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Augmented Reality, information systems, mobile device, client-server

Jan BAJANA*, Martin KRAJČOVIČ*, Jozef HERČKO*

CONCEPT OF DATA COLLECTING USING AUGMENTED REALITY

Abstract

The paper present automation architecture offloads industrial automation tasks to mobile devices. We describe communication between devices and cloud system to take advantage of distributed computing and processing resources and directly connection to industrial units via the OPC UA technology. The architecture can by use for development all layers of industrial information systems as MES or SCADA. We use Augmented reality and markers like support technologies to improve visual effect when displaying data and to unique device identification. Augmented Reality (AR) technology is becoming more available not only for everyday applications but also for industrial use.

1. INTRODUCTION

Manufacturers of modern MES (Manufacturing Execution Systems) and SCADA (Supervisory Control and Data Acquisition) in the framework of modern trends and innovations continue to increase its attention on user environment and mobility software solutions. Mobility systems in general are among the major trends of the present time, which will affect the whole area of industrial information systems for the future. In this paper we focused on mobile solutions in MES and SCADA systems. Companies are already sufficiently saturated intelligent mobile devices based on modern platforms such as iOS, Android, Windows which want to increasingly integrated into the business processes. The idea is not the creation of a complete execution system for mobile platforms but rather the integration of some already exist functions in mobile devices build main concept for this system based on cloud services and modern standards for industrial communication. We use AR (Augmented Reality) technology and AR markers for device identification and create new visual effect when displaying data.

2. INDUSTRIAL INFORMATION AND CONTROL SYSTEMS

Manufacturing Execution Systems (MES) are computerized systems used in manufacturing. MES can provide the right information at the right time and show the manufacturing decision makers. MES work in real time to enable the control of multiple elements of the production process as inputs, personnel, machines and support services.

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SCADA system is the repository of the real-time or near real-time reported data collected from the remote terminal units connected to it. It is generally standard computer hardware equipment and very few SCADA system suppliers have ventured out to make their own computer equipment. HMI or Human Machine Interface is simply the way by which humans interact with machines. This is the place when we can use mobile devices. For data collection from process layer or manufacturing unites we use the OPC Unified Architecture (UA) communication technology. The OPC UA, released in 2008, is a platform independent service-oriented architecture that integrates all the functionality of the individual OPC Classic specifications into one extensible framework.

For MES systems is typical to not directly collect data from the technology but download it from the database. A MES needs data in exact form about all unites in process layer also with history. There is a typical SCADA that collects data from process units. It can be made by the OPC UA server directly included in a SCADA system.

3. INTEGRATED AUTOMATION

At different production sites several MES and automation systems based on many platforms from various vendors are installed. Process control systems from many manufacturers are connected to discrete automation provided by many others manufacturers like Siemens or Mitsubishi. However each of the plants uses different set of equipment. Interoperability issues and incompatibility of many different proprietary protocols are big challenge at this kind of environment. On Production Level harmonized communication on the field and production level using ‘Classic’ OPC is already a standard and is successfully used in process control. However, Classic OPC is not a very good solution when there are communication needs to other company networks. It is not unified for all platforms in automation. The centralized applications need to collect data from process control, packaging and warehouse control. MES, Track & Tracing, OEE, LIMS, and database connections into the IT network require firewall friendly, cyber secure and reliable standardized protocol. The solution is the new OPC UA standard.

3.1. OPC UA Transport Protocols

OPC UA defines an abstract set of Services that is mapped to different technologies. Currently there are two protocol mappings and two encodings supported. The reason for having abstract Services is that, if a new technology for data communication enters the stage, OPC UA can be adapted to that technology just by defining another mapping. The reason why OPC UA supports two protocols is that OPC UA will be applied in different application domains with different requirements. Supporting HTTP and UA TCP allow it to run Internet applications crossing firewalls with HTTP as well as running optimized applications with limited resources via the UA TCP protocol, which is optimized for the wire (no overhead) and the needed resources (no HTTP stack needed). But the main optimization on the wire is not UA TCP versus HTTP but exchanging binary encoded data versus XML encoded data. “Fig. 1” summarizes the use of different protocol options in a simplified form [1], [2], [3].

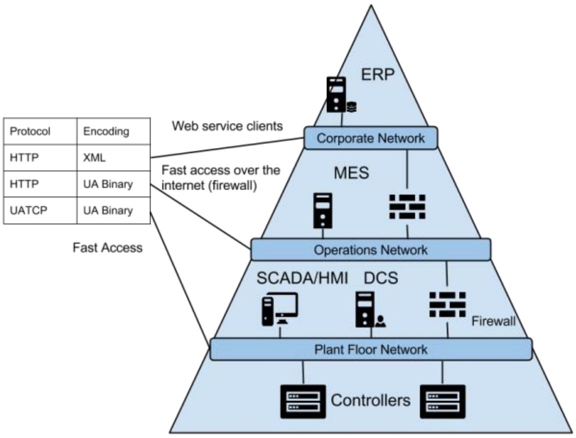

Fig.1. Simplified view of OPC UA transport protocols and use.

4. OVERVIEW OF THE SOLUTION

4.1. Architecture

Our automated system describes cloud services build from main modules. One of them is OPC UA server considered as an information server. Given the approach that is encrypted and secure certificates, it is possible to securely connect from other places than direct local network. Another described module "Target Manager" is used to recognize and identify markers for augmented reality, be regarded as a system for managing markers. This system use REST full web service to recognize markers. See "Fig. 2" for all architecture.

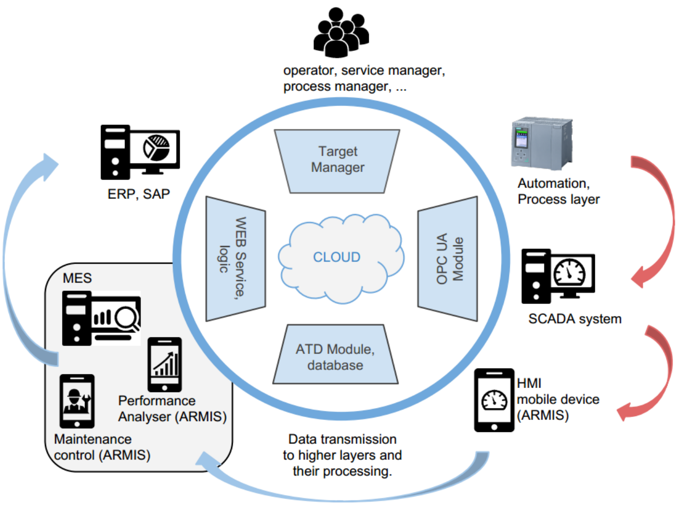

Fig.2. Simplified view of OPC UA transport protocols and use.

4.2. Augmented Reality and unit identification

The task of this work is to design a system where are integrated functionalities for the collection and evaluation of production data via the network connection. The essence of the implementation is identification of the industrial production unit using the augmented reality technology, connection to the industrial network via OPC UA interface, collect data about the identified unit through the network, their processing and visual display.

We use augmented reality and marker-less systems for identification manufacturing unites. The marker-less system detects and tracks the features that are naturally found in the image itself by comparing these natural features against a known target resource database. Every manufacturing unity need unique marker with unique identifier ID, see “Fig. 3”.

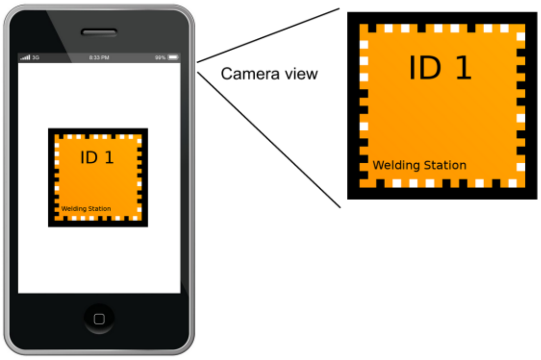

Fig.3. Simplified view of OPC UA transport protocols and use.

5. CONCLUSION

In this paper we proposed an efficient system based on AR and modern industrial communication based on OPC UA standard and cloud solutions. We focused on mobile solutions like integrated part of complex MES or SCADA systems. We see great potential for integration smart mobile devices, distributed cloud solutions and AR technology.

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ERGONOMIC PREVENTION PROGRAMS AND PRIORITIZATION ERGONOMIC IMPROVEMENTS

Abstract

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

1. APPLYING ERGONOMIC PREVENTION PROGRAMS

Order for an undertaking achieve optimum productivity and efficiency and to ensure minimal risk of injury, should apply **ergonomic prevention program**. The main thrust of the program is to identify and eliminate ergonomic risk factors in order to eliminate the number and severity of **musculoskeletal disorders** (MSDs) to improve better conditions in the workplace for employees. It is necessary to thing to realize, that a comprehensive and integrated approach will have the best results in the long term. The comprehensive approach is one which:

- improves workplace conditions through a systematic process of improving ergonomics,
- creates "healthy workplaces" through systematic education and training of the process, early intervention and involvement of staff in the process of improving ergonomics.

As with all issues relating to health and safety at work, employees should be a key element in the development and implementation of ergonomic prevention program. Therefore, it is important that management understands the benefits of effective ergonomic prevention program and supported it.

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1.1. Prioritization of proposed ergonomic improvements

After reviewing the proposed risk management approach is necessary to provide them priority. In the majority of cases, the work activities with the highest risk of musculoskeletal disorder will be determined the highest priority. It may also happen a situation where work activity with lower risk and therefore with a smaller which may result of musculoskeletal disorder can have higher priority. In this case, it will be higher benefits, especially financial.

Effective tool for prioritization of proposed ergonomic improvements is a tool that can be abbreviated as CID. (Tab. 1). Symbols are an abbreviation for three factors that should be considered when establishing priorities:

- ✓ **Cost** – It should also take into account costs. With an emphasis on financial constraints, the company must decide between several alternatives. Often the best solution is very difficult to implement if the price is too high.
- ✓ **Impact** – It can be measured using indicators such as cost savings that would have been incurred for treatment of injury, increase productivity, improve quality and other benefits.
- ✓ **Difficult** – Should be assessed the difficulty of implementation in terms of the resources available and the time required to complete the proposed solutions.

CID is a tool that uses predefined values for each of these three factors to determine the priority objective manner. The proposed values and their ratio can be adjusted if necessary. If the sum of this value is higher, after that is the higher the priority of the proposed solution.

Tab.1. Tools CID with predefined values for determining priorities ergonomic opportunities

CID	Cost	Impact	Difficult	**Total**
High	0	2	0	
Low	1	0	1	

The tool uses a matrix format, where the column headings are the criteria: cost, impact and implementation difficulty. Each of these factors must be assessed and classified as high or low (it is necessary to make a clear choice). If the price of the implementation of the proposed solution is high, takes the value 0 if it is low, takes the value 1.

In the second column, if the impact of the proposed solution to the elimination of musculoskeletal disorders is high, takes the value 2. If it is low, the value is 0.

In the third column, if the difficulty of the implementation of the proposed solution is high, the numeric value is 0. If it is low, the numerical value is 1. The reason that the value of the criterion impact is higher than the of the investment cost and difficulty of implementation is that this criterion is in terms of ergonomics has paramount importance. This criterion should govern business decisions more than other factors. Determination of the numerical value which is associated with each of the three relevant criteria, can provide five different variations of the results listed in the last column - Total.

Tab.2. Tool CID - score 4

CID	Cost	Impact	Difficult	**Total**
High	0	**2**	0	4
Low	**1**	0	**1**	

If the overall score is 4, it can be classified as an extraordinary opportunity. Ak je celkový výsledok 4, This is because it is possible to generate a high impact of the proposed solution with low costs and low intensity of implementation. These opportunities not appear frequently, so the negotiations should be immediately.

Tab.3. Tool CID - score 3

CID	Cost	Impact	Difficult	**Total**
High	**0**	**2**	0	3
Low	1	0	**1**	

Opportunity with a total score 3 can be considered as significant opportunity that can generate high impact with difficult of implementation, but the cost is high in this case. It can also generate high impact associated with high costs and the very low difficult of implementation. It is also recommended to respond to this opportunity.

Tab.4. Tool CID - score 2 (option 1)

CID	Cost	Impact	Difficult	**Total**
High	**0**	**2**	**0**	2
Low	1	0	1	

Opportunity with score 2 is an opportunity that can provide either a big impact with high costs and difficult of implementation. (Tab. 4.).

Tab.5. Tool CID - score 2 (option 2)

CID	Cost	Impact	Difficult	**Total**
High	0	2	0	2
Low	**1**	**0**	**1**	

The second case can be low impact, which will be achieved at low cost and almost no difficulty implementation. (Tab. 5.).

All proposed solutions to achieve score of 1 under the use of a tool CID should be reviewed and in the near future should not be implemented. Opportunity that would achieve score of 0 could not be further investigated.

Tool CID can be useful and to help the company to sort ergonomic opportunities that have been identified. It is appropriate to include this tool in the create and application of ergonomic prevention program.

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

2. CONCLUSION

Preventive ergonomic programs can be regarded as proactive security programs, which promote the ergonomics and health protection at work. All employees should work together and ensure the safety and health of their colleagues. Therefore, it is very important to develop a skilled workforce, which will apply the principles of ergonomic and healthy lifestyle while ensuring a decrease in work-related accidents.

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Standardization, Visualization, GAP analysis, Success story

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5S STANDARDIZATION

Abstract

5S is one of our company seven lean core tools, which consists of 5 steps. It is a systematic approach for waste elimination. Workspace are clean, tidy and standardized to improve safety, quality and productivity. Global 5S standardization is considering 12 items to have to be done in each plant. The GAP analysis and ROAD map used for controlling activities. Activities which are done in each month are explaining in success story

1. STANDARDIZATION

This year is for us and our company start year for global standardization in basic 7 lean core tools.

Seven Lean Core Tools have been selected to be globally standardized and used across all Nemak plants. These Lean Core Tools are:

1. 5S (Workspace Organization Across the Facility)
2. Standardized Work
3. TPM (Autonomous Maintenance)
4. VSM (Value Stream Mapping)
5. Systematic Problem Solving
6. Kaizen Workshops
7. Suggestion System

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2. 5S INTRODUCTION

5S is the foundation of Visual Factory. It is a systematic approach for waste elimination. The principle of “A Place for Everything and Everything in Its Place” is established. 5S is a visual management tool used across the facility to communicate status relative to established norms. Workspaces are clean, tidy and standardized in order to improve safety, quality and productivity.

5S represents 5 disciplines of maintaining a visual work place in order to create and sustain a cleaner and more organized workplace (Fig. 1):

1. Sort
2. Set in Order
3. Shine
4. Standardize
5. Sustain

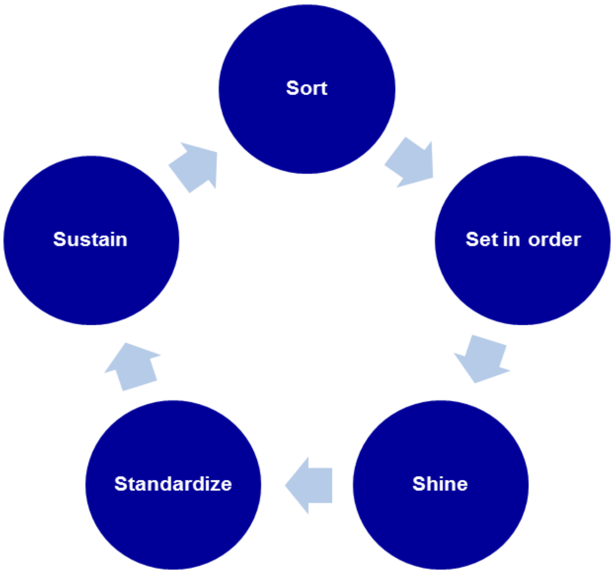

Fig.1. 5S cycle

It is an important visual control tool to enable recognition of abnormalities, thus facilitating immediate response towards continuous improvement. Key elements are Team involvement, training, 5S implementation and a sustainable system including roles and responsibilities, Location map with red tag area, check sheets and periodic audits.

2.1. 5S Vision

Create and sustain a world class working environment by continuously improving employee involvement in waste elimination.

2.2. 5S Objectives

- Clean & neatly arranged
- Specific location for everything
- Efficient, self-Regulating and employee managed
- Safe and visually manage work environment
- Cost Optimization
- Better scrap management
- Better retrieval time and reduced inventory
- Avoid errors and malfunction

3. GAP ANALYSIS AND ROAD MAP

It is necessary for all plants to have 5S standardization till end of February 2016. In this standardization is needed to fulfil 12 MUST items, which present individual requirements and 5S steps. GAP analysis attend to analyse current state of start of standardization and also during 5S standardization. Implementation of 5S system is divided to 4 areas, which are:

1. Shopfloor
2. Common areas
3. Offices
4. Meeting rooms

All plants must fulfil basic requirements in this areas. Condition is to have one of 12 MUST each month in each plant. Plan of realization individual activities is write down in ROAD MAP. GAP analysis and Road map for all Nemak plants is shown in Figure 2.

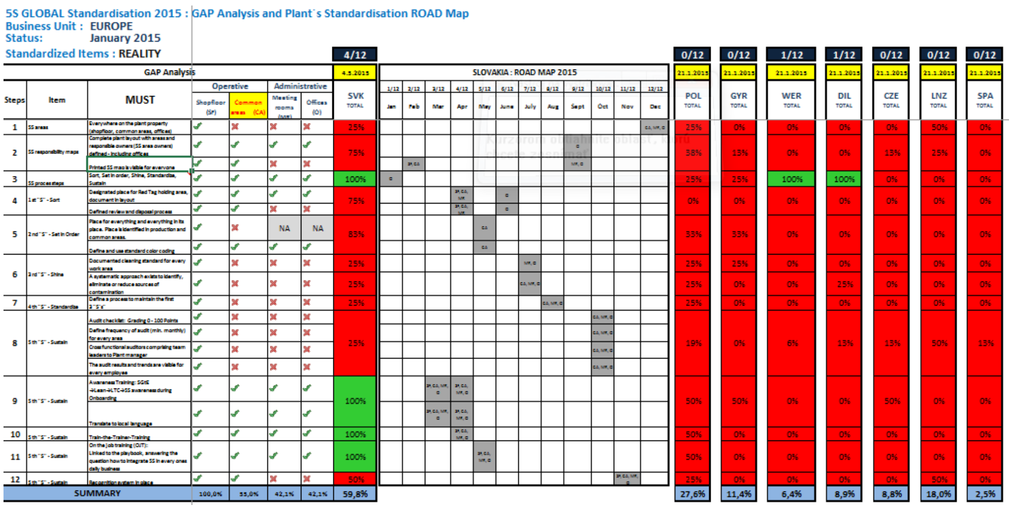

Fig.2. GAP Analysis and ROAD MAP

4. BEST PRACTISE SHARING

Every month are controlled activities which are done in each plant. Responsible people for 5S create success story. This success story explain activities what they done in last month. It contain 3 part, original status, activities what they done and new situation. Examples of one success story is shown in Figure 3. All of this stories are at plant´s disposal.

