$U = \frac{MTTR}{MTTF + MTTR} \tag{6}$$

The outcome of calculated indices (Fig.1.) will be a theoretical setting of the date of maintenance activities and the time frame of their duration in course of the observed simulation experiment.

.Models.Frame.TableFile

Production unit

	string 0	time 1	time 2	string 3	time 4	time 5	time 6	time 7	time 8	time 9	time 10	time 11
string	Production unit	Planned man-hours	Man-hours worked	Failure frequency	Failure, downtim	MTTF	MTTR	z(t)	F(t)	R(t)	A	U
1	Machining centre	122:16:00:00.0000	127:14:00:00.0000	80	5:10:00:00.0000	1:14:16:30.0000	1:37:30.0000	15:02:56.0000	1:00:00:00.0000	0.0000	23:01:21.0000	58:39.0000
2	Boring machine	184:00:00:00.0000	118:14:00:00.0000	80	4:14:00:00.0000	1:11:34:30.0000	1:22:30.0000	16:11:28.0000	1:00:00:00.0000	0.0000	23:06:25.0000	53:35.0000
3	Vertical miller	122:16:00:00.0000	121:05:00:00.0000	51	2:12:00:00.0000	2:09:02:21.0000	1:10:35.0000	10:05:54.0000	1:00:00:00.0000	0.0000	23:30:54.0000	29:06.0000
4	Grinder	184:00:00:00.0000	94:18:00:00.0000	32	1:06:00:00.0000	2:23:03:45.0000	56:15.0000	8:06:20.0000	1:00:00:00.0000	0.0000	23:41:15.0000	18:45.0000
5	Lathe	184:00:00:00.0000	83:19:00:00.0000	19	22:00:00.0000	4:09:50:32.0000	1:09:28.0000	5:26:31.0000	1:00:00:00.0000	0.0000	23:44:25.0000	15:35.0000
6												

Fig.1. Sample of calculated indices

Input data for dynamic simulation will be the processed historical records of observed failures, from which theoretical distributions of frequencies in individual units of the monitored equipment will be elaborated.

2. INTEGRATION OF MAINTENANCE ACTIVITIES AND OF THE PRODUCTION SCHEDULING

The aim of scheduling is to keep the production requirements and the available production capacities in balance. Dynamic allocation of production orders, effective use of resources and adherence to delivery dates will be applied to a simulation tool whose task is to plan for the existing, but also new production orders under the given condition, so as to ensure all the expectations are met. [2]
Thus created production tasks schedule should provide for detailed chronological alignment of production activities to be performed over a short interval of time at the particular production unit. Scheduling production operations strives to meet the following main goals: [3]

- Maximum use of production machinery,
- Minimum work-in-process,
- Minimum production lead times,
- Adherence to order deadlines.

Scheduling always happens within a particular time frame, which is going to be a single day in our case. This time frame is further subdivided into smaller time periods. A time period within our time frame is going to be an hour.
The already processed data on periodically performed maintenance activities will be the basis for creation of manufacturing activities schedule. Prior to creation of maintenance operations schedule and further subdivision of operations, these data will be entered into the records kept on individual machines. This should enable us to answer the question what would be the capacity used in individual time periods within the scheduling time frame at individual workplaces.

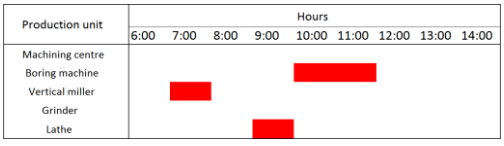

Fig.2. Projected maintenance activities within the scheduling time frame

Figure no.2 creates a preventive maintenance and shutdown schedule with particular dates allocated to particular work to be done at individual workplaces on machinery scheduled for maintenance. Subsequently, the operations are allocated to individual workplaces with time requests for alignment of individual workplaces and idle times. The alignment and / or periodic maintenance can be pre-defined.

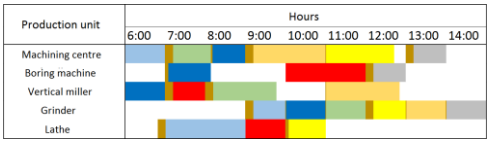

Fig.3. Example of production operations final schedule

A final schedule of production operations elaborated in this way will be the foundation for experimental simulation runs.

3. CONCLUSION

The use of simulation in processing maintenance activities and scheduling production operations offers advantages to decision making and planning. By calculating production units' reliability indices with application of the selected mathematical model, we gain perspective over the maximum admissible capacity of production units within the monitored time frame. In addition, it enables us to observe, deal with and evaluate interruptions. With allocation of production operations, we gain an oversight of operations performed on individual production units, production order deadlines, work-in-process and order lead time.

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Ergonomics at logistics, Manual handling, Exoskeleton

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EXOSKELETON WEARABLE ROBOT FOR EXTENSIONS A PHYSICAL ABILITIES OF THE WORKERS AT LOGISTICS

Abstract

With the expanding trend of mass production and automation is needed to move forward and improve the conditions for workers in terms of ergonomics. One of the major activities of the company is also the logistics. In all of the logistics activities is material handling one of the riskiest activities in terms of health injuries and diseases. Efficient and effective ergonomic solutions can reduce the strain of manual handling and increase muscle strength of humans.

1. INTRODUCTION TO THE ISSUES

Activities of logistic workers involves many physically demanding and various activities in connection with the manual handling of loads. Many workers in the industry companies suffer by back pain, difficulties with upper and lower limbsThe reason is that they have to spend a long time in the position, which is a non-physiological or they do excessive manual handling of loads. The biggest area of logistics activities is manual handling of loads. This also applies to piece production and prototype production. Where the construction and the shape of each product are so individual that is not possible to program the robot to handle with these various components. Humans and robots have limited possibilities for the operation. Cybernetics can increase and expand human capacities and reduce the risk of pressure overload in connection with excessive manual handling of loads. Solutions for reducing the number of occupational accidents and diseases in connection with the handling of a load can be, for example Exoskeleton. Ways as would be the cost connected with the financial compensation of WMSDs is many. One is for example use these solutions as a preventive action for mitigation of damage of the human health. [1, 2]

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2. DISORDERS OF HUMANS RELATED WITH MANUAL HANDLING OF LOADS

Despite the development of modern technology, extensive automation, mechanisation and workrelated interventions, many occupations still require manual material handling (MMH) activities such as pushing, pulling, lifting and carrying. [3]
Work related musculoskeletal disorders (WMSDs) are in the present very common at industrial companies. The most frequently problems associated with work related musculoskeletal disorders are spinal disorders or back injury. One-third of all health-related absences from work were due to WRMSDs, where back disorders having the highest prevalence (60 %), followed by disorders of the neck and upper extremities. [3]
The most common disorders of the spine are at intervertebral disc L4/ L5, an area of low back. This disease is connected with long-term or excessive load, heavy lifting, often bends or frequent rotation in the area of spine. Also are associated with non- physiological postures or whole-body vibration. Ergonomic aids are used in industry in order to reduce these risk factors. These aids can help to reduce physical strain and load of human at work. Some of these ergonomic aids are in the form of hand tools such as the ergonomically adapted screwdrivers or the device for support of spine. [4]

1.1. Influence factors on injury of human body by manual handling

The main risk factors associated with the occurrence of accidents that can be eliminated or completely removed by using exoskeleton during manual handling of loads are: [5]

- Non- physiological work posture (rotations, squat and others).
- Repetitive actions (far-reaching, lifting, carrying).
- High values of strain (carrying and lifting heavy loads).
- High pressures (grasp the load, lean on parts or areas, that are heavy or has sharp edges).
- Static work posture (holding a fixed working position for a long time).

Repeated and continuous exposure of workers to one or more of these factors could caused fatigue or discomfort to the worker. However, during a long time, can damage the spine, shoulders, hands, wrists and other parts of human body. [5, 6]

3. EXOSKELETON DECREASES PHYSICAL LOAD AND INCREASE A MUSCLE STRENGTH OF WORKERS

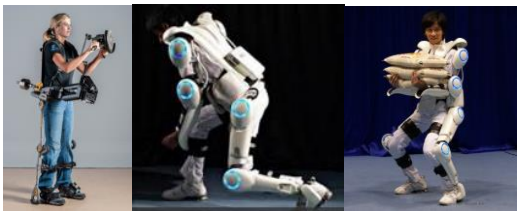
Based on results about damage of health due to excessive manual handling has been developed an exoskeleton as one of the ergonomic aids at the workplace. The exoskeleton is a wearable robot that is connected to a person and helps to humans in motion. Some of the exoskeleton are used in the rehabilitation of people after injuries for support their bodies in movements. Another exoskeletons like for example HAL 3 and HAL 5 were developed to increase muscle strength of workers in industrial companies.. The aim of second type of exoskeleton is assist and support workers in manual handling activities such as lifting and lowering in order to reduce an influence of physical load on the worker's bodyAlso reduce the forces imposed on the worker, in acting with excessive physical load. [5]

Normally used tools for assessment the load, respectively possible back injury during manual handling of loads are for example: Revised NIOSH analysis for assessment of lifting and lowering loads of human, SSP analysis for prediction of the static force during handling loads, S&C and KIM analysis for assessment of manual handling activities and analysis LBA for evaluate the load ofthe most important muscles in the spine and intervertebral disc L4 / L5.[6]

4. APPLICATION OF THE EXOSKELETON AT LOGISTICS

HAL 3 and 5 has several possible applications, such as medicine, social security, support for the hard work and much more. Construction of exoskeleton and connected tool and sensors are customizable based on user requirements for application area. In the context of logistics the exoskeleton can be used at: [6, 7]

- Loading and unloading of pallets.
- Manual handling of goods in warehouses.
- Providing informations from logistics to workers through display.
- Letting older and more experienced workers on more difficult positions.
- Reducing occupational accidents in relation to the hard work and associated costs.
- Increasing a productivity in the context of manual handling of loads.



Obr. 1 Exoskeleton of third generation HAL-3 (pic on the right side) and fifth generation HAL-5 (pic on the left side). [6]

HAL 5 – Hybrid Assistive Limb is a type of robot Cyborg that can complement, expand or improve physical abilities of humans in the following areas [6]:

- As a support to hold heavy equipment and components.
- Reducing injuries due to incorrect manual handling of loads.
- Helps to make work easier and improve productivity.

4.1. Reduce of the physical load by exoskeleton in connection with increase of psychical load of workers

In terms of reducing the physical load of workers where is exoskeleton situated directly on human is need to interested in load and strain of worker that will grow with using this solution. In the process of using this technical solution connected with the human musculoskeletal system will increase the psychological stress and psychical load of workers. This load is increased with influence of work and working conditions on cognitive (human motoric, perception, ability to decide) and emotional processes at humans. The workers may feel high demands on themselves in the context of ability to submit the required performance. The impact is commensurate with the ability of workers adaptation to the new conditions of work, and external factors such as the age of the worker.

5. CONCLUSION

In the future, advantages of exoskeletons will use especially in industrial and full robotic companies where will be workers load by physical load removed. Where won´t be possible to use industrial robots, due to various types of manipulations there is the human factor used only for a decision-making role. In terms of the social aspect exoskeleton also allow that we can keep employees at work in the activities associated with high level of load. From view of company increase productivity and in terms of employee health it helps to reduce damage of workers health, especially of the spine.

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Health Care Systems, Adaptive Internal Logistics, Laser Guided Vehicles

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ADAPTIVE LOGISTICS SYSTEM FOR HEALTHCARE FACILITIES

Abstract

This article discusses about the current problematic of the use of the Adaptive Logistics System in healthcare facilities. Currently, is the many advanced solutions used by leading manufacturers AGVs. However, when they are used in healthcare facilities, there is only a narrow use of this system and significant slowdown of the supply chain by uninstructed public. Impact of public must be more taken into account in hospital.

1. CURRENT STATE OF HEALTHCARE LOGISTICS SYSTEMS

An automated guided vehicle or AGV is mobile robot, automatically controlled transport device, which can move based on the interactions with brand or wire placed to the floor, or it used to track path by laser scan optical symbols. [1] These are devices which not require human guidance. Currently AGVs noted a significant rise, because they facilitate material handling. With their simplicity to use, they improve efficiency and reduce the cost of human operators in logistics.

1.1. Current direction of AGV transportation in hospitals

Currently many companies are dealing with usage of AGVs in medical facilities. The first full integration of AGVs in the hospital was realized in 2009. Since then passed to major advances. The hospitals have very high demands on safety, flexibility, adaptivity and almost need to have tapeless navigation.

Over the years, technology has become more sophisticated and today automated guided vehicles are mainly guided by laser, called LGV (Laser Guided Vehicle) [2]. In the automated process LGV are programmed that, so they communicate via a server located outside the vehicle with other robots and so form a unified agent system. Currently, full tapeless system in

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hospital, was implemented one year ago. The latest ongoing project is the integration of the AGV transportation in the Bispebjerg Hospital in Denmark.

1.2. Current solutions of AGVs in hospitals

Currently, the most sophisticated AGV solutions are based on the same equipment of vehicles: laser guidance, elevated platform and differential control. In Fig.1. are the top products crated by different manufacturers, which are integrated in the pilot projects.

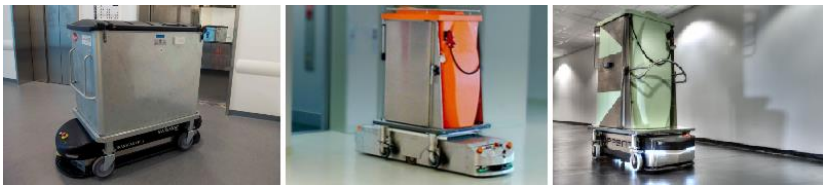

Fig.1. Top-line AGVs in hospitals

It may conclude that the LGVs are current trend. However reviewing the usage of LGVs in full operation, we come to a finding that the uninstructed public often blocks or slow down the supply system. Usability of the supply system should be also extended to other fields and domains.

2. ADAPTIVE HEALTHCARE LOGISTICS SYSTEM

The bases of the adaptive logistics system are the Smart Vehicles. It is not only AGVs communication with the RF Base Station, but also among them. That constitutes the agent system, which does not need AGVs Controller. In Fig.2. is principle of communication with usage of the Smart Vehicles.

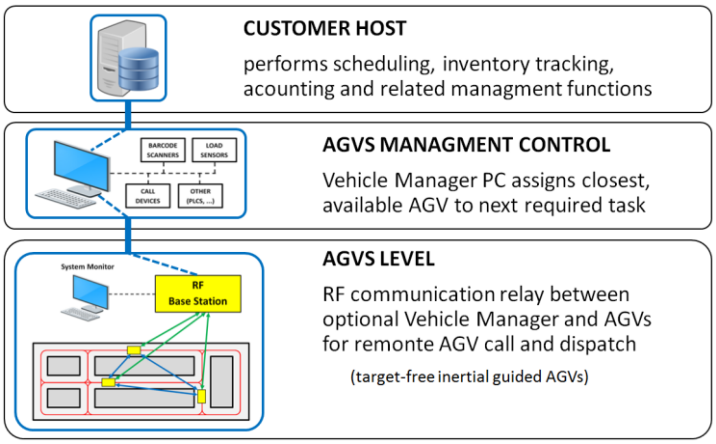

Fig.2. Adaptive logistics system based on Smart Vehicles [3]

2.1. Concept of AGVs Level

At the lowest level of the Adaptive Logistic System is the AGVs level. It is formed by RF Base Station, System Monitor, AGVs and other supporting equipment. In Fig.3. are shown and described new key parts of this level.

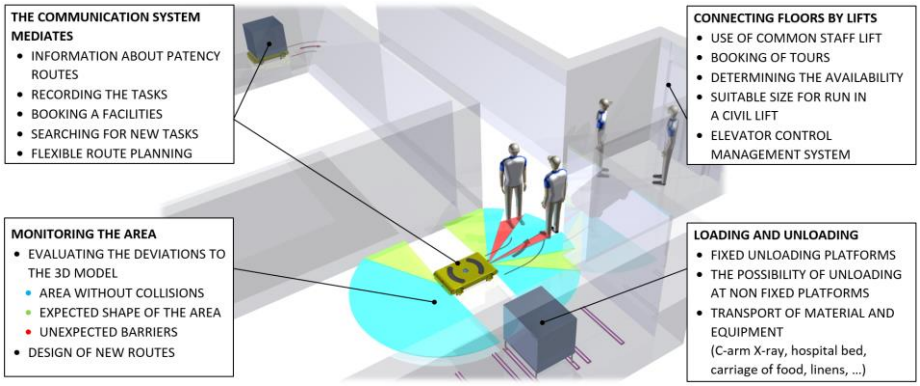

Fig.3. Key features of new AGVs Level

2.2. Concept of the New LGV for healthcare facilities

The main parts of the AGVs Level are LGVs as the Smart Vehicles. The possibilities of higher levels of the Logistics Management System are directly restricted by the possibilities of vehicle itself. Therefore they must be extended, so that vehicles could communicate with each other and so provide system data, for the gradual formation of knowledge and by using sophisticated technical equipment to increase the speed of delivery. In Fig.4. is a new concept of AGVs.