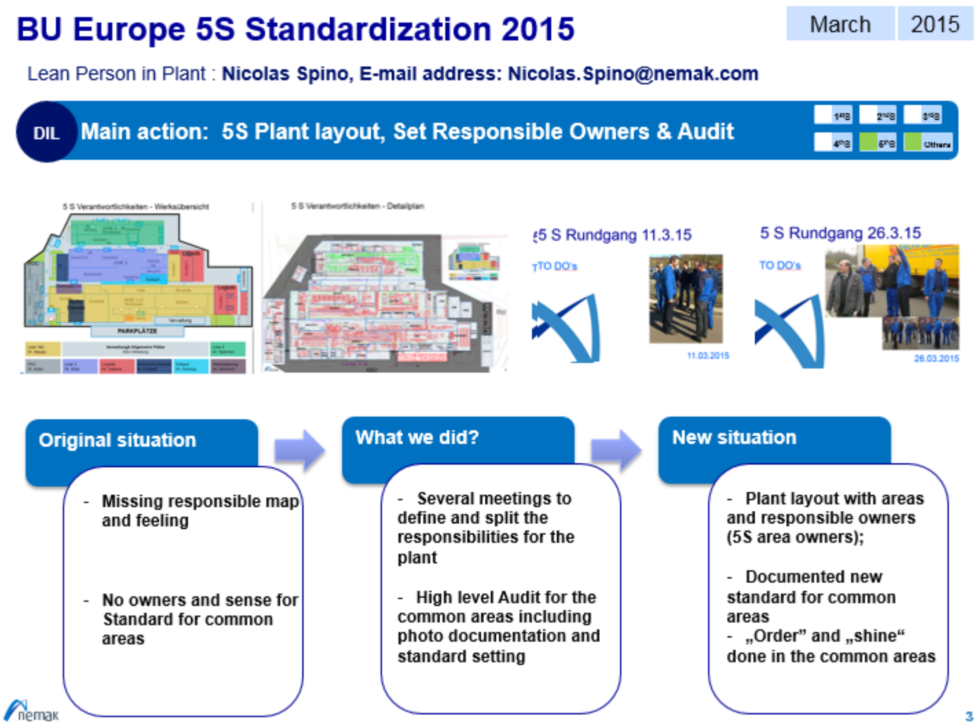

Fig.3. Examples of succes story from Dillingen

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Eco-innovation, environmentally oriented business

Vladimíra BIŇASOVÁ[*], Branislav MIČIETA[**], Ladislav ROSINA[***]

TRENDS OF ENERGY AND MAJOR ISSUES OF SUSTAINABLE MANUFACTURING

Abstract

The paper deals with description of trends for using energy in ways that support sustainable development, which are essential to enhancement of efficiency, productivity and profitability in future industrial processes, because today's manufacturing enterprises provide a number of different processing possibilities for manufacturing a specific product. The second part of this paper deals with specification of significant barrier of greater end-use efficiencies.

1. ENERGY AND MAJOR ISSUE

The environmental impacts of energy use are not new. For centuries, wood burning has contributed to the deforestation of many areas. Even in the early stages of industrialization, local air, water, and land pollution reached high levels. What is relatively new is an acknowledgement of energy linkages to regional and global environmental problems and of their implications. Although energy's potential for enhancing human well-being is unquestionable, conventional energy production and consumption are closely linked to environmental degradation. This degradation threatens human health and quality of life, and affects ecological balance and biological diversity.

In addition, although energy security has been adequate for the past 20 years, and has in fact improved, the potential for conflict, sabotage, disruption of trade, and reduction in strategic reserves cannot be dismissed. These potential threats point to the necessity of strengthening global as well as regional and national energy security. Options to enhance energy security include:

- Avoiding excessive dependence on imports by increasing end-use efficiency and encouraging greater reliance on local resources (particularly those whose development will have other positive externalities such as job creation, capacity building, and pollution reduction), provided these do not involve disproportionate costs or waste scarce resources.
- Diversifying supply (including both suppliers and energy forms).

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- Fostering greater political stability through international cooperation and long-term agreements among energy-importing countries and between importing and exporting countries.
- Encouraging technology transfers (for example, through joint ventures and public-private partnerships) to developing countries so they can develop local resources and improve energy efficiencies.

Options for using energy in ways that support sustainable development, which requires addressing environmental concerns, include for example:

- More efficient use of energy, especially at the point of end use in buildings, electric appliances and production processes.
- Increased reliance on renewable energy sources.
- Accelerated development and deployment of new energy technologies, particularly next-generation fossil fuel technologies that produce near-zero harmful emissions – but also nuclear technologies.

All this options have considerable potential, but realising this potential will require removing obstacles to wider diffusion, developing market signals that reflect environmental costs and encouraging technological innovation.

2. ENERGY RESOURCES IN MANUFACTURING

Rather, the key concerns are:

Can technologies to extract, harvest, and convert these vast energy stocks and flows be developed in time? Will these processes have adverse implications?

Will the energy services eventually generated from these resources be affordable? Historical evidence suggests that these concerns may be at least partly offset by technological progress, but that such progress needs to be encouraged – by regulations to improve market performance, temporary subsidies, tax incentives, or other mechanisms – if it is to occur in a timely fashion.

2.1. Energy end-use efficiency

Achieving higher end-use efficiency involves a great variety of technical options, because it has little visibility, or politicians, the media, or individuals looking for recognition and acknowledgement. The significant barriers – primarily market imperfections that could be overcome by targeted policy instruments as prevent the realisation of greater end-use efficiencies.

These barriers are shown in figure 1.

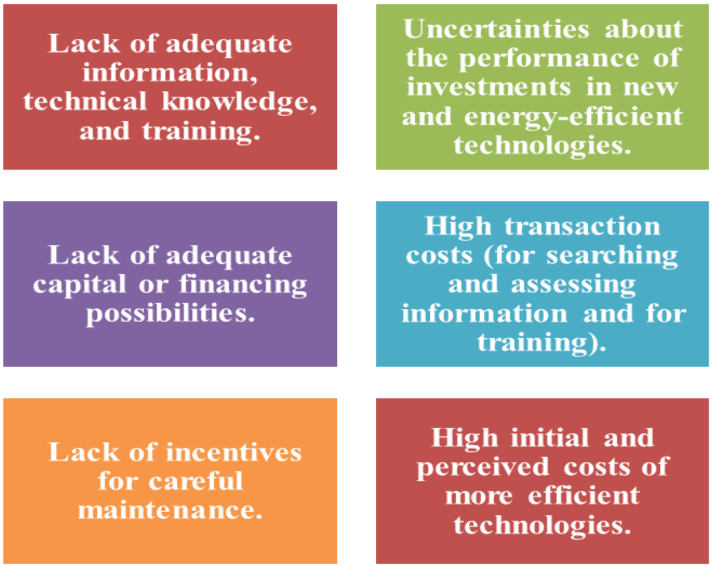

Fig.1. The barriers of greater end-use efficiencies

Realising cost-effective energy efficiency potentials will be beneficial not only for individual energy consumers, but also for the economy as a whole. For example, saved energy costs can be used to produce energy-saving domestic goods and services.

And as cost-effective energy improvements are realised, additional profitable opportunities for improvement will continue to open up as a result of research and development, learning curves, and economies of scale. That means that continual cost-effective energy efficiency improvements can be expected.

2.2. The options for energy saving positioning

The development of advanced industrial engineering and new energy efficient technologies are essential for security of supply, sustainability and competitiveness of industrial sector.

Energy and environment related research has contributed strongly to energy efficiency. With development of sustainable production is necessary to pay attention of reducing energy consumption and increasing the energy efficiency in manufacturing processes.

On factory side all sensors and control units are elements of the shops and generate information around events. This can be called “a smart factory”. Real time information combined with histories and future (simulation) make it possible to realize a new generation of IT-driven factories and enterprises.

With energy and environment remain important global issues and sustainable development becomes increasingly more important, it is expected that energy efficiency and related environmental indicators will continue to play an important role in providing information for policy makers to address national and global energy, environmental, and resource depletion problems.

Reduce energy expenditure via a structured approach to identifying, measuring and managing energy consumption.

Lean Manufacturing is an operational strategy oriented toward achieving the shortest possible cycle time by eliminating waste [1].

By energy saving positioning we will mean strategic management decisions in relation to place of energy saving in management priorities system of the industry. The decision should be made in compliance with aims, requirements and anticipated result of energy saving program implementation.

Energy saving positioning determines energy policy of the enterprise. We can identify three options for energy saving positioning in the enterprise. Energy conservation and energy efficiency as:

1. a way to solve particular problems of power supply service. Such positioning implies that energy conservation goals to provide solution to the problems related to rectifying defects in industry's power supply service [2]. It can result in lowering industry's energy consumption both in physical and monetary terms, reduction in energy consumption associated with production of certain types of goods, etc.
2. a way to increase the industry's performance in investment development programs. Energy conservation in that case is regarded as one of many business lines to increase the industry's performance, together with delivering production technology innovation, upgrading operating machinery, adapting advanced materials, etc.
   The effect of energy saving declares itself in growing production and commercial performance of the enterprise [3].
3. a way to solve strategic problems of corporate development.
   Energy saving and efficiency is considered as a strategic direction to increase competitiveness of the enterprise [4]. Therefore, successful task solution in this field exercises a dominant influence on the corporate strategic targets.

3. CONCLUSION

Energy manufacturing systems as an operational strategy are oriented toward achieving the energy efficient manufacturing by eliminating energy waste. Increasing energy efficiency through local optimization of individual systems and structures is already showing notable savings potential. Integrated analysis, planning and design are the next logical step.

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Industrial Internet of Things, Economic, Automation

Monika BUČKOVÁ*

INDUSTRIAL INTERNET OF THINGS

Abstract

In this article are processed basic information about reshaping Internet to Internet of Things and development of Industrial Internet of Things. In introductory chapter there are described different waves of Internet changes and its understanding. Description of Internet influence on industry and its development is core of article. In article it is presented how can industrial IoT affect methods, procedures and methods of collection, storage and processing, evaluation, selection, and distribution of necessary information in requested format and quality.

1. RESHAPING INTERNET

Over the past 50 years massive changes occurred in information technology. We could say that it happend in two waves. These waves gradually affect on production strategies, status of each department in the company and decision-making capabilities. It should also be said that current world of information technology stands on edge of the third wave (Fig. 1). In many literature describes this situation as revolution.

The first wave of transformation took place roughly from 1960 - 1970. The manufacturing activities in this value chain should be described in steps, from order processing to bill payments; from computer design to planning production data; from manual labour to advanced types of automation, etc. Effectiveness of these activities improved in these years greatly. In times when information could be captured and analysed data, standardization provoked revolution in production process. Since then, there was dilemma which every business must face.

In 1990, access to the Internet grew and became more affordable, which triggered second wave of IT. The emergence of Internet facilitate cross-border, regional cooperation and consolidation through production activities. Over the past 15 years Internet revolution changed business sectors such as media, retail and financial services, many important questions, including those that have impact on existing industries, value chains, business models and workforce, and that actions leaders need to be able to ensure long-term success. To address these and other issues faced by enterprises, developers of Information Technology created Industry Internet of Things.

2. INDUSTRIAL INTERNET OF THINGS

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Research in Industrial Internet of Things refers to development of four distinct phases:

Phases 1 and 2 are immediate opportunities that may be basis for short-term acceptance. These activities are happening now and it is expected that development of these activities have in course of next two years will accelerate.

Stages 3 and 4 represent long-term structural changes that are roughly three years from mainstream adoption. Statistics suggest that industrial IoT change not only industry, but doing business. The biggest changes may occur in the third and fourth phases of economy and man – machine relationship. Achieving better results requires firm to conclude new partnerships, ecosystem focused on customer needs rather than individual products and services. Because dominant market players starts development and growth of software and platforms. In view of the fact that actual IoT is already rooted in every industry, their association results in economy, characterized by high automation and flexible production.

Emergence of strong internet of industrial things also supports growing need for industrial cooperation on common interests such as security and interoperability. These include Industrial Internet Consortium (IIC), AllSeen Alliance and Open Interconnect Consortium (OIC). While AllSeen and OIC that are designed to connect devices, IIC goal is to accelerate adoption and deployment of Industrial IoT through new technologies. They record using cases and requirements for development. Since its founding in 2014 IIC expanded its base. It includes more than 100 organizations, with one third in countries outside the US. Rapid growth and diversity IIC highlights strong need for high level of communication and cooperation in this area. Industrial IoT points also on increasingly growing level of risk capital, which in 2014 was estimated at $ 1.5 billion.

2.1. Outcome Economy

The goal of every company is to provide high quality products at competitive prices. They help customers meet their needs efficiently and effectively, for example. produce bulbs that last longer, but consume less energy. Manufacturers gradually reveal new opportunities for creating value by helping customers use its products to meet specific outcomes, such as optimization of personal transport within larger distances. This focus on solution, why buy, is key factor in promotion of products to services. Increasing availability of intelligent products will accelerate process. This new world is called "Outcome economy", where companies compete on their ability to deliver products to offer its customers in particular place and time. To achieve these goals, companies will increasingly rely on business partners, ecosystems, advanced analysis and new data flows from smart products.

As products become more intelligent and connected, software emerge as connective tissue to create value, even for companies that sell physical goods. The convergence of physical and digital worlds begin to use sensors and sensory data, which automate and quantify model for product-tracking and customer behaviour in physical world. Thus, data become part of Industrial Internet economy. Miniaturization, performance, cost and power consumption make intelligent products more accessible. These types of sensors are integrated into for example most recent types of locomotives which are equipped with more than 250 sensors, which measure 150 000 data points per minute. All this is for much of companies more difficult prospect. Among other things, providers will require deeper understanding of customer needs and contexts in which they used their products and services. It is digital age that with increasing number of sensors transforms physical world, which becomes online, information is increasingly available and quantified. Sensory data streams from connected devices contain detailed traces of use by customers and their behaviour. By using advanced analytical tools for collecting these data, together with right external data and domain model, companies can better understand the interaction between input variables and optimize them. What it leads to achieve desired business results.

3. ACCEPTANCE OF INDUSTRIAL AND IMPACT OF THE INTERNET OF THINGS

Despite many promises and new opportunities of Industrial IoT, many factors could hinder its future growth. Safety and interoperability are the two main obstacles. Other major obstacles are low return on investment (ROI), older equipment and technological immaturity. Additional concerns and potential problems based on their experience, including (WORLD ECONOMIC FORUM, 2015):

- Lack of vision and leadership.
- Lack of understanding values between different levels of the company.
- Lack of proven business models (eg. Result based on revenue sharing or profit sharing).
- Rapid development of technology makes companies a low return on investment.
- Changing business processes.
- Any sufficiently aware of current state of technology.
- Lack of infrastructure. Lack of tools for application development.
- Higher costs of modern sensors.

Regarding risks, it is possible to allocate vulnerability information from cyber-attacks which are often the most important concerns. Many respondents indicated that probability of such attacks is "very or extremely high." Associated with it is related even slightly different risk of breaching the privacy of personal data, which also achieved a high level.

A 2014 World Economic Forum estimated 3 trillion dollars of potential economic losses in cybersecurity issues from the horizon of 2020. In first half of 2014 has been compromised records associated with energy, medical devices, transportation and other areas. Potential disruption to existing business models are another significant risk. Shift and innovation of products, services and information about results not only disturb internal operations, but will affect market. Considering to ensure access and control points will be open. Digital market, as in traditional markets of company will face competition from larger number of companies, including those whose business is based on new models and platforms. In fact cooperation is essential if they are to meet t growing expectations of customers. With the current possibilities of enterprises is difficult to imagine the company as individual who can handle the entire value chain.

At societal level, it is important to consider potential movement in work that occurs in some sectors due to increased automation. Many argue that if intelligent machines is more extended, there will be more jobs and even human gets strongly into forefront. They will create new types of jobs - jobs that will require unique human qualities such as creativity, critical thinking and collaboration. It is important to realize that technology is constantly raising bar for the low-skilled. Consequently, it is necessary to constantly upgrade their skills. It is necessary to focus attention on education, modification of existing educational systems and approaches to better prepare young people for the upcoming digital workplace.

4. NEW POSSIBILITIES

At time when Industrial Internet of Things will lead to emergence of new hybrid industries, such as digital medicine, precision agriculture and smart production. As machines take over routine tasks, companies will rely on people as individuals who provide creative solutions to problems, new forms of communication, cooperation and the ability to adapt to unfamiliar situation. For example, in highly automated factory may require fewer production workers at manufacturing facilities. But at the same time will be increased need for experts and analysts, who will have ability to focus on tasks that can be automated, including system planning, engineering, process changes, coordination.

To support hybrid industry, there are new opportunities for example medical robots designers, intermodal transport network and others. More and more traditional companies creates demand for traditional professions.

5. CONCLUSION

It is important to note that machine, also intelligent machine, are still machines. In case of questions, human experts must be prepared to use decision of principle has reversed recommendations for transition to automated systems. Companies will need more IT managers and specialists to ensure smooth transition to automation and IIoT as companies increasingly move their business processes to cloud. Cloud computing is evolving still further. The benefits are indisputable, especially low-cost, self-service, standardization, flexibility and usability means.

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Simulation, Simulation software, Automation, System

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RECENT TRENDS IN THE FIELD OF SIMULATION OF MANUFACTURING SYSTEMS

Abstract

Basic information about new possibilities of manufacturing systems simulation are prepared in this article. Introductory section describes basic information about production system. Core of article consists of simulation software description and its development in 2015. Article described progress that has been made in development of simulation software.

1. MANUFACTURING SYSTEM

Development of automation, machinery, equipment, information technologies leads to formation of integrated production systems in which automatic control, computer controlled manufacturing process may be included various factors relating to manufacturing of product, including construction, technology, intermediate, final inspection, assembly, and also packaging products.

The role of such system is implementation of planned and prescribed technological process to designate intermediate product that is created with given geometric shape satisfying qualitative indicators required specification. It can be said that it is bounded arrangement to each other operating services / features. These parts may be elements, methods of thinking and their products such as diagrams, mathematical methods, simulation models etc.

2. NEW TRENDS IN SIMULATION SYSTEMS

Development of engineering industry has moved significantly forward. Today's manufacturing systems are characterized with options and features to process any type of components, parts, pre-established production processes and customer requirements.

It is very dynamic field that is constantly changing. It is necessary to apply new technology of company to be competitive. Among the latest trends include new innovative software solutions that help users to give detailed view of factory buildings or equipment. Use of such advanced techniques in specialized areas such as systems engineering is a qualitative reversal.

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2.1. Tecnomatix Plant Simulation 12

Tecnomatix Plant Simulation 12 offers management and monitoring of life cycle from design to enter into production (PLM-MES), integration with Simatic IT MES and other offers, and handling of large amounts of data affecting quality of production, which will help to reduce cost, quality and schedule targets. These solutions enable faster response to installation, implementation, quality and production problems. New options:

- **Tecnomatix Easy Plan** - Easy Plan is web application that is intended for creation of production plans, warn against fluctuations in making predictions and numerous product configuration.
- **Tecnomatix Test Manager** - Provides planning, management and implementation of digital test before assembly associated with the roadmap.
- **Planning - Line Designer** - Line Designer allows you to organize and better visualization of the complete production line.
- **PLM-MES integration** - New options for integrating PLM-MES bring improvement in quality of products that combine design intent directly to control activities, use of information and product manufacturing information (PMI - Product and Manufacturing Information) in 3D models using data JT.