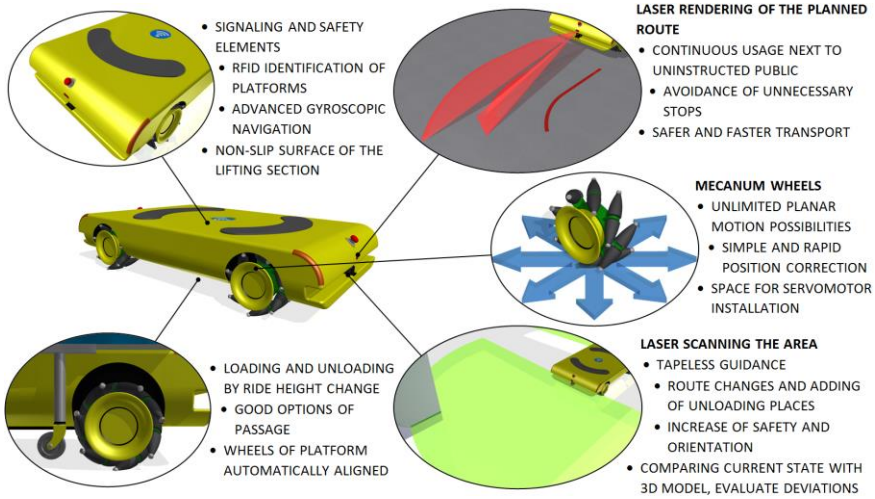

Fig.4. Concept of the New LGV

2.2. The principle of Laser Guiding

In the medical facilities are very successful tapeless (target free) guided LGVs. For accurate and safe navigation is used of a combination of modulated laser with gyroscope accurate positioning of LGV. Modulated laser beam provides greater range and accuracy than a pulsed laser beam. By emitting the modulated laser beam, system receives uninterrupted reflection as fast as a scanner shall supervise the spotlight. For example, the scanner LS9, which uses a modulated laser, achieves angular resolution of about 0.1 milliradians. In Fig.5. is the cluster of points captured during the LGV´s pilot driving compared with a reference 3D model.

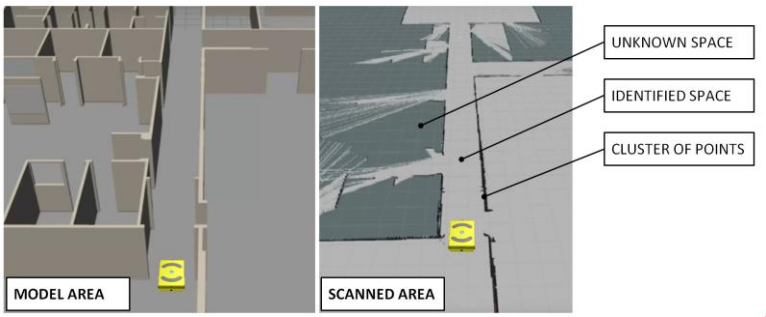

Fig.5. Comparison of LGV Laser Scan and 3D model of hospital [4]

Laser navigation serves not only to identify the location, but also for the orientation during evading obstacles, preventing collisions and in conjunction with the Agent Communication System can inform others LGVs about a possible blocked one of the corridors. However in long corridors without changed relief, it can come to the lost exact position of the vehicle. That was reason why this new concept is designed to support laser guiding by gyro guiding for determining the exact location. By the gyro guiding is possible to determine the change in the vehicle position with an accuracy of 2-3 cm. The precise positioning during loading or around barriers mediates laser scanner.

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Value-added, Continous improvement, Healthcare

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LEAN PROCESSES IMPLEMENTATION IN HEALTHCARE

Abstract

This paper deals with methodology of implementation Lean method which are knows from industry to non-industrial area. At first are described value added and non-value added activities especially in healthcare. In last chapter is new basic model of implementation methodology with competences of management and which methods of industrial engineering should be used.

1. WHAT IS LEAN HEALTHCARE?

Lean is a management system, predicated on the Toyota Production System, which is used to deliver world-class quality and customer service to patients, caregivers, and their surrounding communities. The Toyota Production System (yes, the same Toyota that makes personal transportation in the form of cars, trucks, and sport utility vehicles) is the comprehensive business approach and corresponding culture Toyota embraces toward continuous process improvement to deliver compelling value to their customers. The words Lean and the Toyota Production System (TPS) are used synonymously. [1] Technically, these two terms are not identical, but both words are recognized as being one in the same, so I will use the term Lean going forward. Before I describe what is meant by continuous improvement, it will be helpful to better understand a few essential Lean terms. After we understand these Lean concepts, we can more easily define Lean healthcare.

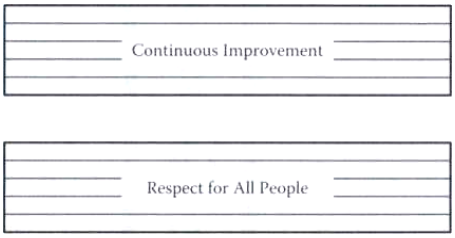

Fig.1 Themes of Lean improvement

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2. VALUE-ADDED

Lean improvement is based on two themes; Continuous Improvement (a different way to state elimination of waste), and Respect for All People (Fig. 1). To understand the first theme, continuous improvement, it is necessary to understand the value-added/nonvalue-added principle. Every activity that occurs in any organization falls into one of two categories; value-added or nonvalue-added. A value-added activity when producing a physical product is easy to grasp. Activities that change the form, fit, or function of the product would be considered value-added. Another definition of value-added activity is any action (either product or service related) for which a customer is willing to pay. An industrial example of value-added activity might include drilling, painting, heat treating, or assembly of a product. For a service, a value-added activity might include help desk services offered on the telephone. Within healthcare, a value-added activity is any activity that directly meets the needs of a customer. An example of healthcare value-add would be the action of a surgeon completing a surgery. The need to have a problem resolved through surgery is directly meet.

3. NONVALUE-ADDED

Nonvalue-added is by default, the opposite of value-added, or any activity that takes time, space, or resources, but does not change the form, fit, or function of the product. Another definition would be any activity taking time, space, or resources for which the customer is not willing to pay. Examples of nonvalue-added activity would include conveying a part from one machine to the next or counting inventory items to ensure accuracy of on-hand quantities. Within healthcare, an excellent example of nonvalue-added activity would be filling out insurance forms. No patient would "pay" to complete this activity. Filling out insurance paperwork doesn't directly meet a patient's need to receive assessment, diagnosis, and treatment for a medical condition. [2]

A third category of activities that organizations perform are activities required by law or by business obligations (accreditation or third-party certification). These might include following Occupational Safety and Health Act standards (OSHA), or ISO standards, or Generally Accepted Accounting Principles (GAAP). While it can be tempting to classify these differently, at the end of the day, many of these activities are usually nonvalue-added to the end customer. Changing the classification of the activity doesn't change the value-adding/ nonvalue-adding principle. In healthcare, the definition of value is slightly different. A value-added activity is any activity that directly meets the needs of the customer. In order to determine if a step is value-added, you need to be clear on two things: [1] Who is the customer and (2) what are their needs? Many times, in healthcare the dialog jumps from the customer being the patient and/or the caregiver to the customer being the provider or the administration, etc. It is helpful to remember value is always specified by the customer. And, there can be only one. One must determine who is creating the pull for the services needed in order to understand who the true, single customer is. So, if we are trying to figure who the customer is in a surgical procedure, we try to understand where the pull (need) for the service comes from. Because we would not need a surgical center, sterile processing, materials and supplies, equipment, surgical staff, a surgeon, a billing department, etc., without a patient needing surgery, the patient is the customer. In this surgical procedure, value will be specified by the patient, so value-added and nonvalue-added activity is from the eyes of the patient. The second decision we need to make is to define what the customer needs. Healthcare professionals often have expertise and knowledge that can be very helpful in determining customer needs. However, it is not

exclusively the role of the staff and provider to specify the customer's needs; nor is it the insurance company's role. [3]

With information available at a click of a mouse, many customers (patients) are quite capable of specifying their needs. As I tell healthcare professionals, when I work with highly skilled engineers designing new products, they are quick to articulate that the consumers do not know what they want/need. The engineers have to make those decisions for the consumers because they have the technical expertise. I think every consumer can determine the features and benefits he/she is looking for in a new product or service. It would be quite expensive, and impractical to drag an engineer around with us every time we shop for a product. As a consumer, we have no problem specifying value-added and nonvalue-added activity within our purchases. This same theory holds true with patients when they seek medical services. Even though you may be the healthcare "engineer," the patient is generally quite capable of determining his/her needs. Being an outdoor enthusiast, you fell while skiing a black diamond trail during a recent snow skiing trip, and your knee is hurting. The physician provides an examination and gives a diagnosis of an ACL (anterior cruciate ligament) injury. To further refine this diagnosis, he or she orders you to get a CT (computed tomography) scan. When one gets a CT scan, one will likely need to schedule the exam date and time, register with someone when on arrival, and complete some paperwork. While all of these activities are common during a typical CT exam experience, none of them will directly meet your needs.

So, the collection of all of the activities, as described, would be considered nonvalue-added activity. [4] To summarize, in order to determine the value-added activity, we need to identify the customer, specify his/her needs, and determine which activities directly meet those needs. The customer in this process is you, the patient needing the exam. Your "needs" include the examination and the corresponding results. The value- added activities would be the actual exam (which takes minutes) and the actual reading of the exam (which also takes minutes). But, what about the cleaning of the table, the preparing for the exam, the transcribing of the results, the charting of the activities, the sending of an invoice, etc. When we can understand both VA and NVA activity, we can start to look at the ratio between the two activities. A typical process is 95% NVA to 5% VA. World-class organizations understand this and take advantage of the insight this ratio provides (Fig. 2).

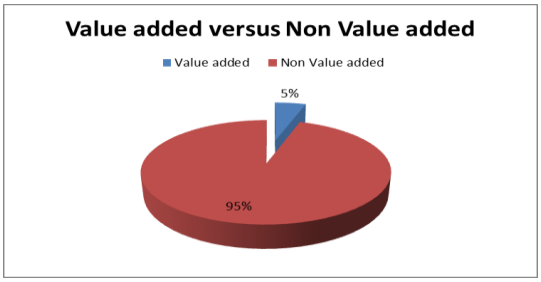

Fig.2. Value-added/nonvalue-added principle

Improvement using Lean fundamentals involves the identification and elimination of nonvalue-added activity. Another term for nonvalue-added activity is Waste. When 95% of the activity is nonvalue-added that leaves a lot of room for improvement. Focusing on nonvalue-added activity provides two benefits. First, the improvement potential is much larger. Would you

rather pay attention to the 95% opportunity or the 5% opportunity? This is why Lean organizations can and do routinely show 25 to 50+% improvements. They understand the value-added/nonvalued-added principle and they choose to play in the 95% space. Secondly, the cost of the improvement is significantly less. When we focus on eliminating nonvalue-added activity, we are in essence "stopping" some kind of work. How much does it cost to stop doing something? The definition of nonvalue-added activity is an activity taking time, space, and resources, but not directly meeting a patient's needs. So, if we eliminate nonvalue-added activity, then we free up time, space, and resources. These newfound resources can be used to add even more value to our customers.

4. THE LEAN IMPLEMENTATION MODEL

The implementation methods model describes the different approaches to Lean and compares them to Toyota (Fig. 3). This whole discussion is confusing as the word Kaizen appears in all four methods. In order to clarify, let's examine each method.

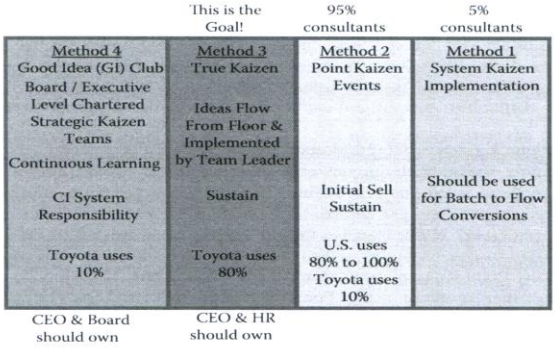

Fig.3.Lean implementation methodology

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EVALUATION OF SAFE OPERATION OF A SHOT PEENING MACHINE

Abstract

Work safety largely depends on the experience of operators and the technical conditions of machines and equipment they need to operate. The paper presents the outcome of a safety assessment conducted for a shot peening machine, based on a checklist designed by the authors.

1. INTRODUCTION

Work safety, which is one of key priorities in industrial enterprises, tends to be determined by such factors as the technical condition of a company's stock of machines. Understandably, every employer would like their machines to be well operated and, at the same time, to remain safe – in the broad meaning of this term - for operators who work on them. In case of new machines, safety issues are handled by manufacturers, which are obliged by the law to produce equipment which meets the basic requirements in this respect. When it comes to so-called old machines, however, i.e. the ones brought into the market before Poland's EU accession, the situation is different. Under a regulation which applies in that case, entities which keep such machines are responsible for adapting them to minimum safety requirements. Otherwise, they will no longer be allowed to use the machines. There are a number of companies which have failed to satisfy these requirements so far and continue to use their working tools in a way which is incompliant with the legal regulations. Likely reasons for that may include a company's poor financial standing as the adaptation of the machines which have been in use for a long time can be quite expensive.

2. MINIMUM SAFETY REQUIREMENTS

Under the regulation on minimum health and safety requirements related to machines used by employees in their work, the term 'machine' should be understood as any machines, technical equipment, tools and systems used at work. According to the regulations, the use of a machine is the performance of any activities connected with the machine, such as, in particular, starting and switching it off, handling, transporting, repairing, modernising, modifying, maintaining and operating [1]. The minimum requirements apply to control elements, the control system, starting

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of the machine, switching it off - as part of normal and emergency procedures protecting it against thrown-out items and gas emissions, fumes and dust and the stability of the machine. The regulation draws attention to protection against movable components, lighting at a workstation, protection against being affected by microclimate, safety signs and signals, and safe maintenance of machines. The requirements are presented in a fairly general way and do not provide any detailed guidelines; therefore, machine owners can choose and apply a solution they find appropriate [2]. Polish standards, which include specific examples, may be quite useful. The adaptation of a stock of machines to minimum safety requirements can be carried out in five steps:

1. Review of the existing machine status - type, model, production year, depreciation, quality, planned useful life, fitness for purpose;
2. General assessment – comparing the existing status with legal requirements, calculating estimated costs of necessary modifications, the time needed to adapt the machine;
3. Detailed assessment – thorough analysis of the machine, risk assessment, a plan of adaptation;
4. Performance – technical and organisational actions;
5. Supervision – evaluation of results. The employer should make sure that the machines are adapted to the work to be performed on them and pose as little risk as possible [3].

3. RESEARCH METHODOLOGY

In the absence of clear legal guidelines, it is not an easy task to establish whether minimum safety requirements are met or not. A tool which may be used to evaluate the safety of a machine is a checklist. Such a list was devised, for the needs of the paper, based on the Ordinance on Minimum Requirements related to Occupational Health and Safety for Operation of Machines by Employees, the Ordinance on General OHS Regulations, the Labour Code and the Polish standards. A well-composed checklist can be used to assess and review working conditions at a given workstation. The list contains 42 questions which cover 5 areas under survey: control elements, precautions, maintenance and repair, the workstation and employees. The questions deal with visibility, correct marking of control elements, emergency stop systems and machine covers. The questions also concern signs placed on the machine, protection against risk, cleanliness and good order at a workstation, availability of operation manuals, machine and vocational risks and personal protection equipment (PPE) for employees.

4. SAFETY ASSESSMENT FOR A SHOT PEENING MACHINE

4.1 Description of the analysed object

The analysis of operation safety involves the evaluation of equipment and technical condition of the shot peening machine, type GW 1500 – 415 (Fig. 1), as well as suggestions for corrective actions. The machine belongs to a process cycle and is designed for surface cleaning of metal items with a stream of shots. The machine is composed of a roll feeder, a working area and a roll picker. The roll system is a roller table which carries pieces to be worked. The working area is a shot blasting chamber, where a surface cleaning process is carried out. Flexible curtains separate the chamber, on the inlet and outlet sides, from the remaining part of the workstation.