2.2. AUTODESK - AutoCAD Plant 3D /plant layout design/ (2015)

Boost productivity, improve accuracy, and coordination offers redesigned AutoCAD Plant 3D plant layout. It is built on AutoCAD software platform known, but new tools bring modern design, 3D equipment for designers and engineers who process images and documents to process. News in the field of projects using AutoCAD Plant 3D: Partial Workspace (DWG files do not need to be downloaded locally):

- Improved Get / Check Out dialogs (Cleaner and less intrusive)
- Plant Vault Options dialog box (Synchronization settings)
- Root-level Project Management (Check In all, Get / Check Out all)
- Synchronization Balloons (Simple way to keep up to date with other user check-ins)
- Vault folder support for projects (Root-only is no longer required).

2.3. AUTODESK - Simulation (2015)

Autodesk Simulation is part of Autodesk solution for Digital Prototyping. It helps to anticipate behavior of product to test innovative concepts. Verify products before production, which will also help to better understand the actual production of the product.

Mechanical part is made up mainly software Autodesk Simulation Mechanical and Autodesk Simulation Moldflow®.

- **Autodesk Simulation Mechanical software** predict product performance, optimize design and verify behavior of product before it enters production. Simulation provides finite element analysis (FEA) for all designers, engineers and analysts, helping to make great and quality products.
- **Autodesk Simulation Moldflow®**. This software provides injection molding simulation capabilities that help CAE analysts, engineers, and designers to verify and optimize plastic parts, injection molds and injection process.

2.4. AUTODESK - Fusion 360 (2015)

Fusion 360 allows to quickly and easily explore new ideas and product designs. Project begins with simple steps to dial shape modeling tools or insert already formed in the shape of the environment Fusion 360. Thus, it is possible to create your own complex of mechanical structures. It also supports import and export files with unlimited CAD translation. Fusion 360 supports translations from more than 50 different types of files.

2.5. Witness - Witness 14

About WITNESS 14 could be said that it is new dimension modeling and simulation. 3D visualization capabilities WITNESS 14 improves previous options Quick3D. Prediction Quick3D environment is generated as in previous versions, it is possible to form 3D model based on model of 2D arrangement. Simple direct import is now taken as standard, enabling users to customize their model using a variety of open libraries with 3D objects.

The main advantages WITNESS 14:

- Higher performance. All models in new software works much faster.
- With graphics cards are supported by features such as shadows - graphic design is significantly better.
- WITNESS 14 provides enhanced library of shapes and objects - provides access to the libraries directly from the Web and free products like SketchUp and Blender.

2.6. VORTEX Simulation software

CM Labs' Vortex technology provides simulation capabilities that set standard for interactivity and 3D dynamic simulation devices and their behavior. Through simulations, help expand knowledge and reduce risks of complex operations. Operators, soldiers, engineers, and drivers are trained to deal with Vortex for over 1000 simulation devices worldwide. Here are describe some of basic program modules:

- **VORTEX Dynamics software** - Allows you to simulate not only mechanical system, but also the interaction in operational environments - including terrain, water barriers, camera systems, gripping, and more.
- **VORTEX dynamics for Vehicles** - Is deployed in hundreds of applications, and simulates complete vehicle drivetrain, steering and braking systems, tire and track ground interactions, and suspension.
- **VORTEX Human** - From port and construction workers to offshore platform riggers and soldiers, Vortex Human characters move and behave just like real people. You can create and configure trainee avatars and avatar points of view, and add non-player characters (NPCs) with assigned AI scripts and forbidden/permitted zones.
- **VORTEX Simulink** - Similarly, robotic controllers developed within Simulink can be run on simulated robots that provide the same results as they would in reality, saving you significant system-level development time and prototype expense.

2.7. Further developed and supported software for year 2015

Website "Capterra The Smart Way to Find Business Software" provides perfect simulation software for the year 2015th. These include: **Nei Nastran - NEi Nastran Finite Element Analysis Engineering Software** (analyze linear and nonlinear stress, dynamics, and heat transfer characteristics of structures and mechanical components), **Powersim Studio** (simulation of environment), **Enterprise Dynamics** (simulation of complex, new or varried processes), **AnyLogic** (dynamic simulation for business applications), **3D Electromagnetic Simulation**, **6SigmaET** (thermal simulation tool), **ANSYS Mechanical Software Suite** (Simulate every structural aspect of a product), **Automation Studio** (simulation of fluid power and automated systems), **C-Radiant** (multi-sensor simulation), **Capital SimProve** (detection tool), **CapitalCMS** (capital Market Simulator), **Creator**, **Dymola** (automotive, aerospace, energy, robotics, and other industries), **E-Hub**, **EPCAD OPA** (business simulation), **ExtendetSim CP** (simulation the behavior of any process), **FiledView**, **Flow-3D** (physical flow processes), **GASP**, **HyperWorks** (rapid design exploration and decision-making), **IVRESS** (virtual reality enviroment for synthesis and simulation), **LMS Virtual.Lab**, **MapleSim** (physical modeling and simulation), **MechDesigner**, **NX 8 CAE**, **Pedestrian Dynamics** (comprehensive crowd simulation software application), **Pitch Visual OMT** (creating and maintaining HLA 1516 Object models), **Robotics Simulation Software**, **SimCAD**, **SimCAD Process Simulator**, **Simio**, **Simul8**, **Simulation Modeling**, **SimWalk**, **SLM**, **SolidWorks Simulation Premium**, **VABS** (for composite helicopter and wind turbine blades), **Working Model 2D**.

3. CONCLUSION

Computer simulation is powerful tool for decision making, analysis, design, performance and understanding operation of complex systems. Allows workers at every level of enterprise to test hypotheses and discover new procedures without need for their implementation. Simulation provides large number of methods to verify understanding of world around space and help to achieve best results as quickly as possible.

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knowledge, knowledge management, knowledge-based systems

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KNOWLEDGE IN PRACTICE

Abstract

The article deals with knowledge in companies that are their creators. Points to the possibility that the recording of knowledge and knowledge management offering. Particularly wants to show the benefits of building a knowledge society for people like that. Second, the use of knowledge-based systems also have disadvantages, which are also part of the article.

1. THE USE OF KNOWLEDGE

Knowledge is an intangible asset of any innovative company that wants its market position definitively confirmed. Building a knowledge management is possible in any society, regardless of the business community. Currently, the trend of creation of knowledge management in large software companies and multinational corporations, but this trend is not curiosity, and thus complements other businesses.

The use of knowledge management has significance mainly for companies:

- with multiple branches located in different parts of the country, or the world,
- focused on a number of fields (with multiple divisions),
- producing intangible assets (advertising agencies, software companies, non-profit organizations, schools, foundations),
- with space for creating apprenticeships, communities, with workers willing to share knowledge,
- operating on the principle of project activity,
- with open corporate culture and adequate technical equipment needed to build sufficient network for the knowledge base.

The implementation of knowledge management and its impact on the work in terms of efficiency and productivity positively affects mainly the following areas:

- improvement of communication between workers or workplaces,
- direct communication with customers,
- improvement of teamwork between employees, workplaces and departments,
- increase of awareness of the company (whether inside or outside),
- more efficient work of employees (in terms of documentation, design, information search, communication, etc.),

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- more efficient use of resources (internal),
- building of knowledge-based society and knowledge workers,
- improvement of company processes (e.g. administration, project management, human resources, etc.),
- improved relations between workers,
- use of modern trends in education, collaboration, educational system interactivity,
- cost savings related to these activities.

Generally, the main motive of focusing on knowledge management for most companies is cost reduction (44%) and reaction to increasing competitiveness in the knowledge management field (42%). These two factors suggest that companies respond to the importance of working with knowledge, whether from the perspective of their own savings and greater efficiency, or because of the risk of lagging behind the competition. Other motives for working with knowledge management are higher expectation of teamwork in the organization (30%), increase of actual value of the company (31%), cost reduction (26%) and easier search for new business opportunities, but this is hardly expressible and measurable.

Based on surveys conducted in 1997 it has found that the benefits of the quality of knowledge management projects are reflected in all areas of the business.

But the implementation of knowledge management does not represent a universal solution for incurred company problems. If the company decided to deal with a particular situation using knowledge management, it is appropriate within the primary considerations to specify bottlenecks in the company and subsequently expectations on the knowledge management. In other words, to propose appropriate solutions to problems through knowledge management and not with it alone.

2. NEGATIVE VIEW OF KNOWLEDGE

Despite all the benefits, analysis referred to in the previous chapter, knowledge systems are faced with the negative. The key question is "will" create knowledge management, because this path is a concept of five years or more.

The real problem is the high and exaggerated expectations of the system itself and also the fact that the concept is still forming region, so it is difficult to define whether it is offered by a knowledge system. The fact that someone claims that their information system includes document management features artificial intelligence and knowledge management does not mean that this is the case indeed.

A substantial part of the chaos stems mainly from an undefined terms, thus creating a universal set of concepts, vocabulary standards in the community, which is engaged in a given area. At present the trend to address this issue, many providers in the area "jumps into the moving train" without exactly staging methodologies and technologies of knowledge management, but if these methods are not developed to the extent that they are successfully applied, we can still talk about the lack of understanding areas of concern.

Nevertheless, if it does not change the recognition of knowledge and understanding of their main holders (employees) in the company, but it will dictate the general fact that the market is the one that decides nothing will change. Companies that use knowledge management more efficient, thus producing the higher added-value and strengthen its position in the market are those that will follow the other companies attempting to keep pace.

Moreover, companies forget the "gray" workers who are carriers of knowledge and have thus be of interest to the capture and sharing of knowledge, rather than these experts retire and left the organization.

The problem also is that knowledge management is not easy to express through specific corporate assets, which in this case, the intangible nature of knowledge. Consequently, it is necessary to continue the development of measures and metrics to quantify the intangibles instead of plain use of anecdotal evidence. Despite the efforts of many, this part still remains an open chapter. After they are sophisticated methods for assessment, recognized and approved by the community is more likely to be accepted by senior management.

If the knowledge management from the perspective of senior management accepted and understood efforts, there are still some potential pitfalls that could hinder knowledge management initiative.

These are for example any of the below:

- culture in the organization is not set to the climate "knowledge is power" but not to "share the power" and techniques then available are not sufficient to create an environment of knowledge sharing;
- actual value of knowledge management is not implemented, because the organization takes it as part of the strategic vision of the company;
- knowledge "warehouses" become cumbersome and difficult to maintain;
- the safety of these storage sites may be compromised and thus know-how;
- knowledge management system is poorly designed and the user is difficult to work with him;
- program planning for knowledge management is ill-conceived and problematic;
- in the event that employees are not motivated in any way, knowledge sharing will be unsuccessful.

The organization must be careful and pay attention to these pitfalls. A key element in building a successful knowledge management is the proper management of change. Building a culture promoting knowledge sharing should be a function of change management in the organization. People naturally resist change, so change management steps and processes should lead to the elimination of these concerns.

If change management is good and all these pitfalls, the company has successfully avoided, then knowledge management has a bright future especially for building organizational intelligence and growth. Organizational learning (ie. Training and staff development) and knowledge management must go hand in hand and so the company moves in transformation from individual learning to organizational learning.

The problems that we introduced in this chapter are from the perspective J. Liebowitz, who sees knowledge management as a constantly evolving area especially for the sector of industry and even governments. Vision for knowledge management sees in successfully transforming individual knowledge into organizational mainly through the power of artificial intelligence.

3. CONCLUSION

Knowledge management as a whole is a huge amount of activities which are interlinked and intertwined. Together they are not something that the company will benefit in many areas. The most important ingredient, however, continue to form people. Benefit from the knowledge systems and it is they who when problems arise leading to disadvantages feedback form, which is important. It can be seen that even though the topic of knowledge management and knowledge systems is highly debated, there are always rumors in terminology and definition of terms. Nothing but does not change the fact that they have a future knowledge-based systems and their importance is growing linearly with the increase of technology in society.

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knowledge base, knowledge acquisition, knowledge team

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ACQUISITION KNOWLEDGE PROCESS

Abstract

The article deals with the process of acquiring knowledge. It describes the activities of individual members of the interdisciplinary team, dealing with the creation of knowledge systems. This article intends to demonstrate importance of teamwork in creating knowledge systems and knowledge base itself.

1. INTRODUCTION

At the present time the company does not suffer from the technical lack of data and information on the contrary. Companies employ a number of employees of which potentially have often no idea. Information can be found in several sources and in various forms. A portion of the necessary information in writing (eg. The final reports, forms, contracts) or directly in the form of computer-readable. The part that is most needed for the creation of a knowledge based system, however, this form is not available.

2. KNOWLEDGE ACQUISITION

The acquisition of knowledge is a process of incremental design knowledge base, verification of their interaction in order to achieve the desired behavior of the system formed.

So far, this process approached ad-hoc methods, but this has not led to the desired result, or to such results that would satisfy the knowledge engineer.

Knowledge Engineer at present a major component of the process and this argument justifies a number of arguments:

- experts are experts in the field of operation, but may not be good analysts and their knowledge may not be appropriate for a correct analysis of the problem and by creating the application of knowledge;
- mission of experts is not sensible to have a realistic idea of the functionality of the knowledge system;
- the role of the expert is integrated into the knowledge of their views, perceptions and prejudices that may not be real;
- the development of the entire knowledge system is time-consuming, require expert participation throughout the whole of his work is demanding and very valuable;
- the role of the knowledge engineer is to answer the question to answers that expert would most like to avoid;

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- view the requirements of expert knowledge creating an application system often differ from the actual users of the knowledge system;
- the acquisition of knowledge also affects the number of experts involved in the development of a knowledge based system, the difficulty of obtaining knowledge and effort to summarize them is equivalent to the contradiction and difference of individual information to a particular problem.

On the other hand, the effort and tendency to perform and create an application system of expert knowledge through the automated creation process applications and appropriate support resources. The arguments for this approach are several:

- learn to formalize expert knowledge representation is easier to pass the knowledge to knowledge-based engineers in the creation of a knowledge based system,
- expression of knowledge through knowledge engineer experts often feel that they express their knowledge is not exact,
- creation of a knowledge based system is faster and without the need for process modeling solutions,
- knowledge and their interpretation is not distorted to lose quality during transmission to the knowledge base,
- falling prices of technology knowledge system emphasize the high cost of human labor required for the acquisition of knowledge and mere compliance knowledge base,
- last but not least there is very little knowledge engineers sufficient quality to cover rapidly increasing demands on their profession.

Despite all this argument is in practice very few support the creation of an environment enabling direct application of the knowledge of experts. One of the available we can mention for example. Aquinas, ETS, Student, Teiresias.

3. MEMBERS TEAM OF KNOWLEDGE ACQUISITION

The whole knowledge acquisition process is thus based on intensive and close cooperation of the knowledge engineer and expert or group of experts. Expert is the bearer of knowledge that creates the framework necessary to solve the problem and creating a model for solving the problem.

Participants in the development and application of knowledge are:

- **Knowledge Engineer** - his work consists of acquiring knowledge and creating knowledge base for the domain-oriented knowledge-based agents. Participates in the specification of the characteristics of the knowledge generated by the system. A very intense collaboration with experts. Acquire, systematize, structure and try to capture lessons in a language that represents knowledge and data base so that the problems can be solved. The knowledge engineer must have a deep knowledge of the formalization of knowledge gained, the derivation of IC solutions alone solving problems in general. Whereas its role is to work with an expert or group of experts (people), it is necessary to be a good psychologist who can "get" the necessary knowledge to such an extent that it can be formalized.
- **Software engineer** - his role is different from the fact that the actual creator of empty knowledge system or creating a domain-based knowledge system using an existing empty system. Depending on the extent of different research team (analyst, designer, programmer, tester and i.).

- **Expert** - is the bearer of all sources of relevant problem areas. Through knowledge engineer is involved in the performance, debugging, testing the knowledge base and knowledge system. Its role is especially true at the conceptualization and modeling solutions and at its own debugging and testing a knowledge base.
- **User** - is the one that the knowledge system used in practice. Knowledge of the system is designed so that its use will not need any deeper knowledge of the internal structure or method of work. The user despite its non-participation in the creation of a knowledge based system is an important part because it represents the only feedback when developing applications.
- **Other project team members** - contribute to the various tasks and are part of the team (project manager, systems engineers and support staff).

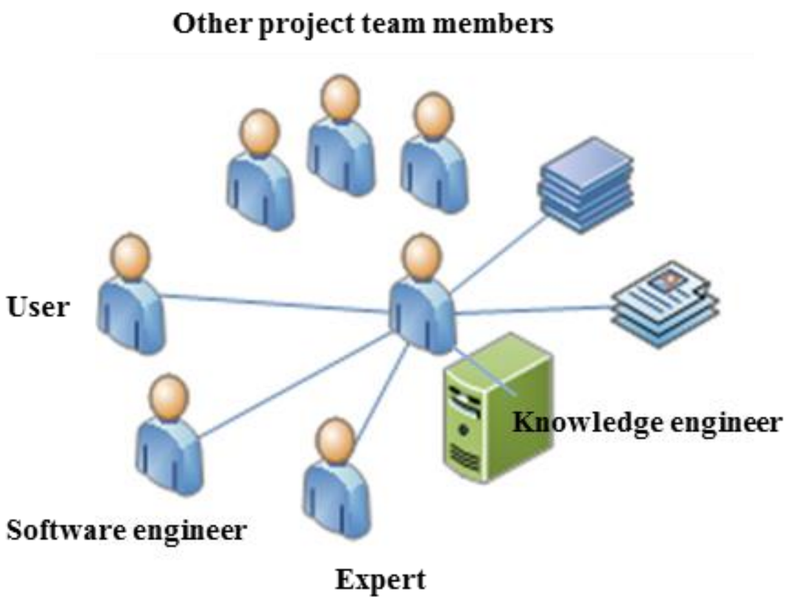

Fig. 1. Members of knowledge acquisition team

4. CONCLUSION

A fact which reflects the need for close cooperation and mutual understanding between knowledge engineers and experts demonstrate subsequent facts:

- in terms of efficiency is a knowledge engineer able to create an average of 3 daily new rules, this fact is in the initial phases of the knowledge of higher and gradually decreases proportionally.
- the price development of one rule is estimated at about $ 700,
- one day expert's work constitutes approx. four days of work a knowledge engineer who analyzes the facts obtained and divided into knowledge base.
- in addition to working in terms of artificial intelligence is an essential part of the creation of interfaces (for data, the surrounding environment, the user).

Knowledge creation and knowledge system not only include acquisition and capture knowledge. The knowledge that we gain, it is necessary to preserve, share and re-use.

Purposeful creation, development, exploitation and valorisation of knowledge is of crucial importance for enterprises and for ensuring their further development as well as in terms of gain and maintain competitive advantage.

The role of knowledge management is to make knowledge within the enterprise to those who need them at the desired location, when they need it and in a form in which it is satisfactory for them to increase the performance of employees and thus the entire enterprise.

Knowledge management is also about creating a corporate culture of technology that will encourage and motivate them to share their knowledge.

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innovations, innovativeness, small and medium enterprises

Irena DUDZIK-LEWICKA*

INNOVATION IN THE ENTERPRISE – AN OPPORTUNITY FOR CREATIVE

Abstract

This article presents and elaborates on the results of a research devoted to innovative actions in small and medium enterprises (SME) in the region of Bielsko-Biała. The aim of the following study is, first of all, to provide evaluation of the innovative character of both small and medium companies, pointing to actions characteristic of each group, and secondly, to offer solutions that would effectively enhance the level of innovativeness in the sector concerned.

1. INTRODUCTION

Innovation, as a crucial factor contributing to development, is fundamental to contemporary economy. It is an inseparable element of efficient management, being of great value to producers, consumers and institutions, with a particular emphasis put on enterprises, since their dynamic development invariably requires innovative actions, that is, new products, services, technologies, operating systems and management strategies. Thus, it seems obvious that innovation plays a fundamental role in business development, as any company which fails to take innovative steps will soon face inevitable stagnation and loss of competitiveness.

Now, innovation is much more predominant in the sector of big enterprise than in SME. This can be directly attributed to the limited scope of action of the latter group, in which case, companies tend to promote just one particular product or service, so that the feasibility of alterations is proportionally lower than in the case of tycoons whose offer is considerably expanded and varied [2]. However, it must be emphasized that it is the SME sector that constitutes the driving force of Polish economy. Therefore, from the viewpoint of the development of economy, what is of paramount importance is the entrepreneurialism, competitiveness and innovativeness of small and medium enterprises.

The huge impact of innovativeness on business has already been appreciated by entrepreneurs in dynamically developing countries. In spite of the fact that the ratio of capital investment in Polish enterprises is continually rising, our country still falls behind if compared with other members of the European Union. This relatively low level of innovativeness in the SME sector is primarily due to financial deficit, since the creation and implementation of innovative actions demands considerable financial outlays. The competitiveness of SMEs on the market lies mainly in their flexibility of the diversification of assortment, as well as in an easier access to the client and attractive price of products and services [1].

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On the other hand, over 90% of business managers partaking in the research within the IMP3rove project[1] declared their readiness to focus on innovativeness. This is an optimistic sign. That is why I decided to conduct a re-analysis in order to verify whether the managers of companies located within the region of Bielsko-Biala actually changed their attitude to innovativeness. The research was focused on small and medium enterprises. The companies put through examination were by no means chosen haphazardly.

2. THE INNOVATIVE CHARACTER OF SME SECTOR IN THE REGON OF BIELSKO-BIALA

The first batch of results concerns the innovativeness of small enterprises. In the questionnaire, the respondents were asked about innovative actions they had recently taken. The results obtained through the questionnaire illustrated that in the course of the past three years the number of innovations enforced by the majority of subject companies had been considerably low. Out of 40 small firms which took part in the test, 38% had introduced at least slight changes in their current business activity. The remaining 62% admitted to have made no innovative contribution whatsoever. The results of the test show that companies employing between 1 and 49 employees are those which fail to implement any innovations. Whenever any innovations had been eventually introduced, they concerned mainly new products or services (52%) or the improvement thereof (24%).

There is a palpable preference towards the introduction of new merchandise, rather than the improvement of production technologies. This may imply that entrepreneurs see a better alternative in launching new products which would satisfy growing demands of consumers, as well as in improving the quality of products already existing. Such an attitude may be conceived of as less costly and unoriginal, but it is definitely more imitative in comparison with modifications of production processes. In conclusion, what can be inferred is that small companies which took part in the research focus on the improvement of their assortment.

Now, the innovative character can be judged not exclusively on the basis of the actions already taken, but also according to planned investments that are yet to be realised in the foreseeable future. As became transparent in the course of analysis, small companies declare a strong inclination to enforcing innovations. Out of 40 firms involved in the test over a half of them (26) promised to undertake innovative actions, whereas 11 of them had already introduced some changes during the past three years.

The results confirm that the companies plan to expand and improve the current range of products, with simultaneous technological improvements. Thus, the majority of the subject entrepreneurs see a new product as the most efficient way of strengthening their position on the market. There is no denying that in order to survive and secure their position, companies must implement innovations and develop their business activity, eventually fostering their competitiveness. The respondents of small enterprises tend to cherish the possibilities of development, which they include in their business plans.

As far as the medium enterprises are concerned, they can be viewed as innovative. They successfully invest in their own development, making use of the means offered by the region of Podbeskidzie.

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1 From May 2007 to April 2008, in Poland, there was an opportunity for a free verification of the level of business innovativeness as a part of the IMP3rove project “Innovation management in SME”, launched in all countries belonging to the European Union.

From what can be seen above, enterprises which decided to introduce alterations opted for new products or services (37%) and the improvement of currently used technologies (26%). On the other hand, although the enforcement of novel technologies reaches up to 15% only, it is quite promising considering the fact that even a slight technological modernisation poses a challenge, and yet medium companies decide to take appropriate steps. It seems that through such innovative actions the subject companies attempt to improve the quality of their products or services, as well as to strengthen or secure their position on the market.

The firms engaged in the project declared that their future marketing strategy entails innovative actions. Only 2 companies showed no interest in bringing in any innovations.

The above statistics illustrate that future innovations involve the design of new products (37%) and the improvement of technologies already employed (29%). It is worth noticing that the respondents place the development of new technologies over the improvement of products currently on offer. The obtained results imply that the enterprises are going to implement those solutions with which they are already familiar, and which have been at least partly introduced before. This, in turn, can be attributed to the fact that innovations are carried out more efficiently if managers possess adequate knowledge and experience. Otherwise, companies need uniform and specific innovative changes, such as, for instance, new technologies.

3. CONCLUSIONS

The research directly points to the varied nature of innovative actions taking place in the SME sector of the Podbeskidzie area. Therefore, it is hard to provide a brief and explicit argument that would aptly summarize the point. Generally speaking, the level of innovativeness can be viewed as average. Nevertheless, such an evaluation should preferably be done separately for each of the groups, i.e. for small, and for medium enterprises. As far as small firms are concerned, their level of innovativeness is relatively low. As was exemplified in the course of analysis, only 38% of the companies have managed to introduce some innovations, whereas all the medium enterprises are currently engaged in robust innovative undertakings. Thus, the group of medium enterprises can be characterised as highly innovative.

The SME sector is basically predisposed to new products or services (small businesses – 52%, medium businesses – 37%), as well as to their improvement (small businesses – 24%, medium businesses – 22%). Furthermore, a considerable number of the medium companies have also managed to introduce modernized technologies (26%). Once again, the results confirm that business entities located in the region of Podbeskidzie are mainly focused on product development. Process developments, on the other hand, are generally preferred by medium firms.

Considering future arrangements, almost all respondents assured that they were going to work on the implementation of innovative changes in their companies. The anticipated increase in innovative activity is to be based mainly on the improvement of assortment. While small enterprises are going to introduce entirely new or modernised products, medium companies opt for the release of new products and the modernization of the technologies used. However, both groups look forward to product development as well as the improvement of current technologies. This regularity is quite logical since innovations in technology lay foundations for the creation of innovative products.

Judging from the results of the research there has been a profound change in the managers' mentality and attitude towards innovations and innovativeness (especially when it comes to medium businesses). What can be observed is a heightened interest in innovations. This is positive news; however, in order to catch up with international companies, Polish enterprises should take more decisive steps to implement innovative actions.

First of all, Polish firms should enforce innovations based strictly on knowledge. The situation on the market (be it local, domestic or global) demands constant observation of potential stock market players and consumers willing to acquire new products. What is more, enterprises ought to begin with in-house changes. The method does not need to consist in personnel rotation, but nevertheless, energetic and thoroughly trained staff plays a crucial role in business development. Secondly, qualified personnel should also be creative, imaginative and inventive. Only having such employees on the board can the SME sector be successful. A staff encouraged to engage in innovative actions is stimulated to come up with novel solutions. On the other hand, the lack of innovative changes and ideas can be obviated by means of in-service training on creativeness. There are multiple techniques (such as brainstorming) which help to stir up creativeness and improve conversational skills of the staff, thus enhancing their efficiency. Thirdly, what is of paramount importance is to secure cooperation between enterprises and research units, whose priority is to support the development of local enterprise. Judging from the observations done during the last few years, the image of this peculiar cooperation is rather negative. It seems that the two environments are more prone to rival with each other rather than cooperate for a common goal. Entrepreneurs accuse researchers of lacking practical knowledge, whereas the latter blame the former for inadequate qualifications of the board. Probably each side has an argument on its favour, but nevertheless, this apparent mutual aversion brings about no benefits but takes a heavy toll on enterprises. Last but not least, a unique opportunity for the development of enterprises in the region of Bielsko-Biała is the development via cooperation, i.e. clustering. The establishment of clusters is the best way to enhance business competitiveness. Companies should therefore form strategic alliances as it leads to lowering the cost of production, a transfer of technologies, a rise in employment, and a subsequent amelioration of the standard of living. What is more, companies that function in clusters have facilitated access to resources granted by the European Union. This is a convincing argument since most managers complain about the scarcity of financial resources for the creation and implementation of innovations, so the subsidies come useful as an invaluable aid.

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ergonomic aspects, work improvements

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ERGONOMIC ESTIMATION OF WORKPLACES

Abstract

Nowadays many machines are not suitable for operators. It comes from short time to modify or create them. Designers have to meet the assumptions for the project. Ergonomics requirements very often are at back side of the project assumptions. This problem can be met in each company. It is important to create set of ergonomic requirements and implemented them before machine is created.

1. INTRODUCTION

One of the method to be competitive company in the present day market is to have ergonomic workplaces on high level. It helps to achieve the goal of the ergonomics: maximum productivity of workers with minimal costs. It involves to have safe workplaces.[1]

What is an ergonomic? "Ergonomics applies information about human behaviour, abilities and limitations and other characteristics to the design of tools, machines, tasks, jobs and environments for productive, safe, comfortable and effective human use" [4].

There are many norms regarding to ergonomics created by European Committee. The organization responsible for all norms is called the International Organization for Standardization (ISO). This organization is responsible for the development catalogs and standardization documents.

There are a few norms which should be taken into consideration during machine design: PN-EN ISO 6385:2005 (Ergonomic principles in the design of work system requirements), PN-EN ISO 26800:2011 (Ergonomics – General approach, principles and concepts requirements), PN-EN 13861:2012 (Safety of machinery – Guidelines for the application of ergonomics standards in the design of machines - requirements) and PN-EN 1005-4 A1:2009 (Safety of machinery - Human physical performance - Part 4: Evaluation of working postures and movements in relation to machinery). [3]

During designing machine it is necessary to take into consideration all essential norms to keep machine safety and ergonomic. However, not all machines in the plant are designed with

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necessary norms. That is important to create set of requirements individual matched to the machines in the company. This standard can be evaluated in periodic audits. [2]

This paper shows form to evaluate different positions in the company and which machine/position is the least ergonomic.

2. ERGONOMICS ESTIMATION OF THE POSITIONS

Analyzed situation comes from automotive market. The company belongs to world class corporation which manufactures high quality fluid transfer systems. The analysis was performed for many working positions to show which machine is the least ergonomic.

It is often that designers take into account just minimum of requirements regarding ergonomics. Designers focus on correct detail process. It is important to create set of requirements which should be implemented during machine design and it must be taken into account during making offers and orders. It could cost more, but it is more profitable in long term.

It was created the questionnaire to evaluate each machine in terms of ergonomics in the company. The questionnaire is fill it out by production operators to evaluate if a machine is enough ergonomic.

There are four evaluated parts in questionnaire: the process of working, information and control, working space and working environment.

There were evaluated 19 positions (from warehouseman and quality controller to machine operator). There are shown only 7 at Fig.1 (result of other positions are similar to shown once).

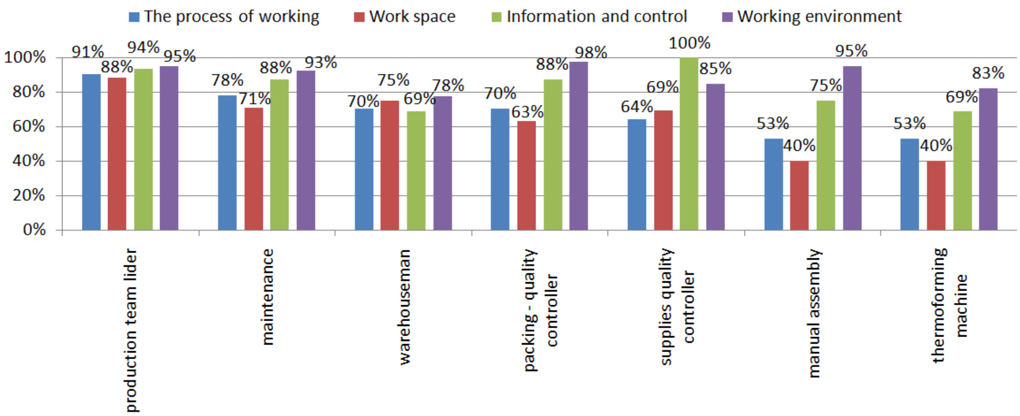

Fig.1. Audit of the positions (without balance)

It was observed that operators rated questions in different way. All these data did not bring much information. These data are very vary and not balanced. It is difficult to rate which position is more or less ergonomic. Certainly the last position (thermoforming machine) at Fig.1.is the least ergonomic All their indicators are below another once.

To see better ergonomic of position, it is essential to deploy balances for each question. It was chosen 5 experts to rate each question from the questionnaire. Based on their evaluation, it was assigned to each question the right (calculated) balance (Fig.2). Average of five experts rating is calculated in before last column and rounded in last column.

	Proces pracy	Expert I	Expert II	Expert III	Expert IV	Expert V	average of balances	balance admitted to the analysis of data
1	number of activities performed in one cycle is optimal to prevent monotypical, one-side movement, the structure of working movements is correct	5	4	5	4	3	4,2	4
2	energy expenditure (dynamic workload) within a limit value	2	3	3	4	3	3,0	3
3	low static workload, the positions held by the employee for more than 3 or more hours during the working day	2	2	3	3	4	2,8	3
4	low mental effort, stress, time pressure, the probability of conceptual work structure	1	2	1	1	2	1,4	1
5	low monotony and monotypes during work shift, high number of rotation within a working day or during the working week, no working on shift	3	5	4	5	4	4,2	4
6	the height and shape of the workplace according to the operator work tasks, high possibbility to adjust workstation	4	4	3	5	5	4,2	4
7	assessment of workers positions (for example by OWAS, REBA, RULA methods)	3	5	4	5	4	4,2	4
8	low weight and easy to handle shape of work pieces or the elements repeatedly raised by the employee	5	4	3	4	3	3,8	4
9	no one-sided load of selected muscle groups - no local effort, total efford is expect	3	4	5	5	5	4,4	4
10	no forced position while working, no necessary additional pressure during operation	3	3	4	3	3	3,2	3

Fig.2. Experts' evaluation of the questions in the questionnaire

The Fig.3. shows rating of the positions after balancing. It is more readable and it is possible to draw more conclusions.

The thermoforming machine is the least ergonomic machine in whole plant. It was necessary to introduce some activities to increase ergonomic rating of this machine. During observation of thermoforming process and thermoforming machine work, it was noticed about 40 points to improve. These improvement would be able to improve operator's work and work's ergonomic on this machine. It is necessary to analyze all cases to implement the best once with small investments.

At first, it was introduced that operator working on this machine is changed every 2 hours. This operation reduce stress, tiredness, wrong working position. As second activity, it was reorganized work process. There is another operator which support the operator working on thermoforming machine. In case of changeover this operator helps to change tools and forms. These activities did not cost anything, because it was necessary to reorganize correctly the working place where the thermoforming machine works. It improved an ergonomic and organization in production line.

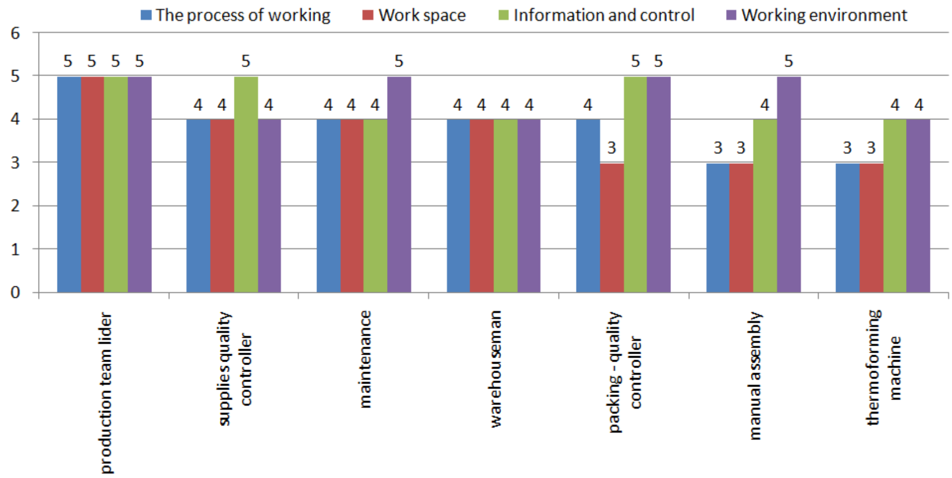

Fig.3. Audit of the positions (with balance)

3. SUMMARY

Continuous improvement of production system is one of main tasks competitive company. Monitoring of working area helps to notice the problems. Improving of one area can cause problems in another area. That is so important design workplaces with European standards to have safe workplaces. Analyzing the norms help to improve workplaces by creating checklists. These kind of checklists consist questions regarding to the rules and law, what cause to see compatibility with standards. There are a lot of areas to improve. But everyone should remember that modifying machines or reorganize workplaces to have high efficiency and safe and ergonomic workplaces, it is necessary to have common sense approach. Designers should balance cost, quality and time regarding to all expected standards and norms. The main point comes from analysis is that designers should have training in ergonomics to have appropriate information about risk coming from wrong designed machine.

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Multi-agent systems, Service-oriented Architecture, Intelligent Product, D-MAS

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THE STRUCTURE OF THE INTELLIGENT MANUFACTURING SYSTEM ARCHITECTURE

Abstract

This article describes the current technological trends. These trends are divided into three layers and integrated into the structure of the control architecture of the intelligent manufacturing system. Ubiquitous computing layer provides industrial internet of ubiquitous things, each with a unique identity that can communicate in real time, capable of data processing and storing on the device or in the cloud. Layer of the virtual factory provides autonomous, intelligent, virtual entities, which are capable of decision-making and communication between them by specific domain ontology. Bionic layer is able to predict and eliminate negative phenomena of the multi-agent systems.

1. INTRODUCTION

The purpose of this article is to briefly describe some of the available technologies and integrate them into the technological structure of the control architecture in intelligent manufacturing systems.

By using these technologies, it is possible to improve the fault tolerance, scalability and modularity of the system. The proposal may achieve better agile and flexible characteristics. The aim is also to reduce the complexity of the control software, to achieve interoperability and reconfigurability thereby achieving overall productivity and reduce the cost of the system.

The proposed architecture consists of three layers (Fig. 1.). These layers are ubiquitous computing, layer, a virtual factory layer and bionic layer.

2. UBIQUITOUS COMPUTING LAYER

Ubiquitous environment is the concept of software engineering and computer science. The basis of this environment is that the computational potential is present everywhere. Ubiquitous computing [1] represents the ubiquity of information technology and computing power that is present in everyday objects we use. This layer provides industrial internet of ubiquitous things, each with a unique identity that can communicate in real time, capable of data processing and storing on the device or in the cloud.