Fig.1.A shot peening machine, type GW 1500 - 415

4.2 Results of the analysis

The examined machine has control elements, which are not marked correctly (buttons are marked with incorrect colours and the text is incomplete). The basic buttons, such as 'Start' and 'Stop' are difficult to identify. Due to the specific character of the shot blasting process, the operation is enclosed but the curtains at the inlet and at the outlet do not provide complete coverage. As a result, substantial amounts of dust and smoke are generated and spread onto the workstations which are in proximity. Danger zones are not marked. The size of the machine prevents an operator from spotting the presence of any other people within the danger zone. The operator, when standing at a control panel, is not able to see the end part of the machine. If the operator goes there, however, he or she cannot control or stop the machine. Another important issue is the absence of any system for placing and moving pieces on conveyor rollers. Workers have to step onto rollers or stand between them to do that. This happens before the process starts, as well as after shot blasting, even when the machine is still in motion.

5. SUGGESTED SOLUTIONS

The first thing to be done in order to adapt the shot peening machine to the minimum safety requirements is to make sure that the control elements and the danger zones are correctly marked. The control elements need to be located outside the danger zones, in a place where they can be easily identified. Specific elements need to be labelled with symbols and with the text in Polish - with the minimum height of characters of 30mm – to be placed on the control buttons or just above such buttons. The buttons should be colour-coded so that they are easy to differentiate. In compliance with the Polish standards, start buttons should be in green or white colours, while stop buttons should be in red or black. An emergency stop has to be in the red colour. As this button needs to stand out, it has to be placed on a yellow background. In addition, the curtains separating the working area have to be replaced in order to adapt the machine to the safety requirements. This will reduce the exposure to dust, smoke or shots, generated during the process, at this workstation and the adjacent ones. It will also improve visibility and, consequently, will result in safer conditions for the operator as well as any other people, who are now exposed to dust, despite being outside the working area of the shot peening machine. Such dust may pose a serious risk to workers' health. To make sure that permissible levels of harmful factors are not exceeded, it is recommended that examinations and environmental measurements should be conducted. Their results may help to choose additional technical measures, such as

machine housing or local exhausts, which are undoubtedly needed. In order to control the presence of any outsiders within the danger zone, installation of some mirrors may be considered. The safest solution, however, would be the installation of a control system to generate audio or visual signals before the machine is started. To prevent any future accidents during the operation of the shot peening machine, operators should be firmly and repeatedly encouraged to strictly comply with the rules for safe operation of the machine. A helpful solution would be installation of technical measures, such as a pressure-sensitive matt, a bar or tripwire. Such a device may guarantee that no worker is present within the danger zone. Pressure on the element would disconnect the power supply of the machine and the worker would be less exposed to the risk of an accident at his or her workplace. The factors which make the work at this workstation more difficult are a high noise level and inadequate lighting over the control panel as well as the entire workstation. Environmental measurements should be conducted and any required solutions should be provided.

6. CONCLUSION

The analysis has involved the examination of the shot peening machine. The results show that the machine, which was produced in the previous century, should be adapted to the current minimum safety requirements if it is to be used in compliance with the standards. A number of shortcomings, which may have an adverse impact on operators' safety, have been identified. Therefore, the shot peening machine requires a series of technical and organisational measures to be implemented. The employer should take any possible action they can afford to minimise the risks related to the machine operations and thus improve work safety.

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Lateralisation, Ergonomic engineering

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ERGONOMIC ENGINEERING FOR PEOPLE WITH LATERALISATION

Abstract

Ergonomic engineering ensures rational solutions for people with different physical and mental abilities as it has a set of tools for optimising human-technical facility system at its disposal. People with lateralisation are an increasingly higher percentage of the society and, at the same time, of employees, which is connected with specific problems. These are problems which can be easily solved with tools of ergonomic engineering.

1. INTRODUCTION

The effectiveness of ergonomic actions in the field of shaping quality for people with lateralisation results from the fact that ergonomic engineering has a set of efficient tools for adjusting technical facilities to psychophysical human abilities and allows for optimisation of any system operation: people - technical means. [1]

Developing proper conditions of functioning for people with lateralisation is important in various fields of society functioning and is connected with adjusting the infrastructure to the abilities of the people with lateralisation. About 8-15% of the population is left-handed or left-sided which means that the actions requiring high movement precision are performed with the left hand. Unfortunately, most of technical facilities, both those used for performance of the occupational tasks and those used for performance of tasks outside work, are not adjusted to be used by people with lateralisation. Ergonomic engineering can achieve a lot in this field.

2. LATERALISATION

The lateralisation process takes places in the movement development - as a result of which the advantage of one side of the body over the other is developed. It concerns only the even movement organs and organs of sense and its result is the preference to use a given hand, leg or ear. We can distinguish uniform and non-uniform lateralisation. This former can be divided into right- and left-sided. The right-sided is characteristic of a preference to use the right hand,

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leg, eye, ear. which shows the domination of the left brain hemisphere (neural ducts, transferring information to the brain and back cross - the left hemisphere directs the right side of the body, the right one - the left). This one occurs most frequently, therefore, it is considered to an ideal model. Left-sided lateralisation is characteristic of - analogically - the willingness to use "left" organs more often, which, in turn, is the sign of the right hemisphere dominance. [2]
Currently, the emphasis is put on recognising lateralisation in a child so that a proper education program can be implemented. In turn, adults are left on their own. The conducted research shows that among teenagers the number of the left-handed is ca. 15%, whereas, as the age increases, the number of the left-handed people decreases - there is a hypothesis that the left-handed die earlier due to, e.g. higher number of accidents affecting the people maladapted to the world of the right-handed people. Among adult people with left-sided lateralisation and people with cross-lateralisation there are more problems reported from the school period in the form of difficulties in writing and reading, including the change in the order of letters or mirror reflections of written letters caused by the disturbed visual-motor coordination.
These people also have problems connected with the spatial orientation which result in mistaking directions. [3]
Below, there is a few examples of technical facilities adjusted or projected for the right-handed [4]:

- mobile phones (microphones are usually placed at the edge closer to the source of sound for the person holding a phone in the right hand),
- computer keyboards (with a numeric keyboard on the right side).
- other computer indicating devices, e.g. mice and joysticks in the shape and layout of keys adjusted to the right hand,
- scissors with a grip (an opening for a thumb adjusted to the right hand), pencil sharpeners, rulers, compasses, drawing instruments,
- chairs with a pulpit folding on the right hand support, used in lecture rooms,

In addition to the above mentioned examples, a range of devices and machines which are visible adjusted to the right-handed people or - considering the control devices operated with both hands, to people with right-sided lateralisation.

2.1. The role of ergonomic engineering in overcoming problems of people with lateralisation

At the start, it should be noticed that ergonomics as a feature of a technical facility does not exist. We can speak of ergonomic quality of a specified facility only when there occurs an interaction system human - technical facility. Therefore, it can be proved that technical facilities have a "ergonomic potential" which allows to achieve ergonomic quality provided the other conditions are met, such as connected with organisation, surrounding or appropriate application of the solution. In order to ensure high ergonomic potential, it is necessary to overcome the barriers which can be identified as:

- organisational, connected with "identification" of the employees with the left-sided or cross lateralisation and deciding if this feature can influence the safety and ergonomics of performed tasks,
- material, connected with the design and performance costs of the construction changes at the selected work positions,
- social - unwillingness to create safe and ergonomic work conditions for an employee with lateralisation.

Actions enabling machine/device adjustment for an employee with lateralisation are presented in fig. 1.
In table 1 there are examples of actions from the scope of ergonomic engineering, aiming to eliminate the identified barriers.

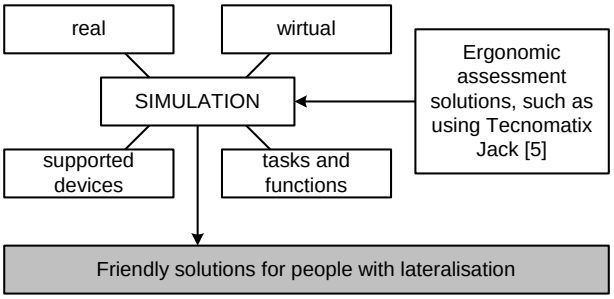

Fig.1 Actions to adjust a machine/device for people with lateralisation

Tab. 1 Examples of application of ergonomic engineering methods in eliminating barriers that concern employees with lateralisation

Barrier	Example of obstacle	Ergonomic engineering solution
Material	- position lighting is placed on the left side of an employee (lighting on the right side covers the work area of a right-handed employee); - a lot of force necessary to open a container (torsional force "to the right" not convenient for left-handed people); - tools anthropometrically adjusted to the right hand.	Application of UD (Universal Design) - universal design for solving problems of project antinomies
Organisational	"Identification" of employees with lateralisation	The development of an ergonomic test allowing to identify lateralisation;
	Threats connected with lateralisation	The development of a procedure allowing for identification of threats along with suggestions of preventive actions from the field of ergonomic engineering
Social	Lack of understanding the needs of people with lateralisation	Accompanying design allowing for better and better understanding of the needs of people with lateralisation

The examples listed in table 1 are few of barriers that can potentially occur during the adjustment of a work position to the needs of people with lateralisation.

1.2. Performed actions of ergonomic engineering for people with lateralisation

Until the 70's of the XX century, in bringing up children, there was a commonly used strategy obligatory teaching children to use the right hand. The results were miscellaneous, especially within the scope of loading a child with stress. But, this strategy also resulted in minimal percentage of the population which could not use the right hand at all. At present, this percentage of the population is significantly larger, but, unfortunately, there are not studies allowing to precise this number. Nevertheless, the percentage of the population with lateralisation became so important that many producers developed interest in potential clients. It refers to - most of all - learning children. There are already available school tools adjusted to the needs of left-handed children, e.g. workbooks with slant ruling (however, the prices of these goods are far more expensive than those for the right-handed). There are available some kitchen tools, e.g. slicer, ladles (two-sided), knives sharpened from the side for the left-handed. They are - one could say - first signs that the problem becomes visible, however, it will take long before it is completely solved. And one of the largest difficulties is (and will be) not the ergonomic engineering barrier, but the social barrier, as now left-handedness is placed in the questionnaire for children enrolling to school in the table "child's weaknesses".

3. CONCLUSION

Concluding, it should be stated that the application of ergonomic engineering is really important to achieve the environment with appropriately high functional and ergonomic quality. It may be stated without any doubts that ergonomic engineering is necessary in the modern development, not only in a strictly technical, but also in an organisation way. Facing arising changes in the lateralisation of the modern human population, it is necessary to apply ergonomic engineering in order to ensure safety, proper efficiency of production systems and employee satisfaction with work.

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Factory of the Future, Digital factory, In-Memory Computing Database

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INDUSTRY 4.0 AND THE DIGITAL FACTORY CONCEPT

Abstract

The FACTORY OF THE FUTURE is closely linked to the creation, and mass and sophisticated design, and operation of the cyber - physical manufacturing system. That is the basis of the INDUSTRY 4.0 concept. In the new manufacturing systems generation, one of the key components is going to be a new generation of the database platforms combined with the new generation of the communication systems.

1. INTRODUCTION

The process of finding the optimal alternative manufacturing system is one of the predominant objectives in the industrial production management, as well as in achieving the production success on the world's global markets. This requires timely and quality information such as summary of data purposely sorted. These objectives are being a subject of extensive research projects.

This issue is being elaborated on the European Union level since the Lisbon Strategy adoption in 2000. Technology platforms, that developed the *Factories of the Future - FoF* Programme, have been created. Subsequently, during the global economic crisis, the *European Economic Recovery Plan* (EIR MAGAZINE, 10, 2010) has been adopted, where the "Factories of the Future" Programme was one of the key programmes. This is also reflected in the EU Framework Programme for Research and Innovation - HORIZONT 2020, where within the scope of the *Leadership in Emerging Industrial Technologies* working line, the *Factories of the Future* sub-programme is one of the dominating.

National programmes for fulfilling these policies have been developed in different states. Systematically and purposefully, it is best developed in Germany as a national strategic initiative organized through a strategic platform. (Final report of the Industry 4.0 Working Group April 2013, (2013) *National Academy of Science and Engineering)* One of the key tasks is the implementation of solutions that are [1]known by the term "Digital Factory". Digital Factory is closely related to the study of new manufacturing systems generation.

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2. NEW GENERATION OF BUSINESS INFORMATION SYSTEM DATABASES

The SAP company has incorporated its innovative technology to the world's largest business network Ariba Network in May 2012. (http://www.ariba.com/) This network now covers almost one million companies, which is more than any other business network. This objective concerns in particular analytical tools, the level of support from SAP systems, and the SAP HANA platform. The Ariba Network serves to link suppliers and customers over the Internet. The current SAP offer will give the Ariba Network customers new ways of cooperation, helping them increase the productivity in sales, orders, invoicing and payment processes. The Ariba Network customers receive SAP tools for the area of social media, mobile technologies, cloud computing, and in-memory computing technology through the SAP HANA platform, and other technologies for business-to-business (B2B) relationships on a global scale.
By utilizing a new breakthrough SAP HANA database platform, there are coming solutions, that push the utilization capabilities technologically in a real time. The SAP HANA allows a real-time processing of large data volumes in the server memory, providing instant results for analytical and transactional applications. The SAP HANA solution is based on multi-core architecture with massive parallel extent, 64-bit architecture, 100 GB/s throughput, the row and column database, data compression (up to 70 %), table partitioning to the parts assigned to the CPU cores (partitioning), aggregation elimination and real-time replication based on the transfers of the data differences. These technological features combined in the SAP HANA can be divided into the hardware and software. Nowadays drastic hardware components cheapening results in a much greater availability of more powerful and capacity devices. The density of the number of transistors cluster in the processor core, and thus the processor performance as a basic computing power of the system is nearing the physical limits. Therefore, scientists are looking for other ways to carry out the future growth of a computing speed.

3. CONVENTIONAL AND MODERN PROCEDURES FOR DATA SELECTION AND DATA PROCESSING

Traditional transactional database products use the concept of row tables where the data is stored and interdependent through so-called sessions. Virtual table created this way is actually composed of relevant interrelated tables. This interrelation, called sessions, can take various forms. Let's imagine a table showing the invoices. A unique supplier number can be assigned to each invoice. This unique supplier number is in the second table, and alongside all the necessary information on the supplier is provided, such as contact person, plant addresses and the head office address. As a result, a link 1 to N is created where each entry in the supplier table has N entries in the invoicing documents table. By joining the tables, a virtual table is created, where all the columns of both of the tables are contained, provided the supplier identifier is equal. Thus, we can proceed further, and link other data. This minimizes the need for storage space, but longer time needed for the data search is a problem. The indexing procedure takes a place here, since there is no need to organize the data in tables. This process can be imagined in simplicity as defining the columns by which later retrieval is expected. These columns are created in the database as a copy of the active data from the linked tables, and they line up according to a defined key stating the original record addressing. Thus,

indexes are created in the database, therefore redundant data necessary to accelerate a search. Each time the data is written to the linked table, the database has to build up the indexes.
This affects the processing power, but also storage. Based on experience, the databases capacity is extended approximately by 30% thanks to indexing. Significant slowdown occurs when a user, by means of an application, requests search by criteria, for which no indexes are created. The linked tables connect virtually then, and a sequential data search begins - record by record. If there is a large number of entries in the tables, this process is extremely time consuming. In case it is necessary to analyse the database data by various combinations of search criteria, the indexing process is not optimal. This resulted in a possibility to use so-called columnar tables where the data is not written into lines, but into columns. Columnar databases were created for this purpose. They feature the ability to combine the row tables indexed for the needs of the transaction data with the columnar tables for the needs of the analysis and quick search without indexing. In case of request to search for a particular data by the search criteria, the search moves to the exact column, and the database provides a result.