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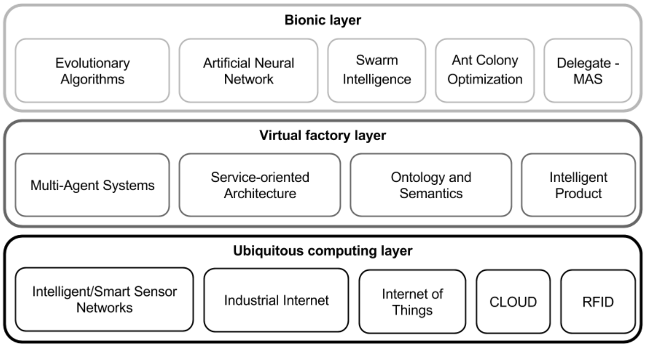

Fig.1. Technological structure of the architecture

2.1. Intelligent/Smart sensor networks

The basis of the ubiquitous computing is a sensor network. In addition to their primary purpose to be able to sense and monitor the physical quantity, sensors can also amplify and filter the signal. Networks of sensors incorporate a digital information processing and communication. Sensors in the network can communicate with each other, perform computations at the level of the entire network and provide processed information on demand.[2].

The network of intelligent sensors allows a higher degree of modularity and reconfigurability of the manufacturing system.

2.2. Industrial internet

The industrial internet is a term coined by General Electric[3] and refers to the integration of complex physical machinery with networked sensors and software. The industrial Internet draws together fields such as machine learning, big data, the Internet of things, machine-to-machine communication and Cyber-physical system to ingest data from machines, analyze it (often in real-time), and use it to adjust operations.

2.3. Internet of things

The vision of the Internet of Things is to connect physical things (goods, buildings, machinery, equipment, buildings, vehicles, animals, people, plants and soil) and enabling the remote control of the physical world. IoT will enhance interoperability and increase the modularity of the manufacturing system.

2.4. Cloud

According to NIST [4] cloud computing is "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

Cloud computing allows fast processing and storing large amounts of manufacturing data. Cloud complements the essence of ubiquitous computing.

2.5. RFID

In production, the RFID is used to uniquely identify the product. RFID is able to store and provide information about the product in which it is located, its material requirements or manufacturing operations. It can store data about what operations have been made on the product and what type of operations and materials is expecting.

This technology enables easy reconfigurability system.

3. VIRTUAL FACTORY LAYER

Layer of the virtual factory provides autonomous, intelligent, virtual entities that are capable of decision-making and communication between them by specific domain ontology. This layer provides a reflection of the real factory in a virtual environment.

3.1. Multi-agent systems

The basis of this layer is the implementation of multi-agent systems. These systems are capable of autonomous and intelligent behaviour. MAS have the ability to be adaptive and to achieve their own goal and plans, using communication, cooperation, coordination and negotiation with other agents.

Emergent behaviour of a phenomenon in which the level of the system has features which are not present at the level of the sub-systems. The whole is greater than the sum of its individual parts.

3.2 Service-oriented architecture

Service-oriented architecture supplements the lack of interoperability. This architecture has the ability to dynamically integrate services within enterprise and inter-enterprise. It can provide unified technology for all levels of the enterprise. Services are the main form of communication, with the emphasis on transparency. SOA improves adaptation and reconfigurability of the control architecture. Manufacturing resources can be changed at run time. The first attempt to merge MAS and SOA was described in [5] as SOMAS.

3.3. Intelligent product

Another technology that directly interconnects the layer of ubiquitous computing with virtual factory and with bionic layer is an intelligent product (or intelligent manufacturing source). Intelligent product has a unique identity. It is capable of effective communication with the environment and is able to retain or store data about itself. On the layer of the virtual factory, an agent of product that actively communicates and uses bionic technology for active visibility of their requirements in a virtual environment can represent it.

4. BIONIC LAYER

Bionic layer is able to predict and eliminate negative phenomena of the multi-agent systems. For example, D-MAS technology uses techniques from ant colony optimization to predict future intentions of agents in virtual environment (weighted graph)

There are also other bio-inspired algorithms. Evolutionary algorithms can bring better adaptation to architecture. Using neural networks, the architecture can learn from old states and predict new states.

5. CONCLUSION

The purpose of this article was to briefly describe some of the available technologies and integrate them into the technological structure of the control architecture in intelligent manufacturing systems. This kind of architecture should improve the fault tolerance, scalability and modularity of the system. The proposal may achieve better agile and flexible characteristics. The aim is also to reduce the complexity of the control software, to achieve interoperability and reconfigurability thereby achieving overall productivity and reduce the cost of the system.

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complex systems, integrated maintenance, integrated manufacturing, supply chain management, customer relationship management

Miroslav FUSKO*

INTEGRATED PRODUCTION MANAGEMENT

Abstract

In the article I described the need for an integrated production management for effective setup of auxiliary and service processes. Of integration systems is at present necessary process to ensure greater competitiveness. In the second part of those requirements which need to be addressed in these systems in the enterprise.

1. IMPORTANCE OF AN INTEGRATED PRODUCTION MANAGEMENT

Integrated production is defined as the use of advanced manufacturing technology (CIM, additive manufacturing, robotics, mechatronics and automation, micro and Nano factories, sustainable and green manufacturing ...), JIT, TQM, human resource management and human capital perspective. Nowadays the companies intend the sentence: the value for the customer is to be created that, to bring value and for their own business. Have not enough to produce products in stock and hope that someone buys them, or forget to introduce new products or forget manage internal processes, and monitor KPIs and under. Today comes Industry 4.0 and this implementation is not possible without knowledge of integrated production management and support processes.

1.1. The starting point is product and customer

The base value, which is between consumers and businesses is product. Every product, whether tangible or intangible nature should be tailored directly to customer, but not long ago it was not. Enterprises provide products, which they so wanted they, so called PUSH system. In today's modern world, it is not quite possible and businesses passed on to system, what customers ask, so called PULL system. Therefore, must change the management of enterprises. In many enterprises at this stage of transformation has picked up, but many businesses, whether productive or non-productive, it is yet to come. Here I can see problem. Businesses are ourselves engaged in very little. [7]

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1.2. What is all needs to integrated management production

If we look at old photos of businesses, we see them often technology-ordinate machines, in some halls was a mess, a large number of inventory and work in progress and the like. But at the current complexity of products, globalization, mass customization, shortening LCC, modularity and reconfigurable production need to standardize the classical forms of organization and management of production must be adapted.Firstly, it is important to awareness of external and internal value chain, which is on display Fig. 1. [3]

Fig.1. External and internal value chain

- SCM (Supply chain management)

  SCM is the external value chain. Relationship with suppliers must have a development and must cooperate with the internal value chain business. Companies must create a network, whether corporate network (pyramidal, dynamic, virtual), horizontal, vertical, combined, across supply chains and the like.
- FACTORY

  The enterprise has in his value chain (internal) to focus on three phases: Preproduction (TPV - research, development, engineering, technology and project preparation and procurement of materials), Manufacturing (technological, auxiliary and service processes) and Sales (usually includes packing, loading, dispatch and acceptance of the product to customers. Here, special rules apply in relation to the quality).
- CRM (customer relationship management)

  CRM is the external value chains. CRM helps plan and manage his enterprise business. There is a possibility of registration of important information about clients, the possibility of breakdowns in customer interest, product or other groups. CRM helps better use, any business opportunity. [5]

Secondly, it is necessary to conduct an audit company and the individual departments. This analysis company finds, that set processes, where there is, what his competitiveness is and is appropriately set KPI´s, development SWOT analysis and benchmarking and the like. SCM and CRM integration into the enterprise, companies can only gain, will help them better communicate with their suppliers and customers, good application PULL system, extermination orders, inventory reduction, better use of resources and so on.

From the above information, follows that, the operational management of production is a complex tool for managing the value creation process in the internal value chain company. It is not just a concept which expresses the level of management, but it is really a genuine complex tool, which they have his partial tools and allows to management control. [4]

2. VISION OF THE FUTURE

Creating production processes oriented on future must anticipate change and use the chance of the resulting faster than competitors. It is necessary attention is not only focused on our own production, we must pay attention also to the creation of value is part of a complex process of the formation of the idea to form the final product. However, the journey does not end here as many companies think. They focus on service and customer satisfaction. [1]

2.1. Complex standardization

In Tab.1 are shown the basic ideas of complex standardization with regard to the process of standardization, the basic directions of the content and information provided by the integrated management of the company. [6]

Tab.1. Ideas of complex standardization

Manage process	Inputs	Processes	Material relations	Indicators of operational management	Outputs
Planned nature	Optimization	Simplification	Exactness	Binding nature	Flexibility
Unification, Simplification, modularity, typification					
Normative base: standards, norms, limits					

2.2. Operational management of production

In Tab.2 are visible integration activities of the external value chain, including management tools of planning, recording and management, with respect to the binding of whether to market, as well as to other outreach activities of the value chain. [6]

Tab.2. Integration activities of the external value chain

Planning	Evidence	Management	Changes
Capital market	Shopping market	Macro-environment	Sales market
Information technology, company tactics, marketing, finance,			
Integration of value creation: sales, production, purchasing			

2.3. Supply chain management

Tab. 3 shows integration activities of the external value chain, in particular the partners and their activities, which enters into an integrated process. In this regard, expresses the target of the mission the partnership of future chain. [2]

Tab.3. Integrations activities of the external value chain

<table>
<tr><td colspan="4">Supplier</td><td colspan="4">Producer</td><td colspan="4">Buyer</td><td colspan="4">Customer</td></tr>
<tr><td colspan="3">Transport</td><td colspan="3">Production</td><td colspan="3">Storage</td><td colspan="3">Business</td><td colspan="4">Customer satisfaction</td></tr>
<tr><td colspan="16">Marketing strategy, strategic marketing, distribution channels, logistics</td></tr>
<tr><td colspan="16">Integration suppliers and customers: partnership, product, markets</td></tr>
</table>

3. CONCLUSION

The goal of any well-functioning enterprise should be the implementation of these new systems. These integrated systems have both positive and negative sides, but if the company wants to succeed in the global marketplace, these new facts must accept and implement them in the company as soon as possible.

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maintenance management, KPI performance, computer integrated system, efficiency, reliability, design

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EVALUATION OF THE EFFECTIVENESS OF MAINTENANCE PROCESSES

Abstract

Maintenance of production facilities is a dynamic system that must take into account many factors, for example type of manufacturing processes, age structure customer requirements (internal, external) and other. In the article are elaborated information regarding the performance improvement of production systems.

1. KPI PERFORMANCE ASSESSMENT OF MANUFACTURING SYSTEMS

If we want to start somethig in the maintenance improvement or transform maintenance on a higher level, we must first evaluate the existing system maintenance. For the evaluation we usde various parameters, for example MTTR, MTTF, MTBF, OEE, R(t), F(t) and others. Necessity is the care of the production facilities, because the more they produce, yet often neglected on maintenance and this we arise disorders and unwanted situations. Because, is a great potential in reducing failures in better maintenance planning which will increase the efficiency of production systems.

Integration of maintenance into manufacturing organization is partitioned into "hard integration" and "soft integration" variables. The "hard" issues deal with integration supported by technology and computers. "Soft" integration, on the other hand, deals with human and work organizational integration issues. An integrated management system technical service (IMSTS) is necessary to increase availability and reliability of manufacturing systems to reduce unnecessary investment in maintenance without great increasing of investment. The integration is achieved through combining optimal maintenance types to have the benefits and to avoid the shortage of individual maintenance types. Thus, the proper maintenance program must define different maintenance plans for different machines. [1]; [6]

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1.1. MTTR (Mean Time To Repair)

This indicator is a basic measure of the maintainability of repairable items. It represents the average time required to repair a failed component or device. Expressed mathematically, it is the total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time. It generally does not include lead time for parts not readily available or other Administrative or Logistic Downtime. [3]

$$\mathbf{MTTR} = \frac{\text{Total time to recovery}}{k_{Rep}} = \frac{\sum_{i=1}^{n} (\text{time to recovery})}{k_{Rep}} \tag{1}$$

where:
- total time to recovery is the sum of the times to recovery for all n objects during a given time period,
- k_{Rep} - the total number of periods in the reconstruction of objects during a given time period.

1.2. MTBF (Mean Time Between Failures)

The definition of MTBF depends on the definition of what is considered a system failure. For complex, repairable systems, failures are considered to be those out of design conditions which place the system out of service and into a state for repair. Failures which occur that can be left or maintained in an unrepaired condition, and do not place the system out of service, are not considered failures under this definition. In addition, units that are taken down for routine scheduled maintenance or inventory control are not considered within the definition of failure. In Figure 1 is MTBF on process discovering the defects. [7]

$$\mathbf{MTBF} = \frac{\text{Total time}}{k_F} = \frac{\sum_{i=1}^{n} (\text{total time})}{k_F} \tag{2}$$

where:
- total time is the sum of calendar periods of service for all n objects, including usable and unusable condition,
- k_F - the total number of failures objects during the observation period.

1.3. Availability

Ability of the item to be in state to perform a required function under given conditions at a given instant of time or during a given time interval, assuming that the required external resources are provided. This ability depends on the combined aspects of the reliability, the maintainability and the maintenance supportability. Required external resources, other than maintenance resources, do not affect the availability of the item. [10]

$$\mathbf{A} = \frac{\mathbf{MTBF}}{\mathbf{MTBF+MTTR}} \tag{3}$$

1.4. OEE (Overall Equipment Effectiveness)

OEE is a “best practices” metric that identifies the percentage of planned production time that is truly productive. An OEE score of 100% represents perfect production: manufacturing only good parts, as fast as possible, with no down time. OEE is useful as both a benchmark and a baseline:

- As a benchmark it can be used to compare the performance of a given production asset to industry standards, to similar in-house assets, or to results for different shifts working on the same asset.
- As a baseline it can be used to track progress over time in eliminating waste from a given production asset. [5]

$$\mathbf{OEE} = \mathbf{A} \cdot \mathbf{P} \cdot \mathbf{Q} \tag{4}$$

where:
- A is availability (scheduled time of operation - break time / scheduled operating time)
- P is performance (normalized time/unit * number of units produced / actual operating time)
- Q is quality level (total production output - the number of rejects / total production output)
- actual operating time = the scheduled operation time - time break

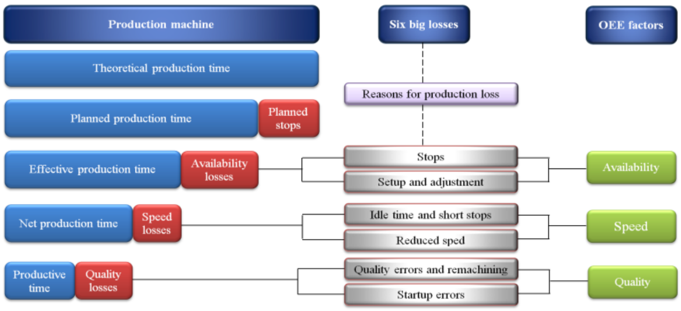

Fig.1. The anatomy of production loss. [5]

1.5. Critical spare parts availability rate

Planning and management of spare parts is one of the key elements of right function of maintenance and service of machines and equipment. Spare parts inventory management system should allow a comprehensive analysis of inventory of spare parts and materials, electronic searching of spare parts and materials and ordering spare parts and materials. [2]

Assessment of criticality of spare parts and material can be performed by two ways:

- expert evaluation – this is difficult in terms of time consumption, labour intensity and qualification of the evaluators,
- quantitative calculation – from the data accessible in information systems.

The best is to combine both ways. First to separate uncritical items from the data available and after that to determine criticality by the expert evaluation for the rest. That is how to save the time of experts which they can spend on critical items. Here are two formulas for critical spare parts availability rate: [8]; [9]

Spare parts cost (maintenance spare perteffort); [local currency and €]; [4] (5)

Material consumption cost (Connection to Purchasing Orders with Good Reception)

- Critical spare parts availability rate (% of critical materials with storage quantity equator superior to defined minimum); [4] (6)

Amount of stocked critical part where available quantity is superior or equal to min / Total amount of critical part with min > 0

2. CONCLUSION

The aim of any well done functioning facilities should be monitoring KPIs indicators. Individual processes are assessed by indicators such. OEE, MTTR, MTBF. Monitoring KPIs is the basis for management decisions. KPIs are very important for the initiation of a new design of efficient and reconfigurable maintenance system. To the performance of the company also contributes an efficient management system of spare parts and materials. In this management system is often used an effective tool - ABC analysis, which shows the most critical group of spare parts.

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OPTIMATION OF PROCESS DOCUMENTATION AS A PART OF CHANGE TO DIGITAL FACTORY

Abstract

The paper presents optimisation of process documentation in company Hessel Slovakia, s.r.o., which was prepared as a part of the change of the company to digital factory. The optimisation enabled to create a user re software tool, which eliminates the errors caused by human factor as well as reacts to the changes in the production system with sufficient flexibility.

1. INTRODUCTION AND PROBLEM STATEMENT

Process documentation in production is well described in ISO 9001:2008, based on which the aim of documentation can be seen in: (a) mediation of information, (b) proof of conformity and (3) sharing of knowledge. Based on the standards, the documents can be used in different forms as hard – copy, magnetic, electronic or optic disks, photos or master sample. The pyramid of documents required in ISO 9001 as defined is given in Figure 1. As described in ISO/TS 16949/2009, documents have to be controlled by the company.

Nowadays, one of the main aims of the company Hessel Slovakia is to transform the company to digital factory. Within this extended process, optimization of documentation is carried out. The attention is paid to minimising the time needed for update of all necessary information in the actual status. This is connected with elimination of hard – copy documents and a software tool availability at each production place. Hereby, all operators would have access to control plans, working instructions and other documents concerning the management of production process.

The paper presents partial results of optimization of documentation in the company applied to selected methods of PPAP.

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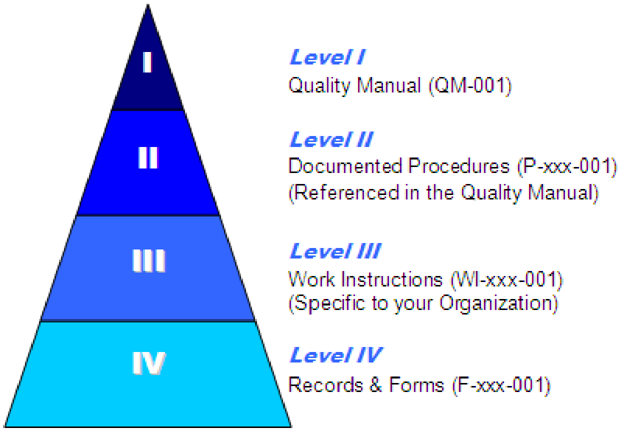

Fig.1. The pyramid of documents (THE9000STORE, 2015)

2. CURRENT STATUS IN THE COMPANY AND IDENTIFICATION OF NEEDS

The aim of PPAP process is to declare that all requirements of the customer which are stated in the documentation of the produced part and the part specifications are well understood and that the production process has the potential to produce the products steadily. Also, that the products fulfil the requirements in planned quantity in every lot size.

The approval process defines requirement, which the company as supplier has to meat including all the specifications from the customer. In this regards, the company has worked out own records for the PPAP management. Following methods were optimized and described in this paper:

a) Process Flow Diagram (PFD)
b) Process Failure Mode and Effects Analysis (PFMEA).
c) Process Control Plan (PCP)

The interaction between these methods is given in Figure 2.

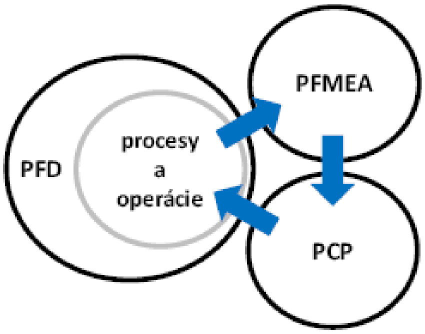

Fig.2. Interaction of the methods used in PPAP (Konduliak, 2015)

The actual system in documentation has several disadvantages. First of all, there is absence of information system for production and actualisation of documents. In operational management of documentation, the main problems may be divided into two groups:

a) Problems occurring in creation of a document – time consuming process, non-uniform terminology, wrong structure of PFD and PCM methods, etc.

b) Problem occurring in sustaining of document – time consuming updating of documents, non-uniform terminology, etc.

Based on above mentioned, the proposed information system is designed so it fulfils following criteria:

- To create „user friendly"system for creation and sustaining of documentation.
- To eliminate actions which are not connected to PPAP process.

3. PROPOSED SYSTEM – OPTIMISED PROCESS DOCUMENTATION

As it is clear from the Figure 2, the relationship among the methods gives the possibility to use the database system. With the use of database system, the content of the PFD, PFMEA and PCP of all PPAP can be unified. This will affect considerably the process control. The main advantages can be defined as follows:

- Creating of the common source of information.
- Replacement of manual typing of data by selection of the existing possibilities.
- Automatic update of changes to all documents containing the changed information.
- Possibility to trace the target documents in printed form, where the change has happen.

The information system is based on the **common database**. It is source of all information and has to provide all available possibilities. The **selective database** use own as well as interconnected sources of data. The main function is to create selection for as many products as the company needs. It means that selection of given data required in documents for selected products are possible.

Out of the selective database, the data are **exported** to **forms**, where all the information is up to date.

4. CONCLUSION

The created software tool offers creation of transparent and accessible database. With the support of created forms and together with navigation among them, user- friendly system can be achieved. The employees do not need to have any special skills. One of the main achievements is, that the time used for process documentation is minimised and errors are eliminated.

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Kaizen, Changeover, Mold, Sustainability

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THE BEST KAIZEN

Abstract

Real sample how to improve and innovate the processes by reducing the wastes using the Lean Manufacturing tools. Kaizen is one of most vital part of these tools. In article we wanted introduce system and describe real case that is implemented in company structure and what is necessary to do to in effective way perform Kaizen events and follow implemented improvements from sustainability point of view.

1. INTRODUCTION TO KAIZEN´S NEMAK SVK

We move our Company forward by everyday use of different activities and tools into improvement. In the last few years we have managed to apply our knowledge and experience through various projects and that has made us better. One of the tools of continually improvement is KAIZEN method, which can reach the set goal within a few days with skilled team of people.

One of the best KAIZEN in last time was focused on shortening of changeover time on Casting line Rotacast 2 (Fig. 1). The main goal was to propose activities for shortening time and consequently to create changeover standard. The team consisted of operators and casting technicians, toolshop specialists, project manager, electrician and process engineer. Two industrial engineers moderated and lead this KAIZEN.

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Fig.1. RotaCast 2

2. KAIZEN DEVELOPMENT

The first day contained training the members of the team about KAIZEN rules and mapping current state by observation of changeover of product VW Crafter to SGM. This observation was focused on recording of operators internal activities. Total changeover duration was over 1 hour and 47 minutes and lot of wasting and improvement opportunities were recorded.

After mapping of current state team analyzed all possible problems using Ishikawa diagram. Afterwards the most important causes were chosen and solution to this problems have proposed.

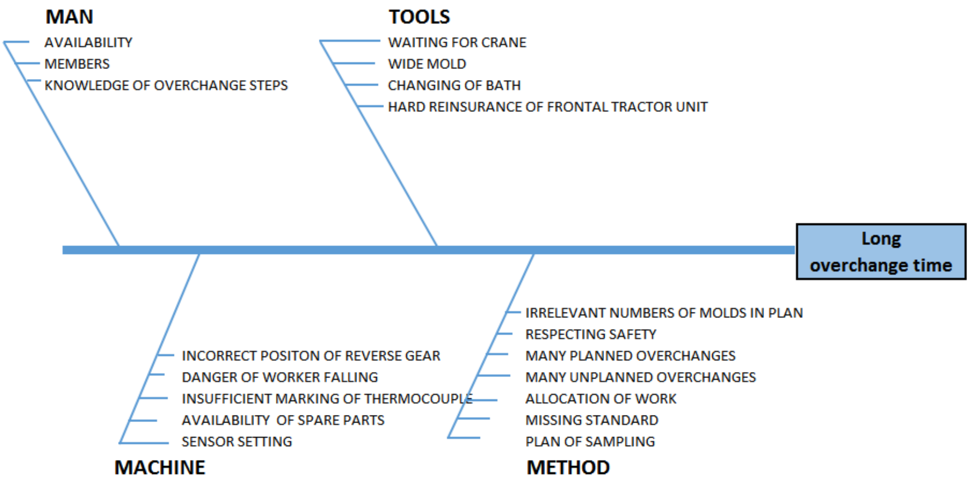

Fig.2. Ishikawa diagram

After implementing most of the activities the changeover was repeated. Single activities and their duration were observed. Changeover was implemented on the last KAIZEN day for product SGM on product SGM – new mold. Total changeover duration was over 1 hour and 5 minutes. This resulting time is 40,2% shorter, which means the goal was reached.

The second goal was to create the changeover standard. The standard was created and so standard for disassembling of mold and standard for assembling of mold.

The moderator task is to written down all activities, which are done during KAIZEN days and make task list. In this document are written all tasks, implementation dates, responsibilities and difficulty of tasks. As some tasks are more difficult and time consuming, they were some open tasks at the end of this KAIZEN too. Tasks fulfillment success rate was 76%. We can see activities divided by importance and difficulty, which were done and brought resultant state changeover (Fig. 3 and Fig. 4).

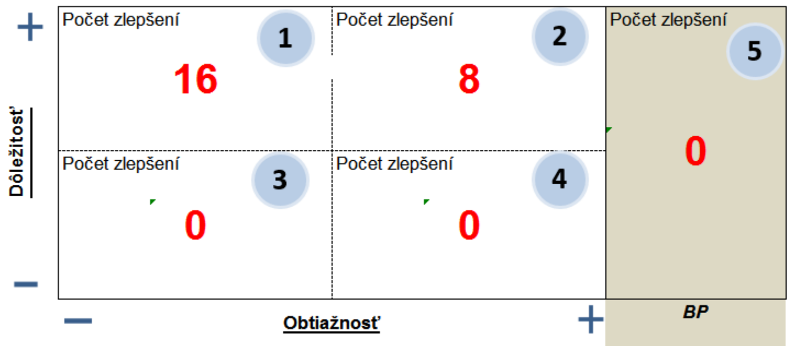

Fig.3. Table of difficulty and importance

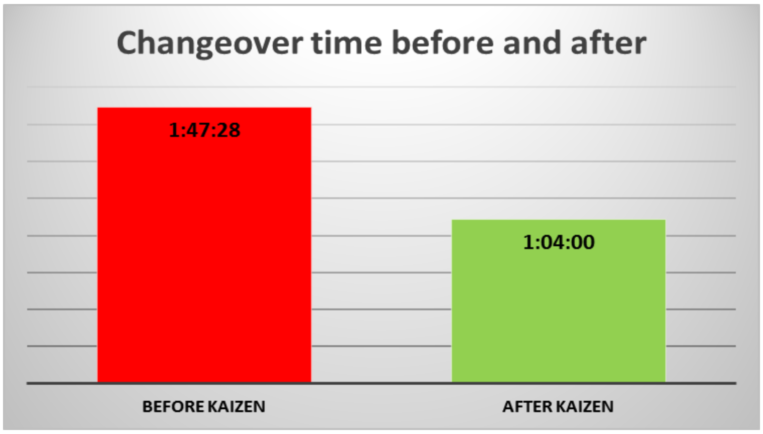

Fig.4. Changeover time before and after KAIZEN

All results as well as open tasks are presented in final presentation in front of involved people and management of our company.

3. FOLLOW UP MEETING AND STATE AFTER

For preservation and development of results achieved during the KAIZEN, the most important is to determine a system of control and evaluation of current situation in define intervals. Each month we control changeover time on this line Rotacast 2 for sustain and improving activities and shorting changeover time.

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Ergonomics, EAWS, physical load, Slovak legislation

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COMPARISON OF SCREENING ASSESSMENT OF PHYSICAL LOAD AND SLOVAK LEGISLATION

Abstract

The aim of the described research was to define the correlation and differences between the ergonomic evaluations of work methodologies and evaluation of physical load by standard methods of ergonomics and requirements for evaluating of physical load of employees covered by Slovak legislation. The outcome of the research was a proposal for an optimal method for the assessment of physical load and requirements of the Slovak legislation.

1. THE MAIN REASONS FOR RESEARCH

One of the area for solutions thought digital factory is ergonomics and evaluation of physical load. Ergonomics is evaluated during process of virtual creating of workplaces. It is an actual topic in Slovak and European industry. We must to evaluate physical load of workers on workplaces and create a health workplaces. This is a main reason – why we realized this research.

The second reason is – we have some legislation, ISO standards, classic tools and digital factory tools. Any larger company (automotive) has its own rating system for physical load. For example OCRA in Italian companies, or EAWS in Volkswagen, or ŠKODA AUTO.

We are able to realize a lot of methods for physical load evaluation. One of new tools is screening method EAWS – Ergonomic Assessment Worksheet. It is a method for 1.st level evaluation of physical load. Thanks to a big researchers and lot of specialist we have also software version of EAWS, named AP-Ergo. In Digital Factory we can use this method in Tecnomatix Process Simulate Human. EAWS is based on a lot of older methods as NIOSH, RULA, OWAS, Key Indicator Method, like technical standards (EN 1005-1, 2, 3, 4, and 5) and some legislation. This methodology, however, not correspond to the conditions laid down by the applicable Slovak legislation. In Slovakia, there is no clear method for comprehensive evaluation of physical load of the employee.

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2. METHODOLOGY OF RESEARCH AND STEPS

The research stages can be describe by 7 main areas:

1. Subject comparisons (defined evaluation systems).
2. Needs of analysis.
    a) To define used materials.
    b) To defined fields of EAWS as the baseline condition for an assessment.
    c) Confrontation of version 1.2.1 and version 1.3.2c.
3. Grounding of the evaluation template - logic and structure.
4. Analysis of origin evaluation systems and their interrelations.
5. Outputs.
6. Evaluation.
7. Draft of methodology.

The exact specification needs to supplement areas / subareas / parameters to the system EAWS and current legislation SR.

2.1. Introduction of way for comparison

1. Defining of evaluation systems.
2. Analysis of the evaluation (analytic part., identification of areas).
3. Identification of subareas.
    3.1 Identification of parameters.
        a. Identification of parameters borders.
        b. Specified a number of intervals for parameters.
        c. Specified a limitations of parameters.
    3.2 Specified articles of evaluation.
4. Comparison: complex and partial.
5. Draft of methodology - Based on the results of conformity and defined differences (strengths and weaknesses of assessment systems).

2.2. Methodology of research

For the solution was created evaluation sheet which was under research modified, based on specific parameters, includes evaluation systems. This worksheet is used to record the detailed characteristics of the evaluation system and serves as input for comprehensive comparison. The fundamental principle in implementing it was content uniformity for individual evaluation systems to allow detailed and accurate comparison. Individual areas - sub-area - parameters - user objects - borders – intervals, had to be named in such a way, when a detailed comparison of the collision haven´t occurred, or issues to be included in the appropriate fields. Precondition for accurate processing was also detailed analysis of each defined evaluation systems. Each of the evaluation systems, has been analyzed in terms of ergonomics - particularly in terms of physical activity. For a comprehensive comparison had to be defined and uniform assessment parameters, had to be comparable regions and sub-regions. They must be by the same system boundaries and intervals recorded in the same units for the defined parameters. The following sections include studies of completed evaluation sheets, as they were behind logically created and filled and corresponding conclusions or model examples. At the end of the research are processed matrix a comprehensive comparison of all four evaluation systems on the basis of sub-regions and parameters that are evaluated. Matrix are divided by areas of evaluation, the evaluation of working postures, action forces a load and repetitive activities. The main part of the research are suggestions for possible improvements EAWS and Slovak legislation in relation to the assessment of physical activity. These proposals are developed based on the results of evaluations and comparisons, which includes the study – as output of research. Each evaluation systems includes strengths and weaknesses of the system, and weaknesses based on their severity have been proposed in the draft modifications (changes) of the evaluation system.

3. WEAKNESSES OF SCREENING SYSTEM AND LEGISLATION

3.1 Main and partial weaknesses of EAWS:

- EAWS - We do not recommend the current output used for the accurate decision on a comprehensive risk reporting workplace. It is a combination of different evaluation systems, which are in terms of ergonomics, but don´t effectively merge these different ratings into a single output.
- EAWS - worksheet in the existing form (in 1.3.2c de) is in training and related materials misleading and it is almost impossible to use it efficiently.
- EAWS - In the worksheet are not recorded all relevant facts - the parameters ranges - borders and the like. (Forces in that module 2 is in row 18 for both hands, the angular range in evaluating the positions of the joints, for example torso position, the possibility of using linear interpolation for the most accurate assessment.
- EAWS - used for interpreting the results non-objectively - as strict bounds "verdict" of workplace three levels - low risk / potential risk / high risk. Method can be used if the presented partial results, is formulated as a measure of risk. Especially these partial results must be comparable with current legislation.
- During evaluating the developed forces - the burden of fingers, arms and body in Module 2 (action force) do not differentiate gender, the correction should occur, because it is about weight load as well as the handling of loads where gender is taken into account.
- Respect to said method of risk assessment in Module 3 - MHL converter evaluation was conducted to analyze objectivity. Based on the conclusions suggest to change the system evaluation in this module.
- Basic postures are missing in many cases the angular range - the borders.
- Assessing action forces - forces the hand, arm - absent take account the position of the wrist.
- By evaluating manual handling limits – carrying and holding 1-2 kg objects are considered as a load in the evaluation only if is transferred more than 2000 times per 8 hours! (Earlier version - 1.2.1). This assessment absent in the newer version 1.3.2
- Pushing and pulling - free identification of the position of the operation, all options are only pushing and pulling with the device - it is not possible to assess the pulling and pushing without device, which are frequent situations.
- Evaluation repetitive activities - it would be more accurate to divide the angular range and do not add extra point for the risk to excess extreme position.
- Repetitive activities - additional factors - disadvantage - can be selected only one factor among many workplaces there is a risk that there are more, and 3-4, in which case the result is a risk of distorting artificially reduced! There is the possibility of adding 2 points for risk when used as a hand tool - but the ergonomics strictly excludes!
- Extra points - other physical exercise - sitting on an incline, work in a protective suit, walking down the grid, control overhead - caster, cost control overhead - to 15 points - i.e. caster.

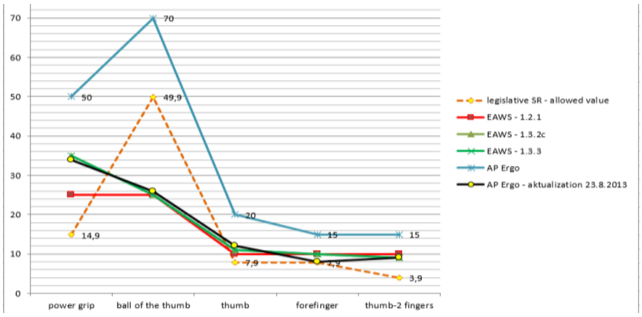

Fig.1. Demonstration of problem- differences of action forces Fmax legislation SR-EAWS-AP Ergo [author]

4. CONSLUSION

At the end of the research was created processed matrix comprehensive comparison of all evaluation systems on the basis of subdivisions and parameters. Matrix are categorized by user, the user working positions, action forces handling of loads and repetitive activities. The main part of the research are suggestions for possible improvements EAWS and Slovak legislation in relation to the assessment of physical load. These proposals are developed based on the results of the evaluation and comparison, the research contains. Creators of EASW in Germany have implemented more than 90% of remedies and in Slovakia is creating new decree to physical load evaluation based also on this research.

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Configuration, Optimization, Arrangement

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OPTIMIZATION OF THE MANUFACTURING CONFIGURATIONS

Abstract

The article deals with the optimization of generated manufacturing configurations. The first part is about approach through which we can generate different manufacturing configuration. In the second part is the attention focused on generation of manufacturing configurations. Here we have used the above approach and we have also selected the most appropriate configuration which structure is then optimized so that we can effectively meet the specified requirements.

1. INTRODUCTION

Modern manufacturing enterprises are facing unpredictable, rapidly changing and growing the global competition and other issues. Reconfigurable manufacturing systems have some characteristics as changeable structures which are modular. This manufacturing system can be quickly adapted to the product, parts and behaviour of customer changes. These changes are driven by competitive struggles, customer needs and innovative technologies. The change must be driven effective in economical way. Therefore it is needed to make research in dynamical optimization of manufacturing systems through reconfiguration by adding and removing of resources.

1.1. Pascal's Triangle as an effective tool for generating manufacturing configurations

Professor Y. Koren from the University of Michigan as first tried to mathematically describe a method of generating manufacturing configurations. On the base of defined operation times, required demand, time of the machine work, can we exactly calculate how many machines from our future system will need. Pascal's Triangle may help as to quantify the number of all possible manufacturing configurations which consisting from the calculated

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number of machines. With the help of this method we can calculate the number of configurations arranged exactly by required manner.

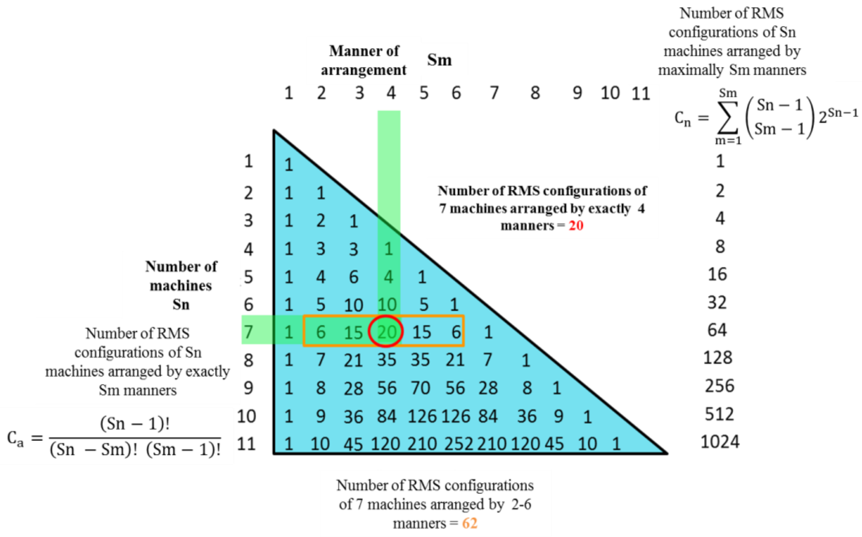


Fig.1. Pascal's triangle for computing manufacturing configurations [3]

For example, production of 150 parts in 2000 minutes with an operation time of 90 seconds per part. Requires Sn = 7 machines. According to figure 1, for seven machines and number of possible arrangements from 1 to 7, there exist exactly 64 possible configurations. The number of possible configurations can be reduced according to operations priorities.