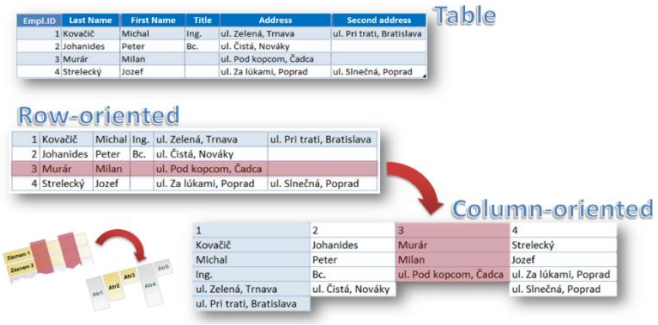

Fig.1. Principle of the row-oriented and the columnar database (Source: own processed)

This approach has two advantages, both fast search without a need to pre-define the possible criteria, and also the database size reduction by the size otherwise needed for the indexes. Generally, we can talk about reducing the database by 30 %, depending on the complexity of the search. By using a multi-core architecture with massive parallel extent and a high data throughput by means of 64-bit architectures, it is possible to carry out a real-time compression of the data in the database. This reduces the required database storage space. Actual experience shows that the database can be reduced by up to 70 % of its original size.
In case of a large quantity of data, when in terms of time, it is not possible to assess and process the data by traditional transactional databases, a clustering also called aggregation is used. Data aggregation is a method creating so-called aggregation tables out of the source tables that contain large data quantity. In these aggregation tables, a certain data is aggregated and re-calculated mathematically. For example, if we have the invoices table with individual days and suppliers, then the suppliers will be grouped by creating an aggregation table, and the overall invoices amount per month will be summed. This way we get a quick overview of billing by each supplier for each month. In case we are going to need the supplier overview by calendar weeks for the analysis purpose one-time, this aggregation table is irrelevant. If we assume that the user is also going to need such a view of the data, we have to create another aggregation table, precisely for this purpose.

This way the storage space grows again, but what is more significant, the actual creation of these auxiliary tables is usually time consuming with large data volumes. Therefore, this process is planned for non-productive working time. For example, the aggregation over the production data of the last day or month is created during the night. The output is available in the morning, it is quick, and it shows an accurate grouped view of the data, but does not reflect the production data of the current day or month. The SAP HANA solution, which uses the features to accelerate the data access, is able to access and group the large volume production data in a real time, and it can deliver the data output without a need to create any aggregation tables. This provides the user with the delivered data flexibility without the previous limits. It manages to group, analyse and process the data in such a detail extent you need in the actual time. The database system contains no unnecessary redundant data, and no overnight system run is required.

4. CONCLUSION

In the dynamically developing global competition of the industrial products, the important feature, which is still coming more to the forefront, is the speed at which the industrial plants can meet the demands, needs, wishes and possibilities of the customers in various structures. Not only the finished product delivery dates are being shortened, but also the speed of innovation is rising coupled with the speed of complex solutions of the necessary scientific tasks that are to be commercialized as soon as possible. These practical goals are still more associated with the revolutionary use of the information and communication technologies. The FACTORY OF THE FUTURE is closely linked to the creation, and mass and sophisticated design, and operation of the cyber - physical manufacturing system. That is the basis of the INDUSTRY 4.0 concept. In the new manufacturing systems generation, one of the key components is going to be a new generation of the database platforms combined with the new generation of the communication systems. Internet of Things linked to the In Memory Computing type databases will influence perfect functionality of the cyber - physical manufacturing system significantly. It is therefore necessary to process the model of the ADVANCED DIGITAL FACTORY CONCEPT, while it is still of a great interest not only for the theoretical solutions, but in particular for the practical solutions resulting in the competitiveness of the industrial plant on the global world markets.

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Humanoid robot, industrial robot, robot-human cooperation

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INTELLIGENT ROBOTS IN HOLONIC PRODUCTION

Abstract

This paper describes a new approach to robotics. The new trend in the field of robotics is human-robot cooperation. Manufacturers of robots as well as manufacturing plants are aware of that fact, hence it is expected to increase the robotics co-workers sale in the coming years. The article deals with the safety of humans and cooperating robots and consequently with application development using ROS (Robot Operating System).

1. STATE OF ART

Almost every company struggle to find a new way how to get flexibility in controlling of their own business, how to be competitive and finally how to get huge amount of the profits to be able to keep their business alive. One of that ways for the companies that are considered to be producers of running product lines producing some car parts, electrical appliances etc, is to get a high flexibility on the lowest factory level on the shop floor. If the companies reach the flexibility, reconfigurability on the lowest level in the company´s technology hierarchy, then they will be able to adapt to market and clients faster than usually.
University of Žilina and Central European Institute of Technology are developing Experimental intelligent manufacturing system called ZIMS (Zilina's Intelligent Manufacturing System) which is based on holonic approach. This paper deals with this experimental application and its concept as the lower layer of manufacturing system prepared for implementation of artificial intelligence methods. [6]

2. CONNECTION OF HOLONS (ROBOTS BASED ON ROS WITH PLC)

In the following section, the reader will be introduced to communication of ROS holons with autonomous machines based on PLC controller.

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Nowadays, the communication with the machines is very important. It is on daily routine to request machines to get relevant data. Then we can collect and process the data to increase the flexibility of the company. [2]
Very important is also the communication of machines to each other. They need to be in touch to satisfy their needs such is receiving the information about the other machines- their status, processes or sending the information to start the process of other machine and so on. Nowadays almost every of industrial machines is based on PLC (programmable logic controller). The actual trend in robotic world is to usage of robots based on ROS (robot operating system). Under the previous sentences we can declare, that generally we have to focus to make a research related to communication between ROS and PLC. The section is not explored, hence we suggest a new concept using the holonic theory. That way we are able to implement robotic co-bots to the company and thus create an intelligent factory of the future.

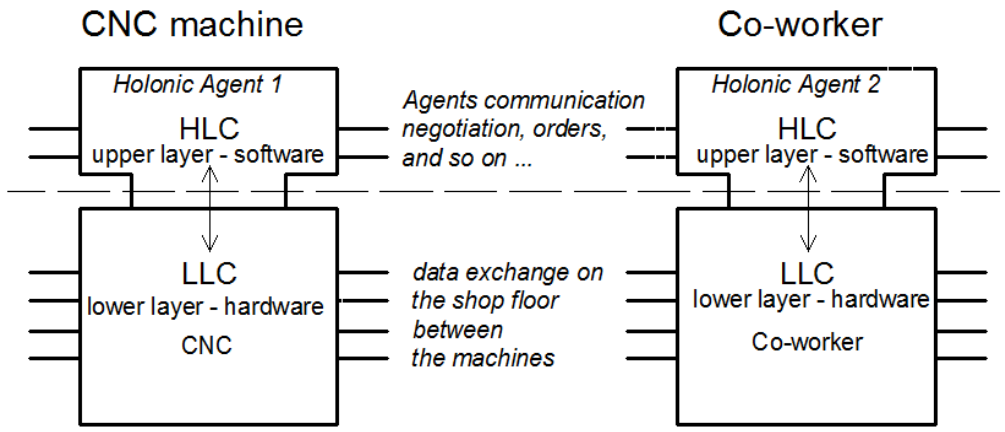

Fig.1. Holonic agents

On the figure 1. we can see our proposal of intelligent communication systems. There are two machines. The first (on the left side) is CNC machine and the second one is robotic co-worker. Each of the machines is composed of two layers. Upper (high) layer HLC and Lower layer LLC. The article does not deal with the high layer. In this article the HLC is just to compose to the reader our vision of holonic agents communication on the shop floor. Generally, the HLC is used to make an orders, negotiations and other important massages exchanged between the intelligent machines. Let us to present you an example: we have to AGV (autonomous guided vehicles). In the case of HLC, the holonic agents might be able to negotiate about: which one of the AGV is supposed to make an action? talk to each other about their statuses, the AGV might to make a reservation of wagons and so on. The situation on the LLC is absolutely different from HLC. The principle consist of data exchange between the two LLC layers of two intelligent machines. We can imagine data such is information about the actual position of motors, presence of the parts on conveyor, generally information from sensors and so on. [3, 4]
Following the previous ideas, we have made the research and experiment with the LLC communication of two technologies. PLC from Siemens (S7-1200) and Robot Baxter based on ROS. See the fig. 2. The communication is realized via the Modbus protocol.

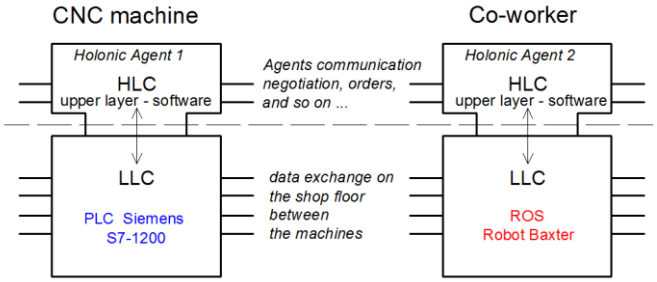

Fig.2. Holonic agents of CNC and Co-worker

On the following figure 3. we present the details of the communication written above on the fig 2. The results of the research is the data exchange so thus the technologies -robotic co-workers might be able to communicate with the intelligent holonic factory machines.

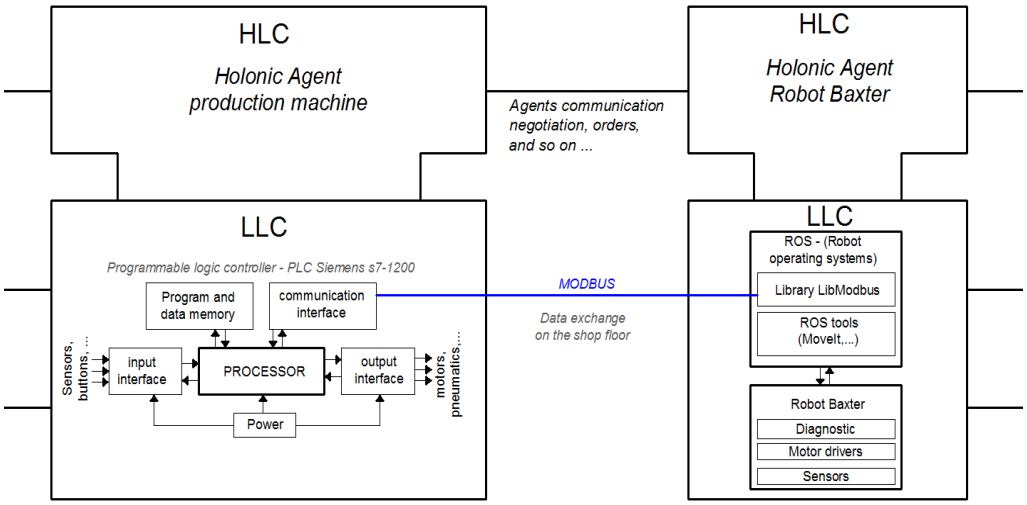

Fig.3. Communication of holonic agents on LLC

We define two possible ways of the communication channel creation:

1. Direct communication: In this method we can differ some alternatives. WIFI, optical cable, serial communication and others on the lower layer of "RM OSI" or "TCP/IP" models and communication standards such are ProfiNet, ProfiBus, CC-Link, IO-Link and others on the upper layer of the models. The channel is created directly via the mentioned possibilities. [5]
2. Using the OPC server: This method is based on another principle. We can see the following figure 4., on which we present the possibility of creation of communication channel between the LLC Holon´s layers via the OPC server (OLE for Process Control). The new specification was founded at the beginning of 2016. It is a new standard "AutomationML

for OPC UA". OPC UA is considered to be the technology supposed to create the communication channel and the AutomationML interprets the data to participants. [6]

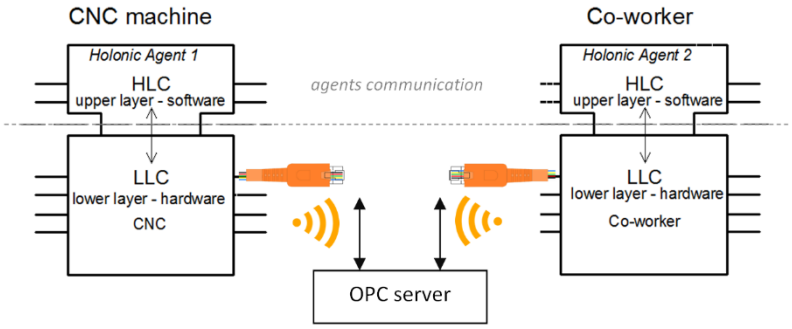

Fig.4. Communication of holonic agents via OPC server

4. CONCLUSION

The main goal of the article was to introduce to the reader a new approach of robotic workstation designing. Nowadays, the cooperation human-robot is very important, but such robot has to be able to cooperate with other machines on the shop floor. In the article, the holonic agents architecture was presented to satisfy the cooperation of robot-machine.

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Internal and external risk, Manufacturing business units (MBU), Risk factors, Specific risks, Global risks, Global conflict, Multipolar world, Supply chain, Industry 4.0, Effective business.

Anton ONDREJ*

CURRENT BUSINESS RISKS IN THE MANUFACTURING SUBSIDIARIES OF MULTINATIONAL COMPANIES

Abstract

The automobile industry, engineering and electrotechnical industries are dominant in economic and social development of the Slovak Republic. Manufacturing subsidiaries of multinational global industrial companies have a key role in these industries. Research of the impact of business risks on these manufacturing business units has an all-society significance, especially when the external environment is extremely turbulent.

1. Introduction

Slovakia is one of the most industrialized countries of the EU, the share of industry in GDP exceeds 20%. Key sectors are the automobile, engineering and electrotechnical industries but the steel industry is also important, although in EU it is facing the pressure of surplus production from China and is partially in recession. Export of the engineering and automobile industry generates (directly, indirectly and induced) together more than quarter of the whole production of Slovakia (26,2%), of which two thirds are of the automobile industry and nearly one third is of the engineering industry. More than half of the indirect effects on the production is generated in services. Every sixth job in Slovakia is generated by the export of engineering and automobile industry. Manufacturing subsidiaries of multinational automobile concerns operating in SR succeed in achieving noticeable above-average labor productivity measured by the share of value added by the employee. The significance of the industries also lies in interdependence with other sectors and indirect effects on the production and employment. [1]

2. External risks of the manufacturing business unit of multinational industrial company

Analysis of the internal and external risks of business units of multinational industrial companies (A. ONDREJ, 2015, p. 136 to 137) shows that external risks to the manufacturing

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business units (MBU) have their own specifics. Specific external risks to the MBU in other regions than their maternal region may have a different nature and intensity of impact than on the multinational industrial company in its entirety. They are affected mainly by three factors. First and most essential factor determining the specifics of external risks is different cultural, social and political environment of the region in which the manufacturing business unit operates. The second factor is behavior and way of management of the manufacturing business unit by the headquarters of the multinational industrial company in the particular region. This factor is a result of improper and inadequate reaction of the headquarters to cultural and social characteristics of the MBU region. As a result, there are frequently generated more new specific risks to the MBU with a serious impact on the whole multinational company. The third factor of the external risks to MBU are global external risks that impact multinational company as a whole and are transferred to MBU. It results from the structure of the external risks to manufacturing subsidiary of multinational industrial company that it is not possible to identify the risks based on global external risks but based on specific external risks of the manufacturing subsidiary and the risk originating from the way of management of the manufacturing business unit by the multinational company. These risks can affect the activity of MBU in long, medium and short term. Accordingly, it is possible to determine the tools and resources on how to respond to the risks incurred. Then it is a matter of strategic, tactical and operative measures. [2]

3. Redefining business success in a changing world

After the global economic and financial crisis of 2008, there is a review of existing approaches to the management of the global economy. At the annual meeting of the world-known politicians, financiers and senior executives, the World Economic Forum in Davos in January 2016, the Annual survey of global CEOs was introduced (http://www.pwc.com/ceosurvey, 2016). The survey was compiled by PwC advisory company. 1409 senior executives from 83 countries participated in the survey. Two-thirds of CEOs sees growing threats at present. It results from the answers that the uncertainty and risks are getting stronger. Chief executives have particular concerns about excessive regulation by the government and international organizations. The second biggest concern is the uncertainty resulting from the global conflict and social instability. The third most important risk is computer security. The survey shows that the external business environment is not only influenced by the economic agents, but geopolitical trends. This certifies that there is a more radical shift from global to multipolar world. In response to this development there will be a need to create more economic models, increase the regional activity of companies, monitor the divergent legislative systems and social structure of population in particular regions. Those are new challenges which were neglected due to unipolar world euphoria and superiority of economic power. It will take more consideration of all stakeholders in the business. Customers continue to be a priority, but in the second place, there are the regional governments and regulators, then the competition and at the end are other business partners. The objectives of the companies will move. It is not only about understanding of these external changes, but mainly about the transformation of companies to negate risks. These risks are also an opportunity. Those who will respond quickly and as efficiently as possible, will be successful also in the multipolar world. Therefore he research of the external risks of manufacturing multinational companies has new dimensions.

4. Characteristics of success rate of manufacturing companies in Slovakia

The biggest manufacturing companies located in the Slovak Republic are part of the structures of multinational companies. Their successful development depends on the proper degree of correlation of external influences and the chosen strategy of using available resources to achieve business goals. Relying exclusively on the global status of a company may cause the Slovak subject to lose competitive position to its subcompanies and cease to exist. But it is also important to monitor the global position of multinational companies – it is the interest of Slovakia that Slovak manufacturing subsidiaries that are part of global corporations will not be affected by flawed decisions of their headquarters and that all the interested groups in this case will act without unreasonable delay. Manufacturing companies in Slovakia achieve good operational parameters, especially in the area of process management, productivity and quality. At the same time these companies are facing the challenges of the relative lack of skilled workforce, high costs for the distribution of electricity and unstable environment.
For the successful development of the industry of the Slovak Republic it is important to master the global challenges in the context of the competitiveness of industry in the EU and the specifics of Slovak economy. Production of each manufacturing company that belongs to a multinational company and operates in Slovakia is measured by global standards. These standards are universal in parameters, such as productivity, quality or financial indicators. Global operating companies divide the world into regions while region can be perceived as a territory with uniform or similar market conditions. From this perspective, the EU is the region with market specifics that distinguish companies that operate here from businesses in Asia or America. The third level of specific conditions of functioning of manufactural companies is the national level (EU Member States). Its specifics are the source of competitive advantages, or represent a threat that the companies must face.

5. Framework of risk model of manufacturing company with foreign capital in Slovakia

The management of business risks in manufacturing companies, which are part of the multinational companies, is generally not sufficiently sophisticated and familiar to professionals. In doing so, these companies have a natural tendency to concentrate great part of available resources on the internal matters and processes, whereas their production systems are integrated in the system of dozens to hundreds of companies in the group. Only a small and usually sporadic attention is paid to the external environment, its challenges and threats. A combination of late detection of external threats with insufficient experience in averting them causes that the threats are overlooked until their risks grow to such an extent that it threatens the functioning of the company. Effective management of business risks is such that potential threats are recognized at an early stage and therefore there are no surprises and there is no need to shift attention to address the acute problems.

In the wake of a major change in the global economy, in the transition from the global economy to multipolar economy, it is appropriate to examine the identification of the intensity of external risks associated with these issues:

- the continued development of the monetary market, termination of the expansive monetary policy in the US and the EU and their impact on the operating model;
- risks from the global political dynamics, the response of the EU and SR;
- reaction to demographic changes, technological changes, relations to the stakeholders in the business;

- is the management model for flexible implementation of the strategy in practice and restrictions affecting the issue in fact elaborate enough?
- what is the innovation performance that satisfies the broader societal needs and creates the conditions for a long-term return on investment (ROI)?
- what are the prepared scenarios for these impacts at the headquarters level and national manufacturing subsidiary level?

These questions should be included in the methodological procedure for risk analysis using methods of strategic management. [3]

6. CONCLUSION

There has been a substantial change in looking on the management of large multinational companies after the year 2008. Multipolarity became a part of the economic world as well. It requires deeper assessment on how these changes will affect strategy for manufacturing subsidiaries from multinational corporations. Apparently the era of competitiveness based on the low costs will be significantly affected by the competitive ability of outputs in a wide range of its perception. How to respond in industrial engineering, particularly in the transfer of methods and techniques of industrial engineering in the new generation of advanced industrial relations called the Industry 4.0. It is related to the opportunities and threats that are risks with potentially destructive effects if revealed late.

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Adaptive Logistics System, Mobile Robotic Systems, Smart Connected Product

Jozef PATKA[*], Tomáš GREGOR[**], Milan GREGOR[***]

THE ARCHITECTURE OF SMART CONNECTED MOBILE ROBOTIC SYSTEMS

Abstract

The paper introduces the information about Mobile Robotic Systems (MRS) in the context of adaptive logistics systems (ALS). It explains the structure of a smart connected product and describes connectivity options for such a solution whereas illustrates this concept on the case of Mobile Robotics Systems of CEIT Company.

1. INTRODUCTION

The use of mobile robotic systems and automated logistics equipment becomes not only a matter of prestige, but also a necessity for the reliable functioning of the internal logistics in the challenging conditions of factories of the future. The standard structure of products, and the value creation for that matter, is being replaced by more sophisticated and viable approaches. Entities of the emergent systems must communicate with each other and based on this communication they have to make better informed decisions.
The forms and means of communication shall evolve progressively to the most sophisticated solutions. The development of information and communication technologies (ICT) allows the integration of various technologies into complex solutions, which is often referred to as the convergence of technologies. [4]

1.1 Forms of interconnectivity in the smart products

The interconnectivity used in CEIT MRS has multiple forms and its development is illustrated in Fig.1.
The first versions of CEIT MRS Connectivity were developed on the basis of direct connection of one individual MRS device to another device (communication, data collection) or to a control system (one-to-one communication). MRS was connected to other devices via a dedicated communication line.

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In 2009 the one-to-one connection was replaced by a new system, where all the devices were connected to one central logistics control system (one-to-many). Fig.1 demonstrates this method of connecting the devices and its obvious advantages (centralization, simplification of communication complexity and decision making).
In the first quarter of 2016 the development of a new connection system, in which each MRS device will be able to autonomously and directly communicate with other devices, was finished (many-to-many). This way of connectivity was allowed by the development of mobile virtual sensor networks. The "many-to-many" type of connection (Fig.1) fully meets the requirements of emergent logistic systems.

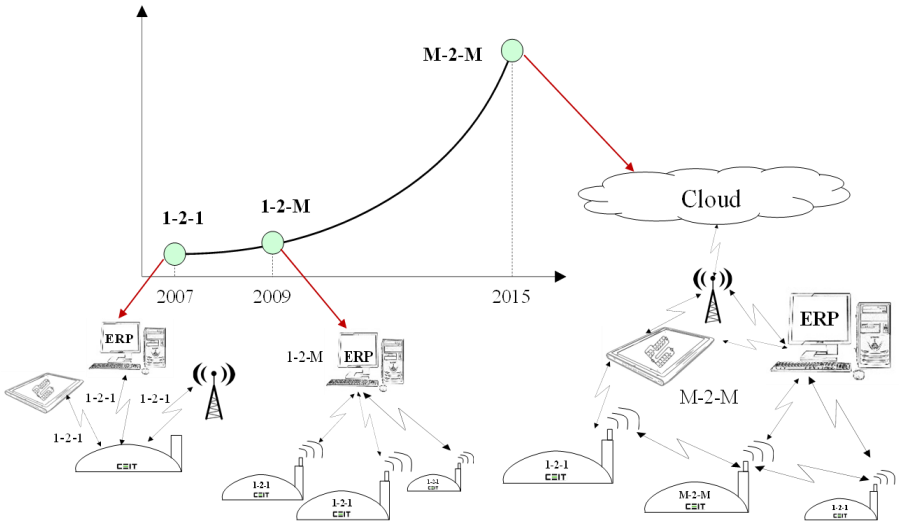

Fig.1. Development of various connectivity forms of CEIT smart MRS systems

In the first quarter of 2016 the development of a new connection system, in which each MRS device will be able to autonomously and directly communicate with other devices, was finished (many-to-many). This way of connectivity was allowed by the development of mobile virtual sensor networks. The "many-to-many" type of connection (Fig.1) fully meets the requirements of emergent logistic systems.
Thanks to the development of new smart connected solutions concepts, hybrid forms of interconnection, which integrate several basic ways of linking the smart products, are emerging (Fig.1). [1]

1.2 CEIT Technology Stack

The term CEIT Technology Stack (CEIT_TS) refers to a non-traditional way of organization and use of technology, which was made possible by new ICTs (cloud, IoT). Technology stack means combining individual technologies into an integrated unit that is available to the user as a technology package. Technology stack then represents such a way of organization and use of technology, in which the designer of the system continuously builds the system and makes it available to the customer. The customer on the other hand selects and uses all the appropriate technologies based on the actual demand. CEIT transforms its smart MRS into a smart

connected product, which requires a whole new technological infrastructure. The technological infrastructure consists of several layers (levels), which are known as CEIT_MRS_TS.
An example of such a three-layer structure is shown in Fig.2.

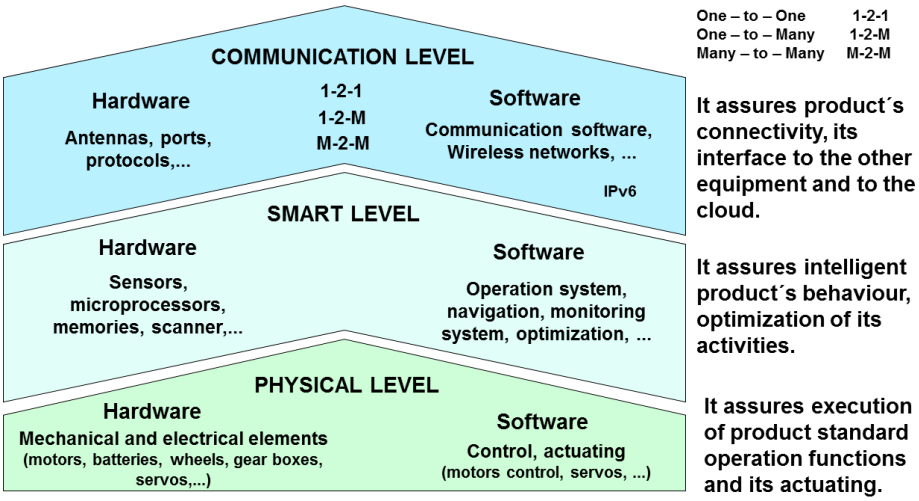

Fig.2. CEIT MRS TS structure

MRS becomes a smart connected product which communicates with its environment. CEIT_MRS_TS consists of hardware, software and its own operating system (as a part of the truck), communication system (today its radio communication) and so called product cloud (running on the clients' server or a public cloud). Product cloud (Fig.3) contains a product database, platform for creation of software applications, rules mechanism, platform for analyses and its own smart product applications. Product cloud isn't embedded in product itself, but it forms an independent part of the whole system. All the data is stored in cloud and the whole communication runs through the cloud. [3]

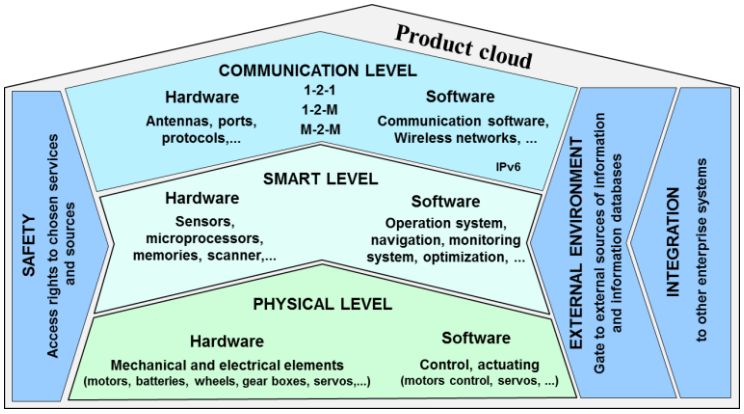

Fig.3. Product cloud

This new technology enables the formation of an environment that provides all the right conditions for a very swift implementation of innovations. Besides that, it allows to collect huge amounts of data about the product and its surroundings, which become a source for detailed analyses and optimizations of MRS operation as well as of the entire logistics system. The development of CEIT_TS requires significant investments and completely new knowledge and skills (systems engineering, AI, software engineering, sensor technology, big data, KBS, data analysis, security of ICT, etc.). Such capabilities and skills are rarely found in today's consumer industry. This makes room for new services that can be offered by CEIT to the industry, but it requires a change in the business model.
The new business model brings different business processes into CEIT, in which new value for the customer is formed mainly by access to useful data. This can be further processed, analysed and used for prediction. The gradual development brings higher-quality solutions, where the physical product provides the basic service (e.g. material supply), but most of the added value is generated through new functionality (software, maintenance, data, knowledge) which is usually offered as a service.

2. CONCLUSION

Mobile robotic systems are one of the most important subsystems of adaptive logistics systems. Their evolution is heading towards autonomous, intelligent solutions with agent control, interconnection via the internet of things (IoT) and cloud services.
The ever growing pressure of competitive environment calls for immediate reaction. It usually requires a change to the company's business model, which brings new forms of value creation for the customer and what is most important, enables drastic cost reduction and rapid growth of competitiveness of industrial enterprises. Fortunately, the prolific cooperation between CEIT Company, the University of Zilina, the Technical University of Kosice, and automobile industry results in the right solutions at the right time.

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Simulation, model, Emergency department, Length of stay, Improvement

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SIMULATION IN HEALTHCARE

Abstract

The article deals with simulation and its use in the health care sector. The authors describe the simulation as a tool of industrial engineering that is appropriate and useful even for complex medical processes. The second part of the article is devoted to a concrete example of application of simulation in increasing the efficiency of emergency departments.

1. INTRODUCTION

Computer simulation is one of the most used operating research tools that are currently available. It is one of several methods used for the assessment, improvement and optimization of many types of processes. Although the simulation had been used in health care for almost three decades, the last five to ten years we have witnessed a dramatic increase in its use. [4] In addition, also general availability of personal computers and significant improvements in the software commercialization indicates that simulation will continue in its way to become a widely used method, both for technical and less technical and medical analysts. Health care providers, for example, generally suffer from unacceptable waiting time in waiting rooms. And this problem could be solved by simulation.

1.1 Healthcare processes

Organizational complexity and the flow of patients of a modern health care system are enormous and extensive. The challenge of simulation model is to capture the complexity of the organizational flow in a systematic and manageable way. On one hand, simulation models should be the tool for process representation. On the other hand, they should also be a simple way of communication and understanding between the third parties and the sources of knowledge. [2] Limited access to primary care led to an extreme rise in the use of emergency departments worldwide. Overcrowding in emergency departments has been recognized by national health groups and regulatory authorities as a major public health problem. All this has led to a significant increase in the use of discrete event simulation and modeling of ED. The key indicator of the health services used by the emergency department is patient waiting time.

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[5] analyzed the impact of the "fast-track" to reduce queue waiting time of low acute patients. Patients are typically triaged according to their acuity, patients with low acuity are waiting excessively long time. Fast Track front is used to treat certain level of patient acuity (in this case, non-acute patients). They found out that fast-track stream that uses small amount of resources could lead to a significant reduction in patient waiting times. [3]

2. WHAT IS SIMULATION ?

Simulation is the imitation of actual running process in time. [6] By emulating logic and randomness of the process, such as the flow of patients through the various departments of medical facilities and random duration of each type of treatment, simulation is a valuable tool for the evaluation and comparison of the proposed changes to the process.

2.1 The simulation study

An important advantage of using simulation for modeling health care facility over other tools is the ability to model the complex patient flows and testing scenarios and "what if" changes in patient flow management [7]. The success or failure of simulation studies in the field of health care often depends on following the standard sequence of steps. [8] To make the model match the reality, we have to consider also the restrictions. The design of the final ED model is in most cases the same, with minor adaptations and modifications.

3. CASE STUDY - EMERGENCY DEPARTMENT

Analyzed emergency department is located at the University Hospital in Zilina and provides urgent medical care 24/7. Department has 3 rooms: internal medicine room, surgery room, trauma room. During one shift, there are 3 doctors, 3 nurses and 2-3 medical assistants on ED. Medical staff is working on two shifts (7: 00 a.m. - 3: 30 p.m., 3:30 p.m. - 7: 00 a.m.) during the weekdays and 24 hour shifts during the weekend.

The main problems:
- overcrowding, caused by non-urgent patients;
- long waiting times;
- high rate of LOS

Department is visited by approximately 19,400 patients per year. Patients are initially classified and triaged by the level of acuity by 1-5 ESI index (Emergency Severity Index).

Tab. 1. Composition and structure of patient arrivals

Type of patient	No. of patients in 2013	Mix	Priority
Non-urgent	6970	36	1
Urgent	9659	50	2
Acute	2814	14	3
Sum	19443	100	-

3.1 "Fast-Track" simulation

"Fast-track" implementation. With this improvement, it would be possible to find out (by quick set of tests) if a given patient need to be treated on ED. ED will be then able to recognize non-urgent patients. These patients would be send home or to another hospital department, so ED will not be overcrowded in such rates. (necessary: triage doctor / nurse).