2. CALCULATION OF REQUIRED MACHINES AND SELECTION OF MANUFACTURING CONFIGURATION FOR OPTIMIZING THEIR STRUCTURES

For demonstration we chose the following example. We considered that we offer two product variants. For each variant is demand expressed in units and deadline of required delivery of the order. We took into account also rewards expressed in euros, which take in to account offered price of product variations and demand for each variation. We also phrased the costs which are expressed in euros. The costs include investment costs for the purchase of new equipment which can not meet the required operations and also costs of whole manufacturing process. The costs include investment costs for the purchase of new equipment which can meet the required operations and also cost of whole manufacturing process. We have also identified operating times for each module of product variant. We have also quantified the average time of tasks within each operation, which based on the proportion of total production volume and of the required production volume for the product variant. For calculating of required machines number we have used the average task times.

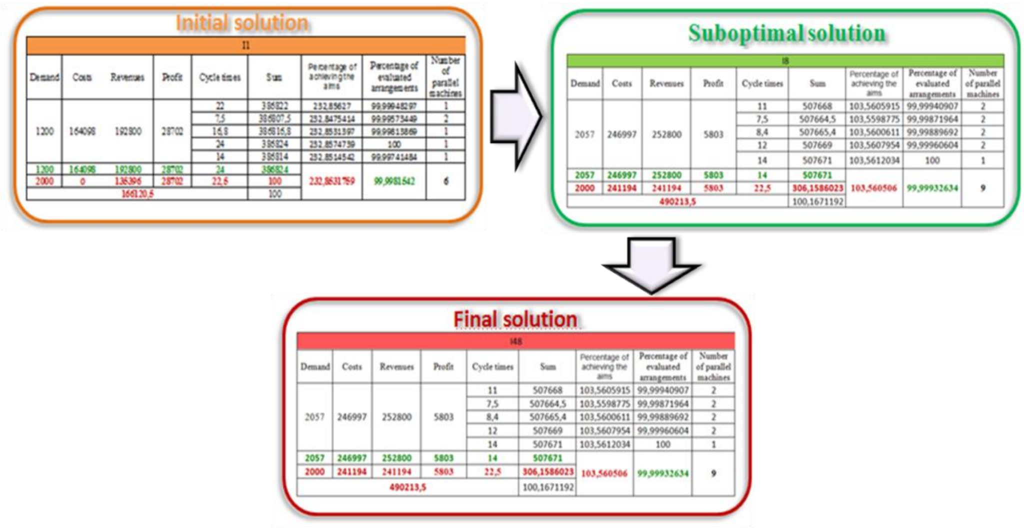
Tab.1. Input data for calculation of the number of machines

	Demand (pcs)	Rewards (euros)	Costs (euros)	Delivery time (seconds)	Variant type	Operation time - Op1 (seconds)	Average task time - Kx1 (seconds)	Operation time - Op2 (seconds)	Average task time - Kx2 (seconds)	Operation time -Op3 (seconds)	Average task time - Kx3 (seconds)	Required cycle time (seconds)	Required number of machines Sn
Variants	800	72800	13533	25000	1	0	0	25	10	15	6		
	1200	120000	12600	20000	2	0	0	20	12	15	9		
	Demand (pcs)	**Rewards (euros)**	**Costs (euros)**	**Delivery time (seconds)**	**Variant type**	**Operation time - Op4 (seconds)**	**Average task time - Kx4 (seconds)**	**Operation time - Op5 (seconds)**	**Average task time - Kx5 (seconds)**	**Operation time -Op6 (seconds)**	**Average task time - Kx6 (seconds)**	22,5	6
Variants	800	72800	13533	25000	1	12	4,8	24	9,6	14	5,6		
	1200	120000	12600	20000	2	20	12	24	14,4	14	8,4		

We concluded that to meet current requirements are needed just six machines. Machines can be arranged in different configurations. The limitation of the configuration number based on task priorities. This approach greatly reduces the number of possible configurations. Since we are talking about five operations, we have taken in to account five stages of the arrangement. From the Pascal triangle we can consider that there are possible only five configurations. After than we have also analysed which configuration meet the requirements. We took also into account production volumes. Calculation of production volumes based on a maximum cycle times identified in configurations and also from operation time of configurations. The challenge was to synchronize the cycle times so that we have a continuous production. We have considered that required volume can be fulfilled by configuration arranged such that in a first stage of arrangement will be just one machine, in second will be two machines, in the third stage will be one machine, in fourth and fifth stage will be only one machine.

3. OPTIMIZATION OF MANUFACTURING CONFIGURATIONS

We have assigned to chosen configuration production volume that can be produce by selected configuration but also production cost of the required volume. We have subsequently assigned to selected configuration aim value of production volume. In our case is aim to achieve the required production volume. By using these indicators, we can quantify if our designed configuration will produce profit or loss. The aim is produce profit. Subsequently we have assigned cycle times to each level of the configuration. The aim is to get within the arrangement such maximum cycle time by which can configuration produce the required production volume. The challenge was to synchronize all cycle times in manufacturing configuration. The cycle times were synchronized so that we can reach continues production. We have also quantified the sum of parameters, which belongs to different levels of arrangement. We have also calculated values for evaluating function and value for the aim function. For reaching of good solution we have adding and removing machines in various stages of production layout configuration. The entire process of generation of manufacturing configurations can be seen in the following figure.


Initial solution

I1								
Demand	Costs	Revenues	Profit	Cycle times	Sum	Percentage of achieving the aims	Percentage of evaluated arrangements	Number of parallel machines
1200	164098	192800	28702	22	386822	232,85627	99,99948297	1
				7,5	386807,5	232,8475414	99,99573449	2
				16,8	386816,8	232,8531397	99,99813869	1
				24	386824	232,8574739	100	1
				14	386814	232,8514542	99,99741484	1
1200	164098	192800	28702	24	386824	232,8631759	99,9981542	6
2000	0	135396	28702	22,5	100			
166120,5					100			

Suboptimal solution

I8								
Demand	Costs	Revenues	Profit	Cycle times	Sum	Percentage of achieving the aims	Percentage of evaluated arrangements	Number of parallel machines
2057	246997	252800	5803	11	507668	103,5605915	99,99940907	2
				7,5	507664,5	103,5598775	99,99871964	2
				8,4	507665,4	103,5600611	99,99889692	2
				12	507669	103,5607954	99,99960604	2
				14	507671	103,5612034	100	1
2057	246997	252800	5803	14	507671	103,560506	99,99932634	9
2000	241194	241194	5803	22,5	306,1586023			
490213,5					100,1671192			

Final solution

I48								
Demand	Costs	Revenues	Profit	Cycle times	Sum	Percentage of achieving the aims	Percentage of evaluated arrangements	Number of parallel machines
2057	246997	252800	5803	11	507668	103,5605915	99,99940907	2
				7,5	507664,5	103,5598775	99,99871964	2
				8,4	507665,4	103,5600611	99,99889692	2
				12	507669	103,5607954	99,99960604	2
				14	507671	103,5612034	100	1
2057	246997	252800	5803	14	507671	103,560506	99,99932634	9
2000	241194	241194	5803	22,5	306,1586023			
490213,5					100,1671192			

Fig.2. Optimization of manufacturing configurations

Within the optimization we have used 48 iterations. Suboptimal solution was identified in the eighth iteration. We found that we need nine machines arranged so as we can see in the previous picture. It should be noted that we must for cost recovery increase the overall price which is offered for product variants.

4. CONCLUSION

Before processing this article were thoroughly analyzed the essential characteristics of reconfigurable manufacturing systems. Optimization of manufacturing configuration was carried out in order to fulfill the set requirements. This approach highlights desired efficiency optimization of the manufacturing configuration of proposed configuration.

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Evolutionary algorithms, genetic algorithm, layout4

Viktor HANČINSKÝ* , Martin KRAJČOVIČ**

A MODERN APPROACH TO PLANT DESIGN

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 at the University of Žilina.

1. INTRODUCTION

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

Genetic algorithms are based on the Darwinian principle of natural evolution that he described in his book "On the Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life"(1859).

The main principles are:

1. The organisms reproduce with geometric progression, but only a small percentage of them survive to the adulthood.
2. Individuals in the population are slightly different (variable). Their survival is not random, but there is a constant struggle for life, where only organisms that are better adapted to the natural conditions than their competitors can survive.
3. There is therefore a natural selection, thanks to which the overall adaptation of organisms gradually increases.

In the seventies of the twentieth century, genetic algorithm was proposed by J.H.Holland as an abstraction of appropriate genetic processes. A decade later, genetic algorithms became one of major rapidly developing fields of informatics and artificial intelligence. The basic procedure of genetic algorithm can be seen in Fig. 1, with evaluation and evolution sections highlighted.

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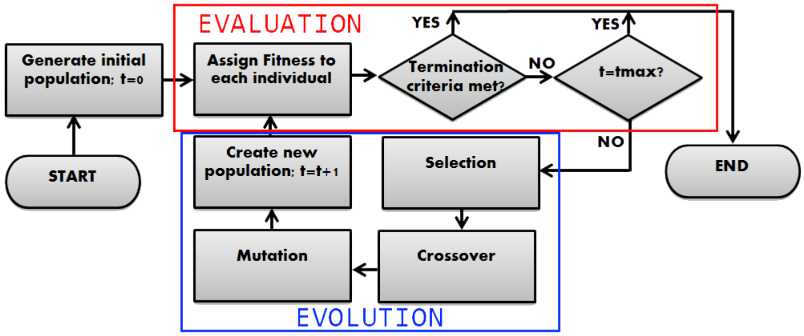

Fig.1. Basic genetic algorithm

2. EXAMPLES OF USAGE

Out of many application fields we can mention the following examples:

- design of products, their components or materials,
- robotics,
- logistics,
- job scheduling,
- facility layout design and optimization,
- balancing manufacturing and assembly lines,
- machining,
- data mining.

If we focus on the plant design, we can also find several solutions. Gupta and Kyparisis in 1996 used genetic algorithm to create product families and also to design a layout for individual manufacturing cells. The developed algorithm however was focused more on the arrangement of cells or production facility areas, rather than creating the layout itself. The arrangement of machines in individual cells was not taken into account (Nur Fadhillah Binti Saleh, et al., 2008).

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

Based on the fact, that no complex interconnection between the plant layout design, genetic algorithms, and software used to develop and optimize the plant design project, we proposed our own solution to this issue.

3. PROPOSED SOLUTION

Currently, within dissertation thesis solved at the Department of Industrial Engineering at University of Zilina, system for plant layout design is being developed, utilizing genetic algorithms and Matlab/Octave environment. At this stage, input and results are transferred from/to Excel spreadsheet, where simple user interface was created. In the spreadsheet, we input parameters such as number of machines, dimensions, types and probabilities of genetic operators or intensities and relationships between workstations/machines (Fig. 2).

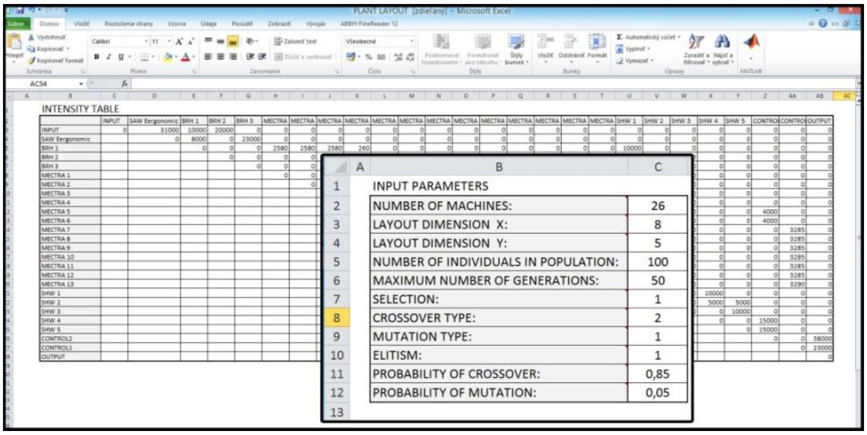

Fig.2. Input sections of spreadsheet

After setting the input parameters we run the layout generator. It is important to note, that the algorithm itself is coded to work with both Matlab and Octave, where GMU Octave is distributed under general public license. The algorithm creates initial solutions in specified quantity and performs evolution. After the run, results are transferred back to Excel. Returned are X and Y coordinates, results of the objective functions and graphic interpretation. Following figure shows the average and best fitness values during the run, and obtained solution visualization in Excel.

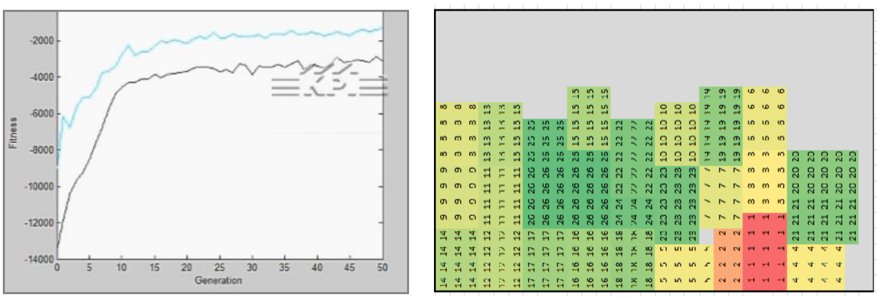

Fig.3. Best and average fitness of the run and the obtained solution

Next steps will include adding third dimension – height to chromosome, to check if machine fits in the particular area of the facility and interconnection with AutoCAD software with Tecnomatix extensions FactoryCAD and FactoryFLOW, where obtained plant layout will be constructed and evaluated.

FactoryFLOW extension allows performing static evaluation of the proposed layout such as material flow analysis, aisle congestion analysis or capacity verification and create graphical representation of the results (i.e. Sankey diagram, D-I chart). With FactoryCAD extension, we can insert 3D models of machines in *.JT format, thus creating a 3D model of machine layout with the ability to perform area analysis. Also, thanks to support of SDX (Simulation Data eXchange) format, we can connect the layout with Plant Simulation software, to perform dynamic analysis. Thanks to these functionalities, we can not only get possible layout solution in 3D, but also evaluate it both statically, and dynamically, which provides us with advantage over solutions where only simple non-interactive block layout is created. The whole concept can be seen in Fig. 4.

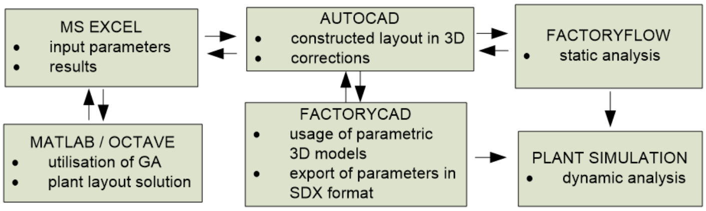

Fig.4. Proposed concept of integration of genetic algorithms within plant layout design

4. CONCLUSION

The aim of this paper was to present concept of utilization of genetic algorithms within plant design developed at the Department of Industrial Engineering. The proposed solution generates layout based on user-defined attributes, such as intensities and relationships between machines/workstations, their dimensions and also parameters of the genetic algorithm itself. After the run proposed layout with results is transferred back to excel. Also, the possibility arises to construct solution in Autocad with FactoryCAD/FLOW extensions, enabling the user to verify obtained layout statically, and with the help of SDX format also dynamically in Plant Simulation Software.

This paper was made about research work support: KEGA 004ŽU-4/2013 - Integration of advanced information technologies and e-learning into education of manufacturing and assembly systems design (AIT-MASD).

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Industry 4.0, cyber-physical system, IoT, IoS, smart factory

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INDUSTRY 4.0 – NEW ERA OF MANUFACTURING

Abstract

We introduce and describe one of the most discussed topic of last years. Group of high-level experts from academy and industry in Germany described now industrial concept called Industry 4.0. In this article we introduce and describe basic facts about this concept, main idea, components and principles of this concept.

1. INTRODUCTION

The first mention of the concept of Industry 4.0 was presented in 2011 at the Hannover Fair. Subsequently, in 2012, a task force led by Siegfried Dais (Robert Bosch GmbH) and Henning Kagermann (German Academy of Science and Technology), which then this concept in 2013 and finalized. This strategy is also known as the fourth industrial revolution. While the first industrial revolution was based on the use of steam and steam engines, the electrification of the second, third on computers and robots and the fourth is based on the use of so-called Cyber - physical systems (CPS).

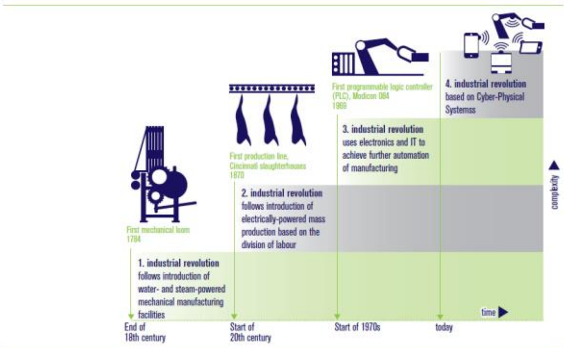

Fig.1. Chronological progress of the industrial revolutions [2]

The main idea of the concept is the interconnectivity of production machinery, machined products and semi-finished products and all other systems and subsystems of an industrial

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enterprise (including ERP, sales systems, etc.). To create intelligent distributed network of diverse entities throughout the value chain forming, these systems operate relatively independently and communicate with each other as appropriate [1].

2. THE BASIC COMPONENTS OF THE CONCEPT INDUSTRY 4.0

2.1. Cyber-physical system

An important component of Industry 4.0 is a combination of physical and virtual world. [2]. 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. Development of CPS is characterized by three phases. The first generation of the identification technologies such as RFID tags, which are used for unique identification and tracking. The second generation of the CPS sensors equipped with a limited range of functions. CPS third generation are able to store and analyze data, are equipped with sensors and are connected to the network.

2.2. Internet of Things

According to Kagermann [3], 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.

2.3. Internet of Service

Internet of service allows provision of services via the Internet. IoS consists of participants, infrastructure services, business models and services themselves. Services are offered and merged into value-added services from different vendors, and communications via various communication channels. This approach allows different variants of distribution in the value chain.

2.4. Smart Factory

Smart factory is also referred to as key advantages Industry 4.0 [2]. Smart factories are defined as factories and machinery to assist people to fulfill their tasks. This objective is fed on the basis of information obtained online, so is every moment possible to ascertain the status of the device, the position and the like. These systems perform their tasks on the basis of information from the physical and virtual world. Information from the physical world as location or condition of the machine, the information from the virtual world as electronic documents, drawings or simulation models. Based on the above definitions CPS and IoT can be described as the factory where CPS communicates through the IoT and helps to achieve its stated goals.

3. THE BASIC PRINCIPLES OF THE CONCEPT INDUSTRY 4.0

Concept Industry 4.0 is based on six basic principles:

- **Interoperability** - Interoperability is a very important means of the concept of Industry 4.0. In companies with this concept of the CPS and people connected via the Internet of Things and Internet of Services. Use of cooperation between these elements is key to the success of this concept.
- **Virtualization** - Virtualization is able to monitor the physical processes through CPS. Sensor data obtained are connected to the virtual enterprise model and simulation models. This creates a copy of the physical world in a virtual environment. The virtual environment is the opportunity to simulate the processes. [3]
- **Decentralization** - With the growing market demand for products increases the complexity of the central control. Embedded computers allows the device to be free to decide which is significantly decentralized control systems.
- **Capacities in real time** - control systems is essential to collect and analyze data in real time. On the basis of the information gathered can respond in real time, for example to malfunction or shifting production to another device.
- **Service-orientation** - services companies, CPS and people are available through IoS and thus they can be offered to other parties. They can be internal or external. It is possible, for example, to access those services through Web services.
- **Modularity and reconfigurability** - Modular systems are able to flexibly adapt to changing requirements to extend or change modules. Modular systems are therefore easily editable for seasonal fluctuations or changes in the product characteristics. One example of modularity modules are plug & play. The system must also be capable of automatic configuration changes. [4] [5]

3.1. Relations between principles and components of Industry 4.0

The above principles and components are interconnected. Not all components Industry 4.0 can use all the principles. For example, the principle of virtualization cannot be used in the Internet of things, but on the other hand, the data obtained in CPS can virtualize and then continue to use them. The basic relationship between the principles and components are listed in table 1.