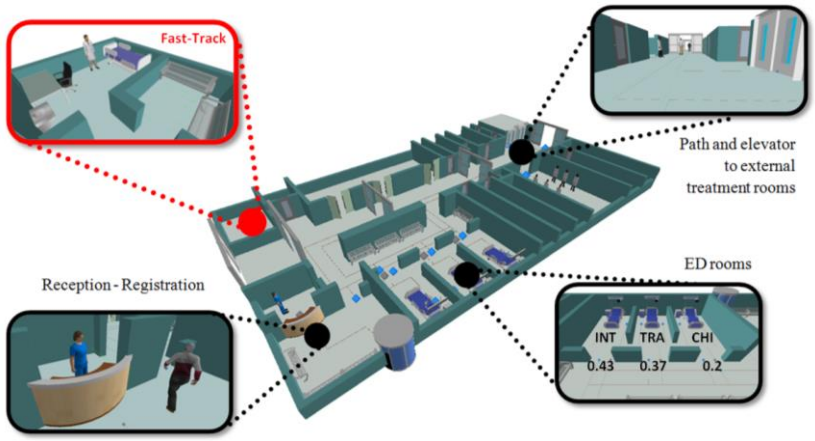

Fig.1. Simulation ED model with Fast-Track implementation

3.2 The results of simulation runs

We set the simulation length for 7 days (one week), and we were simulating the current state and "Fast-Track" implementation. After simulation runs we were able to obtain the results shown in Figure 2.

	Average LOS in ED (hrs.)	
Type of patient	**Current state**	**Fast-track**
Acute	12.04	2.33
Urgent	8.92	2.83
Non-urgent	1.64	2.26

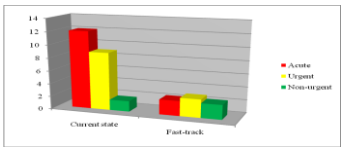

Fig.2. LOS values obtained from simulation runs

From simulated alternatives, we found out that overcrowding and length of stay (LOS) on ED is directly influenced by the number of "non-emergent" patients. The first performance indicator that we have observed was the average length of stay (LOS) of ED patients. From the results, we can see that the implementation of "fast-track" reduced the average LOS on ED. With this implementation we were able not only to reduce the average time that patients spent on ED but also to align these average LOS values of each patient type. We managed to stream out "non-emergency" patients from ED. These patients are then routed either home or to the first aid.

4. CONCLUSION

The key issue for the success of simulation studies of health care facilities is careful formulation of the problem and the involvement of all stakeholders In health care, any errors can lead to loss of life of patients. There is therefore not acceptable any space for errors in the design and application of medical simulation models. We created the simulation model with regard to legislative constraints oriented on norms and patient safety. Using simulation, we were able to verify that the implementation of fast-track will reduce the ED LOS and thus can correct the biggest problem tapering ED - overcrowding.

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High quality large-sized sand casting, AlSi7Mg alloy, Mechanical and electrical properties

Łukasz POLOCZEK[*], Andrzej KIEŁBUS[**]

THE INFLUENCE OF CONSTRUCTION FACTORS ON HIGH QUALITY DIE CAST ALUMINIUM ALLOY

Abstract

The production of light metal sand castings with repeatable high quality in an economic way, requires optimized casting process: casting defects have to be avoided, the formation of local microstructures have to be predicted and the mechanical properties have to be quantified in the as-cast state and after heat treatment.

1. INTRODUCTION

Casting is a complicated production process that involves many critical variables. Various aspects have to be considered simultaneously to obtain a high-quality product. Starting with design to production process, all steps and parameters need to be properly selected to minimize risks of occurrence of accidents and casting defects. To produce light metal sand castings with repeatable high quality in an economic way, it is necessary to optimize the casting process [2÷3]. The main steps of affecting the high quality of large-sized AlSi7Mg sand castings during the manufacturing process comprises: selection of chemical composition, proper selection of mold and core technology, preparation, melting and refining of molten alloy, carrying out finishing work and quality control of the finished product. The main aim of the research was to investigate relationships between the properties of sand cast specimens in form of tensile test specimens and specimens cut from commercial, large-sized casting for the high voltage switchgear housing.

2. RESEARCH MATERIAL AND METHODOLOGY

Material for the research consisted of AlSi7Mg aluminum casting alloy. The chemical composition of the alloy is shown in the Tab. 1. The alloy has been sand cast in form of tensile test specimens as well as commercial, large-sized casting for the high voltage switchgear housing (Fig. 1a).

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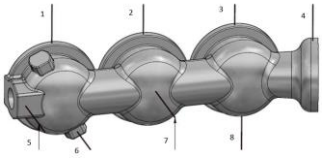
Tab. 1. Chemical composition of the AlSI7Mg alloy (wt. %).

	Si [%]	Fe [%]	Cu [%]	Mn [%]	Mg [%]	Zn [%]	Al
PN-EN1706 norm	6.5÷7.5	0.19	0.05	0.10	0.25÷0.45	0.07	rest
Specimen	6.40	0.14	0.002	0.004	0.27	0.008	rest

The investigations were conducted on the specimens in the as-cast condition and after the heat treatment. The heat treatment included solutioning at 535±5°C for 10h, followed by water cooling and ageing at 200±5°C for 24h, followed by the air cooling. Electrical conductivity of the alloy was measured with eddy-current tester Sigmatest 2.069 with the measuring range from 0.5 to 65 MS/m. 10 measurements were conducted on the each specimen. Regions of the investigations are shown in the Fig. 1b. Tensile testing has been conducted in agreement with the PN-EN 10602-1 + AC1 standard on the tesile testing machine Kappa50DS. Specimens cut from the casting had the diameter ø=6mm and base length l=30mm, while the specimens cast separately had the diameter ø=12mm and the base length l=68mm. The investigations were conducted on the heat treated specimens. Four samples were cut from the casting and 16 specimens were cast separately.

a)



b)

Fig.1. a) Scheme of the investigated casting; b) Regions of the electrical conductivity measurements.

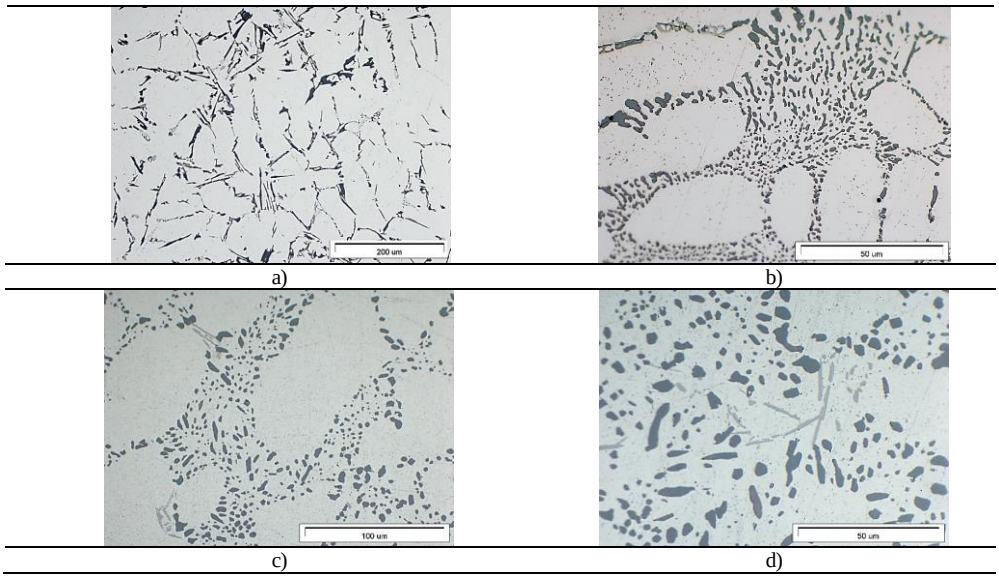
3. RESEARCH RESULTS

3.1. AlSi7Mg alloy's microstructure

The microstructure of the tensile test specimens cast separately was characterized by the finest α-Al dendrites and eutectic Si crystals (Fig. 2b). The specimens cut from the casting were characterized by a coarse dendritic structure and much larger Si crystals. Even in the regions near the cast iron chills, the α-Al dendrites and Si crystals were more coarse (Fig. 2c) than those, observed in the tensile test specimens. Application of the feeders and thick walls led to further increase in the size of the precipitates (Fig. 2d).

3.2. Electrical conductivity

Electrical conductivity of the specimens cut from the casting and cast separately are given in the table 2. It can be seen that the electrical conductivity of the AlSi7Mg alloy taken from the commercial alloy is quite homogenous in each investigated region. The mean electrical conductivity of the whole casting was equal about 28.76 ± 0.19 MS/m and was slightly higher than this, observed in the separately cast specimen (28.54 ± 0.14 MS/m)



a) b)

c) d)

Fig.2. AlSi7Mg alloy's microstructure, LM; a) As-cast condition; b) Microstructure of the specimen cast separately, heat treated; c) Specimen cut from the vicinity of the chill, heat treated; d) Specimen cut from the thick section.

Tab. 2 Electrical conductivity of the AlSi7Mg alloy.

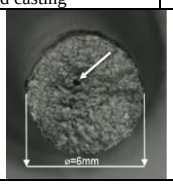
	Electrical conductivity [MS/m]
Specimens cut from the large-sized casting	28.76 ± 0,51
Tensile test specimen	28.54 ± 0.14

3.3. Mechanical properties

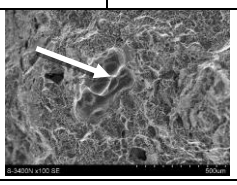
Mechanical properties of the AlSi7Mg alloy are given in the table 3. The properties achieved at the specimens cast separately are similar and are equal to: TS= 229 ± 1 MPa and YS= 193 ± 2 MPa. Mechanical properties of the investigated alloy achieved at the specimens cut from the large-sized casting are remarkably lower, while its plasticity is higher. This is probably due to much larger α-Al dendrites and smaller surface of the grain/dendrites boundaries. It has to be also mentioned that specimens cut from the different regions of the casting reveal significant differences in the mechanical properties. This is due to the presence of various casting defects, which are unavoidable in such complex sand castings. Fracture surface observations revealed some non-metallic inclusions (Fig. 3a, d) and quite large porosity in the one specimen (Fig. 3b, c). Such microstructural constituents acts like a structural notches, significantly lowering material's mechanical properties.

Tab. 3. Mechanical properties of the AlSi7Mg alloy.

	R_m [MPa]	$R_{0,2}$ [MPa]	A_5 [%]
Tensile test specimen	229 ± 1	193 ± 2	3,2 ± 0
Specimens cut from the large-sized casting	150 ± 31	107 ± 31	6.7 ± 2



a)



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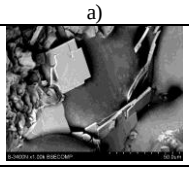

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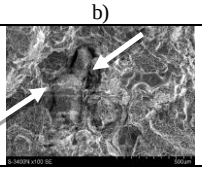

d)

Fig.3. Fracture surface in the specimens cut from the casting; a) Broken specimen with the marked non-meatllic inclusion; b) Porosity in the specimen cut from the top of the casting; c) Fe-containing phases and the shrinkage porosity; d) Non-metallic inclusion

4. CONCLUSION

Microstructure of the AlSi7Mg alloy is the finest in the separately cast tensile test specimens. This has led to the highest mechanical properties among all investigated specimens. Their tensile strength was equal about 229MPa, while yield strength was equal about 193 MPa. The alloy's microstructure in the commercial casting is more diversed. Depending on the wall thickness, application of various mold elements, the size of α-Al dendrites and eutectic Si is significantly different. This leads to diversified mechanical properties of the AlSi7Mg alloy in various regions of the casting. Apparently, presence of casting defects such as non-metallic inclusions and shrinkage and gas porosity leads may result in as low tensile strength as 107 MPa. It has to be also mentioned that electrical conductivity among the whole casting is similar, which could point, that electrical conductivity is rather more dependent on the condition of α-Al dendrites, and less dependent on the general microstructure.

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Lean manufacturing, Toyota Production System, Production improvement, Lean philosophy

Marek SMÓŁKA* Miroslav RAKYTA**

DESIGN AND PRODUCTION ACCORDING TO LEAN PRODUCTION PHILOSOPHIE

Abstract

Failures on transferring Japanese production techniques to European countries point out the need for a more in-depth comprehension of concepts and principles that support such techniques. In the construction industry, the abstraction and adaptation of those concepts and principles started in 1992 since this tie little further discussion has been made on other Japanese production models.

1. INTRODUCTION

Most of construction modernization efforts in the last decades have been made through industrialization and, more recently, through the rationalization of production processes.
In both approaches we can observe a great degree of influence from other industries, as they are usually viewed as more advanced, representing a stereotype where construction industry looks for skills, techniques and heuristic principles that can guide its modernization actions. Discussions that occur along this process are basically oriented towards the contextualization of those skills and techniques, without taking into consideration the principles and the philosophy that support that industrial model (Shingo 1988).
That conventional production model can be characterized by being strongly based on the industrial engineering theories proposed by Taylor, Gilbreth and Ford at the beginning of this century, when products and process were very simple, with most of industrial plants producing a single or very few products. Nowadays, the adoption of new and complex products and processes, as result of technology innovations and market changes, has been driving industrial firms in a more complex management environment. Besides cost and price, have become critical for companies' success. All of these changes tend to drive the "conventional" production model to a state of obsolescence, pointing out the need of a more in-depth comprehension of assumptions, paradigms and basic concepts that support this model.
Taichii Ohno and Shigeo Shingo, from the Toyota Motor Company, made an early effort in that direction. Their studies resulted not only in a "new production philosophy" proposition, but also in its successful implementation in the automobile industry context, which was named "Toyota Production System" (TPS). As a consequence, many trials were made by European companies in order to copy some elements or the entire TPS, most of them unsuccessfully.

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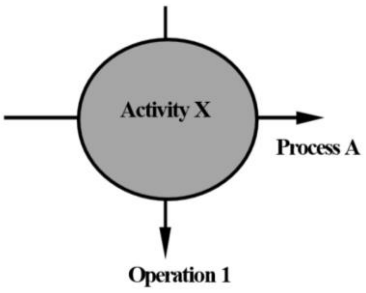
During observation of that process was pointed out the need for some kind of adaptation in order to improve effectiveness on implementation, such as the consideration of regional, cultural and industrial characteristics.

2. PRODUCTION AS A NETWORK OF PROCESSES AND OPERATIONS

This conventional view of production was strongly criticized by Shigeo Shingo, who considers that it is a fundamental mistake to consider processes and operations as having the same nature. Shingo (1988) proposes a completely different interpretation of production phenomena, considering them as composed by two orthogonal axes, each one with a different nature. According to such model, industrial and service production analysis must consider the distinct observation of the object of the work (raw material) and the subject of work (men and machines/equipment) along time and space.

The former determines the processes and the latter the operations. So "Production constitutes a network of processes and operations, phenomena that lie along intersecting axes. In improving production, process phenomena should be given top priority" (Shingo 1988). This, according to his point of view, processes and operations are two distinct ways to observe a single phenomenon. This can be illustrated by the following example, where items are processed with a machine (Shingo 1988): Here, processes and operations intersect. The change that occurs in the object as the machining procedure moves ahead is a process. The change occurring in the machine and in the worker doing the machining is an operation. In this sense, processes and operations are opposite sides of the same coin. However, when the task using this machine ends, the vertical flow separates from the horizontal flow in the following manner: (1) the material (object) flows to the next machine (subject), and (2) the machine (subject) receives the next item (object).



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¶ Fig.1. Activity as process and operation (based on Shingo 1988)

So, all production activities can be seen as composed by Operations (workers and machine flow in time and space) and processes (material flow in time and space), arranged as two orthogonal axes crossing along production, as shown in Figure 1.

3. PRODUCTION AS FLOW

As a starting point of the analysis of the new production philosophy, Koskela corroborates Shingo's point of view as he affirms that the conceptual basis to distinguish conventional and new production philosophies relies on the way that production processes are seen.
Thus, the new production philosophy sees the conversion model as incompatible with the complexity that characterizes contemporaneous productions systems, resulting in the need of a new production model, defined as follows (Koskela 1992):
•Production is a flow of material and/or information from raw material to the end product ... In this flow, the material is processed (converted), it is in specked, it is waiting or it is moving. These activities are inherently different. Processing represents the conversion aspect of production; inspecting, moving and waiting represent the flow aspect of production (Figure 2).
Flow processes can be characterized by time, cost and value. Value refers to the fulfillment of customer requirements. In most cases, only processing activities are value-adding activities. For material flows, processing activities are alterations of shape or substance, assembly and disassembly.
In essence, the new conceptualization implies a dual view of production: it consists of both conversions and flows.

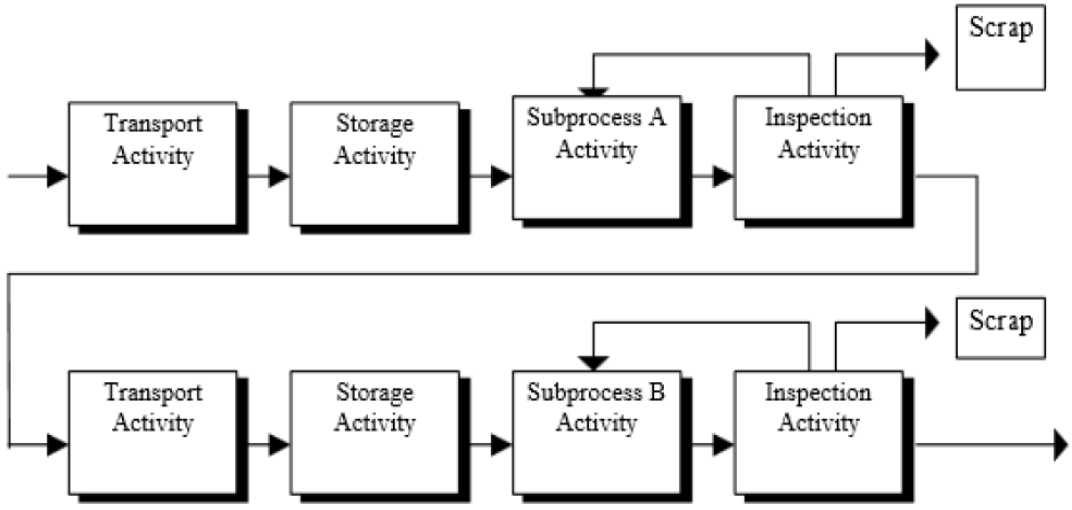

Fig.2. Production as flow (Koskela 1992)

4. CONCLUSION

The difference between the construction environment and the one that originated the Toyota Production System is usually considered to be a major constraint to applying the new production to construction. However, the application of new production philosophy does not imply and must not suppose either an integral or a partial copy of skills and methods from TPS without a critical consideration of structural and environmental factors of the industry. This study tried to point out some basic characteristics of the new production philosophy. Some fundamental concepts and principles were presented as identified by Shingo, Ohno, and

Koskela. Also, it was proposed a conceptual model aiming at representing the cause-and-effect nature of the link amongst market, product, process and operation, which enables a systemic understanding of the improvement-making process in production.
Without the discussion and consolidation of such concepts, there is the risk to make the same mistake made when the conventional production model was conceived: to ignore constraints and implicit paradigms that support the production system. In this respect, it is expected that this paper will contribute as another element of discussion to define a new understanding of the concept of waste in construction context according new production philosophy.

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Lean Logistics, Milkrun System, Pick-by-Voice, Pick-by-Vision

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LEAN LOGISTICS TRENDS

Abstract

It is a daily task of any logistics associate to ensure the required amount of material and products of the right quality are transported to desired destinations.Consumers demand an ever increasing range of products, therefore it is necessary to align the manufacturing system and logistics to suit the consumer needs. Handling and supply operations are becoming dominated by automated systems.

1. LEAN LOGISTICS

Lean logistics is a dimension of lean manufacturing based on the pull principle. Its task is to deliver the right material to the right place, in the right quantity and in the right manner. Lean logistics takes into account various items' structure requirements and also the material and information flow. This pull system is based on the material movement when the place of its deposition signals it is ready to accept the material. On the inside, the companies tend to use the milk run trend with small volumes of great quantity of items moving inside the plant in short, predefined times and allocated loading and unloading spots on the precisely outlined route.

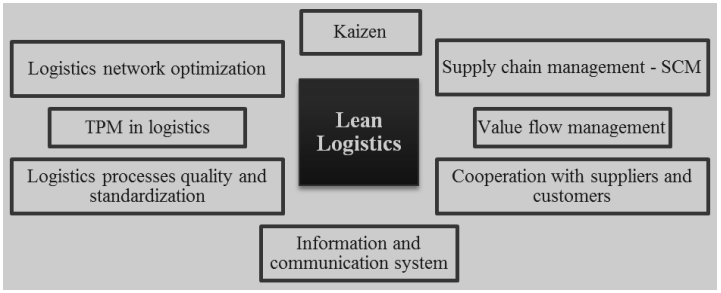

Fig.1. Lean Logistics

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1.1. Lean Logistics Principles

Application of lean methods in logistics makes the latter continuous, clear and translates into production efficiency. To achieve leaner logistics, the following basic methods need to be met:

- the milk run system,
- mixed load trolleys, elimination of cranes and forklift trucks,
- clear and simple routes, short-interval transport,
- transport of material according to its real necessity,
- logistics tact time aligned with production tact time,
- Value Stream Mapping for waste detection,
- pull system, internal kanban,
- elimination of waste in the entire logistics flow,
- Just in Time,
- visual management,
- material and information flow optimization,
- reduction of wide storage bins and bin and crate standardization.

2. SYSTEM MILKRUN

Milkrun periodically feeds the production lines with material in accordance with a predefined schedule. Thanks to kanban cards, the necessary amount of parts is supplied to the right place while empty boxes are removed. Therefore, the material volume in the workshop is reduced and so is its storage space. Material handlers have an exact route map available, with relevant stops. [4]
The following features are characteristic of each milk run round:

- route,
- number of drives,
- schedule of drives,
- tasks at individual stops.

On planned rounds, supply milk run collects components from various suppliers. Thus, empty boxes are returned and items are loaded so that they gradually fill the boxes up. Unlike in a more traditional transport system, there might be greater mileage driven under this new one, nevertheless, it still more effective in the end. [4]

Fig.2. Milkrun

2.1. Ergonomic Preparation

Last, but not least, job performed in the warehouse is material preparation. The warehouses need new range of preparation trolleys that are ergonomic, efficient and safe. Their load varies from 1 to 1.2 tons and their preparation reach spans up to 12 m in elevation. Especially useful is the safety assistant function with RFID and bar code readers. Since preparation works account for majority of operators' time, developers focus their attention on driver comfort. The effort to make the work easier and more efficient has translated into long cabins, operator feet support fitted to the sides of the cabin floor and a safety switch located on the antivibration pad in the centre of the cabin. Newly introduced are tilting side guards with a 15º incline upon the operator's leaning against them, enabling greater reach in the rack. [2]
Ergonomy and comfort are enhanced by low rise cabin entry, very low position of the steering and the driver has a very good view of his surroundings thanks to a panoramic lifting equipment. Driver's seat is suspended, adjustable and tiltable with a heating option and a heated lumbar back area. [1]

2.2. Pick-by-voice Technology

This collection technology has many advantages. Pick-by-Voice enables the operator to fully concentrate on his main task: preparation. Communication takes place via verbal instructions spoken through headphones into a microphone rather than through auxiliary visual lists or displays. Moreover, this concept eliminates awkward data entries and time consuming scanning of the sought material storage location. [5]
Pick-by-voice is a system with the operator using a headset and a portable belt with the device mounted onto it. Instructions are given step by step, just-in-time, by voice. This technology increases productivity, decreases the incidence of errors and offers greater work load transparency. [3]

2.3. Pick-by-vision Technology

Pick-by-vision is a system based on appliction of elements of expanded reality. The operator has a head display in the form of glasses that enable him to see the reality, but with projected information on which palette needs to be approached and how many pieces taken therefrom. Integrated navigation system enables the operator to navigate through stock without any difficulties. Route optimization minimizes the length driven. Visual imaging of the information about the order and the source and target location guarantees 100%, error-free preparation. All selected spots and target crates can be easily checked visually, which improves inventory management and continuous quality control. Batch and / or series numbers can be recorded without the operator's need of additional work steps. [3]

Fig.3. Pick-by-voice and Pick-by-vision

3. CONCLUSION

Success of implementation of lean logistics depends on the plant's management and on the degree of understanding of the concept by its associates. Lean logistics does not only mean inventory elimination, it also means better organization of logistics activities – physical handling of material and obtaining data for its management. Implementation of lean logistics principles is linked to application of automatic indentification technology and mobile communication and functionality enhancement of the plant's information system. It is often the case the productivity is defined as internal material shuffling inclusive. That only amplifies internal losses and does not serve as motivation for making the processes leaner.

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Quality, Die casting, Pareto analysis

Mariusz SZNAJDER*

PARETO ANALYSIS IN QUALITY ASSESMENT PROCESS

Abstract

This article presents quality procedures used in high pressure die casting. Quality assurance process begins with study a chemical composition of the alloy and ends with visual assessment of finished product. Pareto analysis was used to analyze data and define the most significant problems in analyzed foundry process. The resulting chart allows for accurate analysis of selected issues. In the next step corrective actions to improve the current situation were proposed.

1. INTRODUCTION

Quality assessment is going to be more complex process due to the increasing requirement of industry. Multi-stage process is designed to detect errors as early as possible. Despite the fact that the complex quality control requires more financial and time associated with additional measurements, early error detection allows to make savings and apply immediate correction. High pressure die casting is characterized by mass series production [1], because of the high cost of the initial investment. Therefore eliminating scrap and control at each stage are essential for the competitiveness of the company.

2. QUALITY PROCEDURES

In order to minimize amount of defective castings, multi-stage quality process is used. The first element is to check the raw material before melting. For this purpose recycled scrap, ingots and liquid metal delivered to the foundry has to be checked. Control is mainly based on inspection of the chemical composition of the alloy. After alloy check, it is melted in a furnace. Proportions of batch are strictly fixed and must be maintained in order to obtain sufficient purity and composition of the metal. Then it is poured into the ladle and mixed to decrease its density. Aluminum very well combines with oxygen in the air [2], so density of the alloy decreases significantly in melting and pouring process. At this stage chemical composition is checked again. Additionally temperature has to be controlled to avoid solidifying process. The next step is transporting molten metal into furnace localized directly in a foundry station. Once again chemical composition and alloy temperature is controlled. It is very important to achieve proper casting parameters. Inappropriate chemical composition does not allow to obtain

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suitable properties of produced castings [3] and because of wrong temperature the liquid alloy does not properly fill the form and solidifies to early or to late.
After preparing the liquid metal, casting process is carried out. It is important to control parameters such as speed of the piston, the amount of aluminum injected, the duration of each phase. Surface quality and inner structure can be influenced also by controlling the speed of creating a vacuum in the mold. Each of aforementioned parameters depends on the size and shape of the casting or even individual machine specification. Casting texture is mainly dependent on a method and speed of filling the mold, changes in the solubility and release of the gas phase during solidification of the alloy, the volumetric shrinkage of the casting mass in a cooling process. After casting process and cast extraction from the mold, another control process is taking place. There is a need to verify location and seize of runners and gating system, because their lack or inappropriate dimension may indicate errors in casting process parameters or inaccurate mold filling. This process is usually automated. The robot arm extract cast from the mold and transfers it to measuring station. In the next step gating system and runners are trimmed. Then operator visually asses the casting. The geometry of the casting can be checked on the CMM or other measuring methods. The internal structure is checked by X-ray radiation. X-ray requires from the operator a lot of practice and experience to be able to predict which areas are expected to accumulate air bubbles. At the finishing process once again visual inspection is made. Additionally dimension and location of holes for the further processing is checked by gauge. The process of evaluating the casting production quality is complex end requires continuous monitoring and improving of the process. For economic reasons, not full control is carried out for each casting. For example, it would not be possible to check the accuracy of the geometry of each cast. It is also unnecessary because of good repeatability of the high pressure die casting technology.

3. DATA ANALYSIS

In this chapter, data analysis from the high pressure die casting process was made. For analysis, the Pareto diagram was used. This method is based on the 20/80 rule [4]. This dependence is noticeable in many economic or production processes. Application of the method in evaluating the die casting process quality allows to define the biggest problems encountered in production. This allows to decide which actions should be taken to significant reduction of number of produced defects.

3.1. Results presentation

In the [Fig.1] the data quality problems are shown. It can be seen that the biggest problem is production of warm-up castings. They are produced in order to prepare and warm up the cold mold to desired operating temperature. Production with cold mold causes many defects as misruns or gas porosity. Therefore castings produced on the cold mold are automatically defined as a scrap. For presented reference it can be seen typical Pareto chart. It can be noted that first three primary factors are generating over 80% of defects. The first and the most significant problem are warm-up castings. At the second place are mechanical damages. Some of the casting surfaces are machined in a further process, so little failure might be acceptable. However, deep scratch or aesthetic defect causes that casting is rejected. Mechanical damages can occur during the collision with other casting or during control process which is made by operator. Visual verification requires rotation of casting to properly asses surfaces from each site. Such “throwing” of product may cause its damage. Another element generating

mechanical issue is internal transportation system. It takes place in steel baskets, without spacers between castings. During relocation, castings hit each other or steel basket causing damage. Misruns may indicate abnormal flooding pressure, inappropriate piston speed or a failure in a venting system. In the presented data, the defect associated with misruns is at the third place. There must be considered validity of resolving this problem, because changes in the technological process and experimenting with alternative solutions may bring more losses than profits.

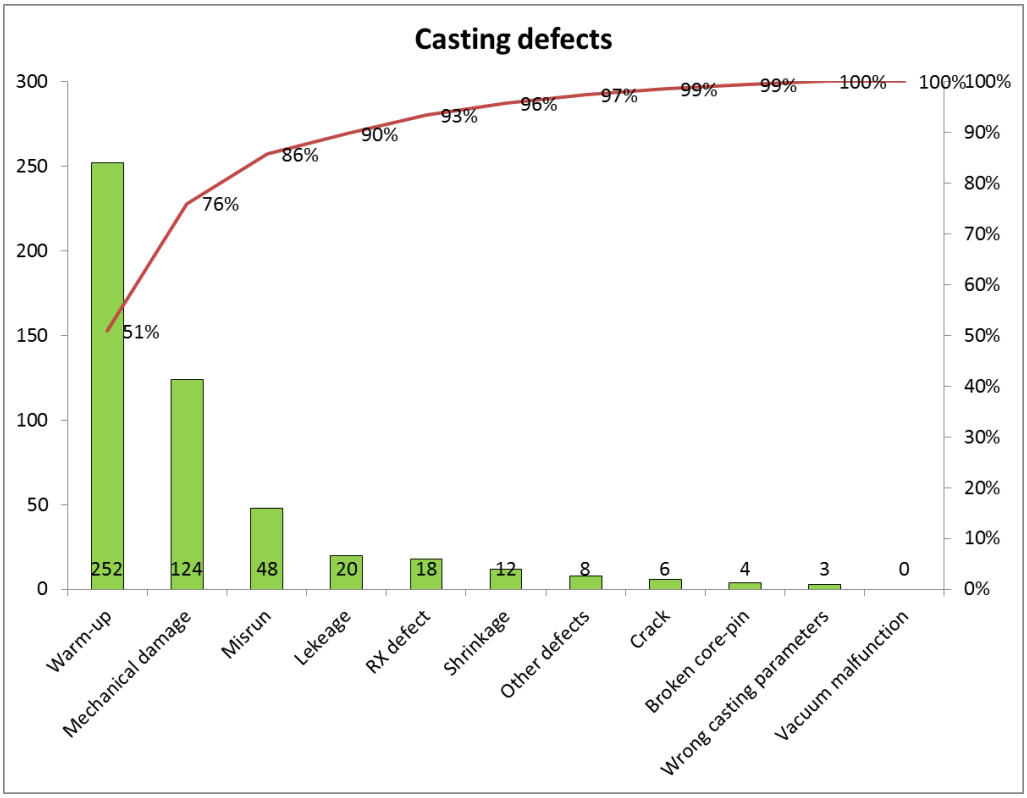

Fig.1.Casting defects

3.2. Improvement suggestions

Analyzed data shows that the main factor generating defective castings are so-called warm-up castings. However, in this case the solution of the problem is not simple. Warm-up defect consist of a number of other factor which effect is the creation of starter castings. There is possibility to modify production plan, which will help in rarely changes in references produced. Less amount in production changes provides to lower starts and mold heating. In other way it requires greater storage space and less flexibility to customers. It is also inconsistent with the trend to implement principles of lean manufacturing. Another factor contributing to the large number of warm-up castings are other accidents such as broken core-pin. Depending on the location and method of assembly, replacement may take several hours.

During this time the mold cools down completely and requires re-heating. Situation is similar in case of misruns or other visible defects which require process engineer intervention and temporary stop in production. Any re-heating of the mold causes three or four warm-up defective castings. Solution of this problem involves rather the improvement of other minor defects which results in rare production start-up than one action which significantly reduce this issue. The second factor is mechanical damage. In this case the best way to reduce defects is the transportation system improvement. This can be done by application protection of transportation basket and use of spacer between stored castings. There should be done more detailed analysis regarding the repeatability and location of damage in order to better appearance defects diagnosis. Other minor defects can be usually compensated by technological process modification. When properly designed, mold has a wide ability to change properties and parameters which have influence on fulfilling mold cavity and solidification process.

4. CONCLUSION

In the case of some of the data presented it is not possible to conclude the proposal of corrective actions due to the complexity of the problem. This phenomenon occurs especially with warm-up castings. Each stop in process causes, that die becomes cold and there is a need to heat it and additional production of warm-up castings. Therefore, in order to improve the quality and process fluency, minor defects should be eliminated. The situation is different in the case of mechanical damage. Application of several protection actions in internal transport should bring measurable benefits and contribute to a significant reduction of defective castings. Minor defects can be eliminated by the technological process changes. In this case, process engineer must have appropriate knowledge and experience to modify parameters properly. Change in one parameter affects a number of factors, so it may therefore lead to a worsening instead of improving situation.

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Method DFX, Method DFM, Assembly process, Manufacturing process

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METHODOLOGY OF DFX METHODS IMPLEMENTATION

Abstract

This article describes a method for Design Excellence and its benefits to businesses in the implementation. Also he spoke on the use of teamwork at each step of the data analysis needed for this method. Below it is dismantled method Design for Manufacturing and Design for Assembly and their individual steps for their implementation and the associated advantages and disadvantages, the rules and principles of these methods.

1. DFX METHOD

The term DFX stands for Design for X which sometimes is interpreted as Design for eXcellence perhaps because in the actual concept X is a variable which can be replaced with a terms from a set of terms that their consideration in design may lead to excellence in engineering, and business. This set of terms include but is not limited to the words like quality, cost, modularity, interchangeability, reliability, logistics, procurement, six sigma, manufacturing, fabrication, assembly, test, serviceability, maintainability, environment, disposal, or obsolescence. DFX provides an integrated framework and guidelines for activities which are taken into account in the design of the product and value chain costs and marketing that affect the product and industrial design process. This enables organizations to create accurate product portfolio that needs to reduce the current diversity of components and allows optimum choice in the overall performance of the chain. [1, 2]

Implementation methods DFX is therefore the possibility of achieving a reduction in overall prices, improved market position, and increase competitiveness. To achieve these requirements, it is necessary to use the correct procedures and methods which are effective, especially if doing so on the results of teamwork.

According to the results of different studies found that 80% of the cost of a new product created in the first phase of the plan of the product, for which it is responsible mainly designer. However, this impact on the process for the manufacture of parts in terms of the type of

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technology used machinery, tools, jigs, gauges, intermediate, standard parts and so on. In addition to this must also ensure simple and rapid assembly of products at lower cost.
However, this places high demands on the individual (constructor), so often applied in the product development teams of designers, production engineers, process planners, buyers and suppliers and any other parties involved in product development. The solution is to create a multifunctional mixed team. The integration of knowledge to benefit the individual specialists that already at the root of the design components are taken into account the comments in terms of various aspects of the product. In Fig. 1 we can see the importance of DFM techniques for implementation.

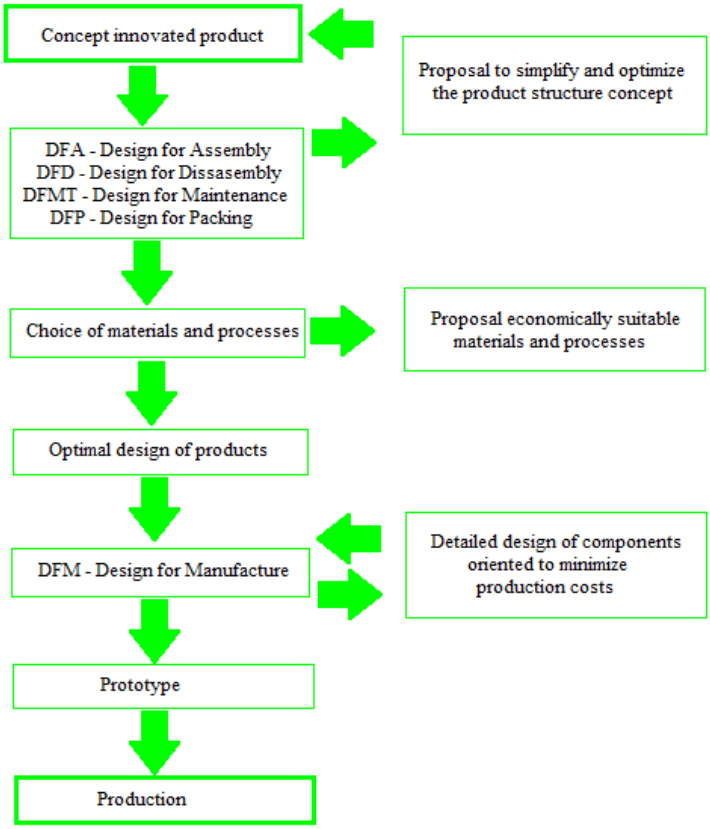

Fig. 1. A typical sequence of steps in the application of methods DFX

2. DESIGN FOR MANUFACTURING

In industry the quality and reliability of any product on the producer's ability to produce the right product. Production problems are one of the main reasons that many companies cannot meet its obligations, which causes them considerable financial losses and, ultimately, market distrust. A large number of engineers and managers also focuses its attention on the production process, oddly enough, even if he is only one reason for a possible failure - development and design of the product has quality production major impact.

Design for Manufacturability (DFM) is an instance of Design for X as well as a pioneering driver of simultaneous engineering. DFM facilitate early consideration of manufacturing issues in initiating phases of product development. DFM shortens product development lead time by facilitating communication between design engineers, process planners, quality experts, tool designers, purchasing agents, suppliers, and any other party involved in product development and reduces unnecessary iterative correspondence between these parties. DFM reduces product development costs as well as production costs by reducing design changes that will otherwise be initiated to remedy design shortcomings due to disregarding process capabilities, tooling provision, test conditions, quality requirements, interchangeability of parts, and availability of materials and standard components. DFM will result in application of fewer parts, and more standard components in the designed product. Adapting to modular design concepts can be another consequence of DFM approach.

Design for Manufacturing (DFM) and Design for Assembly (DFA) are integrating product design and planning processes into one single activity. The goal is to design a product that will be easy and economically most readily prepared. DFM importance is underlined by the fact that the manufacturing cost of the product (the cost of materials, manufacturing and assembly) corresponds to about 80% of the cost, while the design and manufacturing decisions (such as planning or selection processes of machine tools) accounts for only 20% of the cost. [3]

2.1. Implementation Methods DFM

The heart of any proposal for the production system is a group of design principles or instructions that are structured to help designers reduce the cost and difficulty of manufacturing components. [4]

These include a list of the following rules:

- reducing the total number of parts,
- develop a modular design,
- use standard components,
- components should be multifunctional,
- prevent separation operations,
- minimizing installation direction,
- minimize handling.

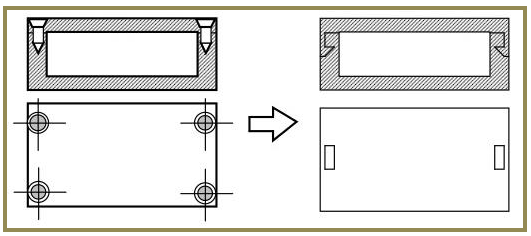

Fig. 2. Removing unwanted screw connections and reduce the number of components by introducing the methods DFM

For correct implementation of methods DFM is necessary to observe 4 principles.

1. **Simplicity** - Do not complicated, unclear and vague shapes.
2. **Standard materials and components** - in terms of production, it is appropriate to use materials and components with wide use and standard semi-finished products with short delivery time.
3. **Standardized structural design of the product** - in the event that several kinds of products produced, and is preferred in the design of these products to use for different types of board products the same components.
4. **Free tolerating** - the name for the tolerated measurements. The higher dimensional accuracy part is prescribed in the drawing, the higher the price will be in production.

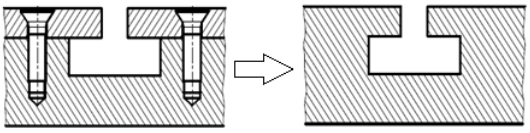

Fig. 3. Cost reduction in the production of parts for analysis DFM [5]

3. CONCLUSION

At present, the method DFX and all its instances in Slovak companies very little used. The problem is the lack of information but largely contributes to this intricately constructed and methodology of their implementation, what is currently devote. Simplification and clarification steps of the gradual introduction of various methods DFX can cause the urgency of their implementation into Slovak businesses through better understanding of their strengths.
DFX is a good mean to shorten development lead-time, enhance product quality, decrease development and production costs, and ensure timely delivery of products and services to customers, improvement of the position on the market and the associated increase competitiveness.

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Logistics strategy, Big Data, Augmented Reality, Autonomous Vehicles

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FACTORS INFLUENCING THE CREATION OF COMPANY LOGISTICS STRATEGY

Abstract

This paper is focused on several trends which impact companies when they create logistics strategy. The first part describes the term logistics strategy and a model of its important elements. Next parts of this article describe three factors from external environment which recently in a large extent influence logistics operations: Big Data, augmented reality and autonomous vehicles.

1. LOGISTICS STRATEGY

The term logistics has a commonly used definition: management of the flow of product from source to point of use. But the concept of a logistics strategy and how it relates to all components of logistics is often confusing for practitioners. If you ask ten managers what are the key issues which should be involved in logistics strategy you would get ten different answers. Useful framework for creating and thinking about logistics strategy is the logistics strategy pyramid (Fig.1).

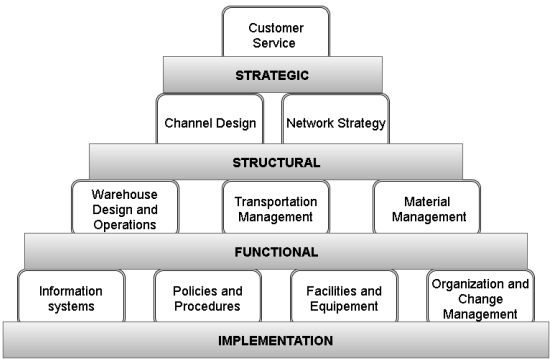

Fig.1. Logistics strategy pyramid

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Each part of this pyramid is influenced by a lot of factors from internal and also external environment. This article is about factors which impact the company from its surroundings. For example, transportation management is influenced by modern types of handling equipment, new technologies used in warehouses etc. There are described three factors which should companies take into account when create their logistics strategy.

2. BIG DATA IN LOGISTICS

The combination of large, fast-moving, and varied streams of big data and advanced tools and techniques such as geoanalytics represents the next frontier of supply chain innovation. When they are guided by a clear understanding of the strategic priorities, market context, and competitive needs of a company, these approaches offer major new opportunities to enhance customer responsiveness, reduce inventory, lower costs, and improve agility.
Companies can optimize distribution, logistics, and production networks by using powerful data-processing and analysis capabilities. They can also improve the accuracy of their demand forecasts, discover new demand patterns, and develop new services by sharing data with partners across the supply chain. In addition, they can increase asset uptime and expand throughput, engage in preventive maintenance of production assets and installed products, and conduct near real-time supply planning using dynamic data feeds from production sensors and the Internet of Things.
But with so much available data and so many improvable processes, it can be challenging for executives to determine where they should focus their limited time and resources.
Companies are typically in the early stages of exploring how to benefit from their growing pile of data, and put this data to good use. According to recent research, only 14% of European companies already address Big Data analytics as part of their strategic planning (Fig.2). And yet almost half of these companies expect a yearly data growth in their organization of more than 25%.

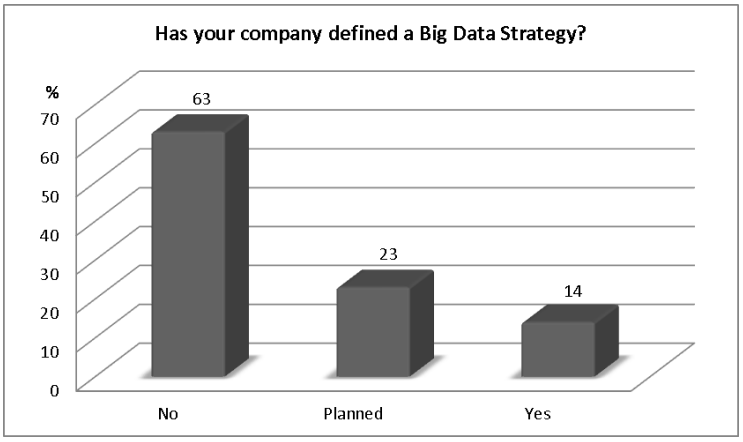

Fig.2. Results of research about big data strategy [4]

3. AUGMENTED REALITY IN LOGISTICS

Although AR is in relatively early stages of adoption in logistics, it could offer significant benefits (Tab. 1.). For example, AR can give logistics providers quick access to anticipatory information anytime and anywhere. This is vital for the prospective and exact planning and operation of tasks such as delivery and load optimization, and is critical to providing higher levels of customer service.
In logistics, the most tangible AR solutions are systems to optimize the picking process. The vast majority of warehouses in the developed world still use the pick-bypaper approach. But any paper-based approach is slow and error prone. Furthermore, picking work is often undertaken by temporary workers who usually require cost-intensive training to ensure they pick efficiently and without making errors.
Systems by Knapp, SAP, and Ubimax are currently in the late field-test phase and consist of mobile AR systems such as a head-mounted display (HMD), cameras, a wearable PC, and battery packs that provide enough energy for at least one work shift. The vision picking software offers real-time object recognition, barcode reading, indoor navigation, and seamless integration of information with the Warehouse Management System (WMS). A key benefit of vision picking is its provision of hands-free intuitive digital support to workers during manual picking operations.

Tab. 1. Augmented reality in logistics operations

Logistics operation	**Description**	**Main objectives**
Pick-by-Vision: Optimized Picking	The solution offers digital navigation to find the right route and item more efficiently, while reducing training time.	Reduce picking errors and search time
Completeness Check	AR devices register if a delivery is complete and ready for pick-up. Automated confirmation of pick-up by AR after the correct number of undamaged parcels is recognized.	Time savings, completeness check, damage detection
Dynamic Traffic Support	Replacement of navigation systems in delivery vehicles with AR devices (glasses or windshield projection). Analysis of real-time traffic data and display of relevant information (e.g. blocked or alternative routes) in the driver´s field of vision.	Improvement of driving safety, minimizing of driver distraction
Freight Loading	Loader receives load plan and instructions (which pallet to take next and where to put it) directly on their AR device display.	Speed up the freight loading process
Parcel Loading	Through AR, all parcels are overlaid with critical information (e.g. weight, destination) and handling instructions, and parcels are loaded intelligently into the vehicle.	Improve parcel handling, ensure load optimization

4. AUTONOMOUS VEHICLES IN LOGISTICS

There is a strong case for suggesting that the logistics industry will adopt self-driving vehicles much faster than most other industries. The best and most common method today and in the future is to rely on a mixture of depth cameras and lasers on the vehicle; these devices

constantly scan and capture the environment to identify the vehicle's position and any obstacles. Vision guidance technology relies completely on cameras that perform 360-degree depth scans of the environment in order to create a 3D map which the vehicle then uses for navigation. These are the next generation of self-driving vehicles in warehouses and they have complete, flexible navigational authority, enabling a much larger range of potential applications and autonomy.
Self-driving vehicles in warehouses have the ability not just to transport goods but also to combine other process steps such as loading and unloading in order to increase the overall efficiency of an entire process. In addition to providing efficiency gains, self-driving vehicles can also significantly increase safety in transport and loading processes.

5. CONCLUSION

Each from this three trends offer a lot of benefits for the company. But how does the company know which of these trends most affect its activity? Based on this article all companies should use each of these technologies – big data analyses, augmented reality and also autonomous vehicles because all of these trends are capable to reduce the cost. However, companies are not capable to implement everything at once time, not only in terms of investments, but this is also because all the elements are not suitable for all kinds of companies. It is necessary to examine the links between company's classification parameters (size, type of process, industry) and different trends. Before implementation of some technology company should consider costs of technology and its benefits. Logistics strategy of a company should include long-term goals in area of logistics and plan of implementation with milestones of reaching these goals.

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