Tab.1. Relations between principles and components [6]

	CPS	IoT	IoS	Smart Factory
Interoperability	X	X	X	X
Virtualization	X	-	-	X
Decentralization	X	-	-	X
Capacities in real-time	-	-	-	X
Service-oriented	-	-	X	-
Modularity and reconfigurability	-	-	X	-

4. CONCLUSION

Concept of Industry 4.0 represents a new orientation of world production companies. As all previous industrial revolutions, this will bring a lot of positives. The successful implementation of this strategy will be necessary to create the conditions to use all the principles of the concept. In addition to the considerable budgets necessary to build adequate human resources and conditions for enterprises. After the preparation of the business will be implemented with the concept of benefit.

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Digital factory, logistics, Tecnomatix

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LOGISTICS IN THE DIGITAL FACTORY ENVIRONMENT

Abstract

This paper is focused on application of digital factory tools in the logistics planning process. We have used software Tecnomatix Process Designer which represents complex PLM solution for digital factory. Environment of logistics module, main workflow and basic functionalities of this module are described here.

1. INTRODUCTION

Design of the logistics system represents an important part of the production system design. Production can`t exist without supply of material from the warehouse to the workplace and transport of products from the workplace to the warehouse of finished products. Therefore it is necessary to create appropriate routes, to define appropriate transported quantities, to choose the technology to be used in warehouses for transport, etc. New technologies are developed rapidly and enterprises have to think about their implementation into the strategy (which technologies to use and in which specific areas to increase company`s KPIs).

Tecnomatix Process Designer is a digital manufacturing solution for manufacturing process planning in a 3D environment. Process Designer is a major enabler of speed-to-market by allowing manufacturing organizations to bridge product and process design with integrated authoring capabilities that leverage digital product development resulting in faster launch and higher production quality.

2. TECNOMATIX PROCESS DESIGNER - LOGISTICS

Tecnomatix Process Designer facilitates the authoring and validation of manufacturing processes from concept and detailed engineering through production planning. Process Designer enables manufacturers to develop, capture and re-use process plans. Furthermore, process design teams can compare alternatives to develop and select best manufacturing strategies that meet specific business requirements. In a 3D virtual environment, Process Designer is a collaborative platform that enables distributed enterprise teams to evaluate process plans and alternatives, optimize and estimate throughput and costs, plan for variants and changes and coordinate production resources.

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Part of this solution is the Logistics module which provides users with a basic data model of logistic objects, allowing them to build logistics-specific planning projects and manage the relevant data.

In the first phase we can start with network planning. In this phase logistics planners are allowed to define logistic networks and to calculate production rates per part family. This requires to use following steps:

- Setup the network structure.
- Setup the part structure (BOM).
- Setup one resource per logistic plant.
- Assign the resource which represents the logistic plant to the logistic plant of the network structure.
- Assign the produced parts to the logistic plant project and define the production rate.
- Create part families automatically out of the BOM. One part family is created for each part in the BOM, and the relevant part is assigned to the part family. Alternatively, the part families can be defined in a library and copied below the logistic project. Based on the information you defined, the system calculates the required transportation relations between the plants. The calculated transportation relations include the calculated number of products and required parts.

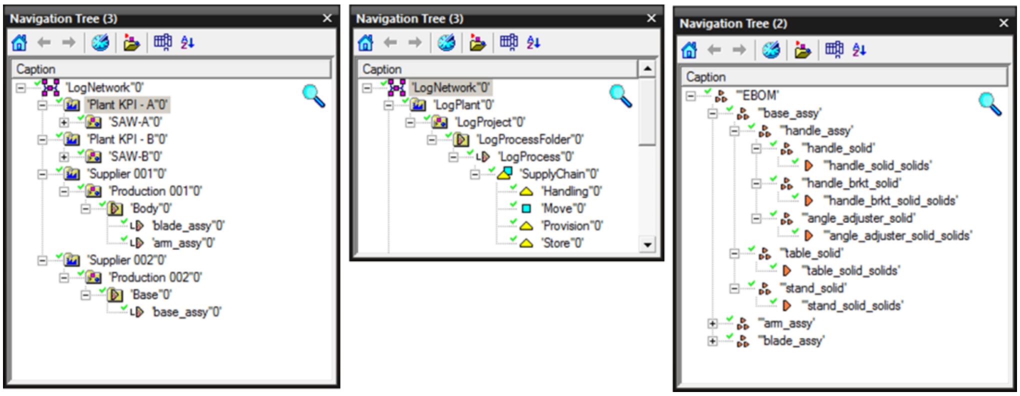

Fig.1. Network and part structure (BOM)

Logistics planners can open the Process Check tab (Fig.2.) to view progress of the logistic planning. The Process Check tab offers the following predefined checks:

- Parts assigned to LogProcess: Is there at least one part assigned to the LogProcess object?
- Container assigned LogProcess: Is there exactly one Container assigned to the LogProcess object?
- Container assigned to logistics operations: Is there exactly one Container assigned to the Move/Store operations of the supply chain of the LogProcess?
- Supply Chain defined: Is there a supply chain defined for the LogProcess?
- Supplier assigned: Is a supplier assigned to the LogProcess?
- Areas assigned to store operations: Are there LogAreas assigned to the store operations of the supply chain?

- Times assigned to logistics operations: Are there times assigned to the logistics operations (do all logistic operations of the supply chains have an allocated time > 0).
- General check that assigned container, supplier, areas, etc., are from the correct defined library: The system checks whether all assigned resources of the following types - LogArea, LogContainer, Supplier, Vehicle, Transporter, SupplyChains (for linked supply chains) belong to the respective library of the plant, under which the LogProcess resides. The libraries are taken from fields such as LogPlant,LibrarySuppliers, etc.
- Consistency check to verify the logistics plan against the production plan to find any inconsistencies. The check is based on the use of the same parts and logistics areas by both production planning and logistics planning. A logistics plan is consistent if the parts and the corresponding logistics areas are assigned to the same station as in the production plan.

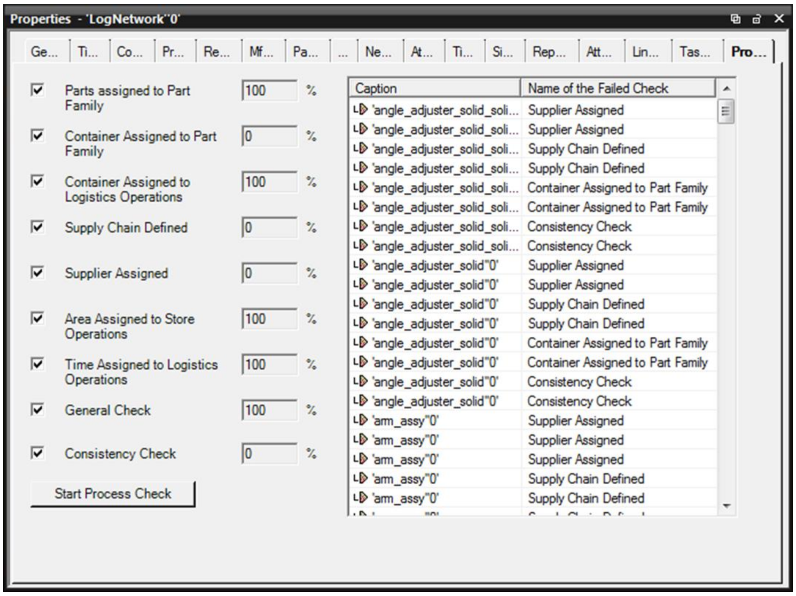

Fig.2. Process Check tab

Logistics areas and tracks features enable to build a logistic path network and logistics areas. Logistics planners can describe full area and path networks by drawing areas and tracks and connecting them, using connection points, to other logistic areas or tracks. Using these commands logistics planners can define the direction of the tracks, and to set them as one-way or two-way. Defined path networks can be used as the basis for calculations of route and transport time.

Using basic commands for drawing, deleting, showing and hiding all logistics areas and logistics tracks they can be seen and designed directly in the 3D layout of production system (Fig.3.).

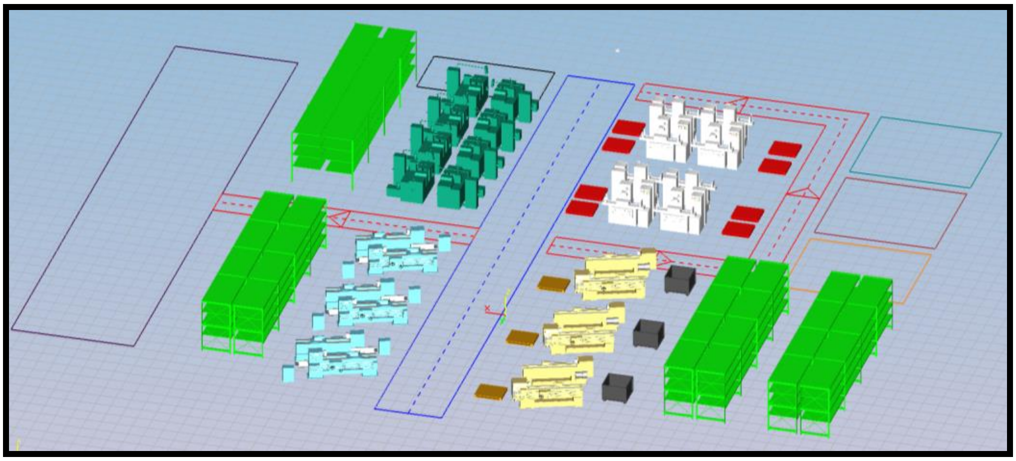

Fig.3. 3D layout of production system with logistics areas and tracks

3. CONCLUSION

Although many different software applications for the field of logistics exist, human with his knowledge is still the most important element for the successful design and planning of logistics systems. His early logistics analysis and optimal definition of supply chain is a key to the effective logistic processes. But using these technologies, companies can prevent unintended failure in case of improper design of material flows and verify their designs before it`s integration into reality.

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scheduling, knowledge, decision tree learning

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KNOWLEDGE-BASED JOB-SHOP SCHEDULING

Abstract

This article describes a way to discover and extract knowledge from production data created in job shop environment. Various approaches to solve job shop scheduling problem are discussed and evaluated by insight they offer into decision making process. Resulting accuracy of created models is presented.

1. INTRODUCTION

Solving Job shop scheduling problem (JSSP) is considered to be a very hard task due to its combinatorial nature. From a computational complexity point of view, most of these problems belong to a class of NP problems. Number of all possible solutions that can be created when considering n jobs and m machines can be computed as $(n!)^m$. Following picture shows processing of jobs in a job shop. Each job has a specific defined path for its processing.

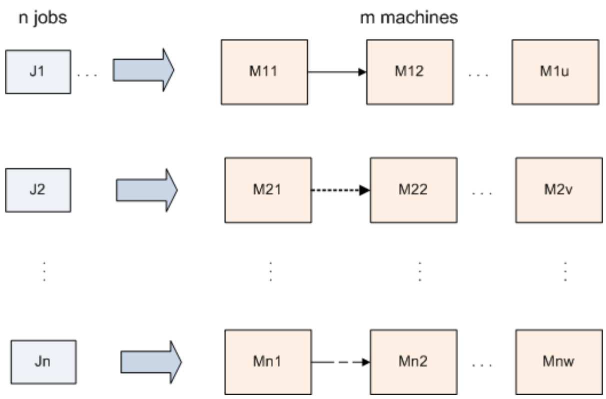

Fig.1. Job shop scheduling problem scenario

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The problem usually lies in finding the best sequence in which these jobs would be processed on each of individual machines, so that the near-optimal value of overall schedule parameters, such as makespan, lateness, tardiness, flow time, etc., is met.

2. JSSP SOLVING APPROACHES

Due to large computational complexity, various methods have been proposed to find near-optimal solutions to job shop problem. These methods can be divided into traditional and modern ones, as can be seen in following list:

- Traditional methods
  - Dispatching rules
  - Computer simulation
  - Mathematical programming
- Modern methods
  - Simulated annealing
  - Tabu search
  - Genetic algorithms
  - Artificial neural networks
  - Petri nets
  - Fuzzy systems

There are many instances, where these methods were used to offer a solution to JSSP in cooperation. For example, Tabu search can be used to limit number of populations generated by Genetic algorithms, Computer simulation, or mathematical model can also be driven by Genetic algorithms. There are cases, when mathematical modeling was integrated with simulated annealing.

Most of these methods are able to provide sufficient results based on target attribute, but because of heuristic approaches that they are based on, they offer a very little insight into how the solution to a problem has been reached. Moreover, actual realization of schedule is affected by many disturbances that are hard, or impossible to predict, and constraints, that are too complex to integrate into a model. This results in deviation from actual schedule, which usually creates a need to integrate an additional decision making.

Many of methods mentioned above are integrating dispatching rules, or sometimes called priority rules, because they offer an easy and understandable way to manipulate schedule and to reach a solution in a relatively short time. Additionally, when comparing with methods, such as genetic algorithms and neural networks, they offer much more insight into how the actual schedule has been created.

We think that, there is a way to formalize these results by discovery and extraction of new dispatching rules, which can pose as knowledge for future scheduling. This can be done by using data mining techniques, such as decision tree learning. In order to support this hypothesis, following chapter describes this approach to knowledge discovery.

3. KNOWLEDGE DISCOVERY

In order to produce input data for generation of production schedule were created using simulation in Matlab. As an input, two job shop test problem instances, namely FT06, FT10 and LA36 were used to create a set of 30 schedules with varying quantities of each product. These test instances consist of 6 products processed on 6 machines, 10 products processed on 10 machines, and 15 products processed on 15 machines respectively. Ten basic dispatching rules, namely SPT, STPT, LPT, LTPT, FCFS, LCFS, EDD, LST, MWKR, LWKR and three of their combinations, namely SPT+LWKR, FCFS+EDD and LPT+LTPT were tested. In order to test accuracy of model, incoming data were split by random sampling into two partitions, from which one with 70% volume of initial data was used to create model, and the other with remaining 30% was used to test its accuracy. Decision tree algorithm used is based on C4.5 and SPRINT techniques. KNIME data analytical environment has been used to measure model accuracy. Following data attributes has been used to model decision making process.

Tab.1. Data attributes for decision tree building.

Data attribute	Corresponding dispatching rules
ScheduledFirst	-
FirstJob	-
SecondJob	-
ProcessingTime	SPT, LPT
TotalProcessingTime	STPT, LTPT
ArrivalTime	FCFS, LCFS
DueDate	EDD
SlackTime	LST
RemainingTime	MWKR, LWKR

Decision tree algorithm splits training data set by specific values (if continuous) or classes (if discrete) of provided attributes.

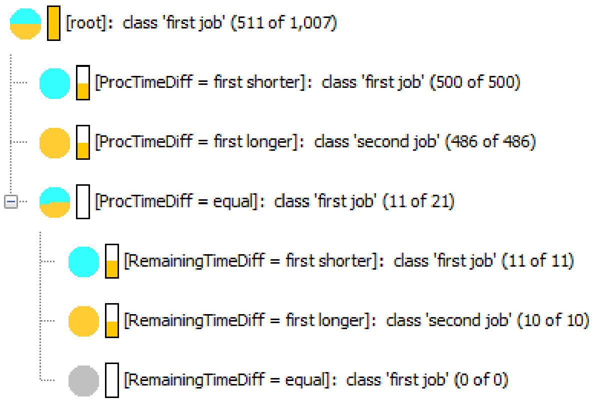

Fig.2. SPT+LWKR rule discovered from provided data

Example of such knowledge can be seen in previous figure, where SPT+MWKR rule has been discovered. Provided data set has been split by two attributes, which are ProcTimeDiff and RemainingTimeDiff, which in this case serve as a tie breaking rule. Presence of SPT rule is evident by the fact, that if the processing time of one job is shorter, then the attribute ScheduledFirst gets a predicted value of first job. Same logic applies for LWKR rule. Following table shows accuracy results for individual tested rules.

Tab.2. Accuracy of decision tree model.

	FT06	FT10	LA36
SPT	100.00%	99.96%	99.97%
LPT	96.30%	99.76%	99.72%
STPT	100.00%	100.00%	99.98%
LTPT	100.00%	100.00%	99.90%
FCFS	95.70%	99.91%	98.41%
LCFS	96.70%	100.00%	98.32%
EDD	99.29%	100.00%	99.97%
LST	100.00%	99.98%	99.98%
LWKR	98.70%	99.85%	99.87%
MWKR	98.56%	99.98%	99.51%
SPT+LWKR	100.00%	100.00%	100.00%
FCFS+EDD	99.55%	100.00%	100.00%
LPT+LTPT	100.00%	100.00%	100.00%

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SOA, REST, Holon, PYTHON, Raspberry PI Bottle

Peter HRUBANÍK*, Branislav MIČIETA**

USING REST ARCHITECTURE FOR DATA COLLECTION

Abstract

This paper deals with the design concept of the use of different communication architectures than what is in use. The proposed communication architecture REST is part of the communication concept Holon in order to improve the functionality of principle versus the use of communication SOA.

1. ARCHITECTURE FOR HOLONIC APPROACH CONTROL AND DATA ACQUISITION

REST (Representational State Transfer) is a way to easily create, read, edit, or delete information from the server / Holon using simple HTTP calls. REST architecture is an interface that is designed for distributed environments. REST designed and described in 2000, Roy Fielding (co HTTP) under his dissertation Architectural Styles and the Design of Network - based Software Architectures. In the context of the work is the most interesting, Chapter 5, in which the principles of REST Fielding derived from known approaches to architecture.

REST interface is usable for a unified and easy access to resources (resources). The source data can be, as well as the status of the application (if it is possible to describe the specific data). REST is therefore in contrast to the better-known XML - RPC, SOAP, or oriented data, not procedural.

1.1. The basic principles of REST

Application status and conduct is expressed by called RESOURCE (key sources), all resource must have a unique identifier (URL).

HATEOAS (Hypermedia as the Engine of Application State in translation hypermedia application status) - represents the state of the application and is determined by the URL. Other states can be obtained by reference to the client receives the response from the server.

It is defined as a unified approach for obtaining and handling Resource with four CRUD operations (Create, Read, Update, Delete).

Resources (resource) can represent (XML, HTML, JSON, SVG, PDF), the client does not work directly with the source, but its representation.

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1.2. Communication protocol

- Client / Server - is used to define responsibility.
- Stateless - Any request must contain all information necessary for its implementation.
- CACHE - Any request may be explicitly marked as cache-grammable or necacheovatelná allowing transparently increase the performance by adding a cache between the client and the server.
- Code - On - Demand - client functionality can be extended code that sends the server (such as JavaScript).
- Layered System - allows the composing layers providing services to increase the variability (cache, transform, load balancing etc.).

There are other ways to addressing the distributed architecture as RPC (Remote Procedure Call). Generally speaking, the difference between REST and RPC is on two levels:

• The semantics of the operations and what is distributed.

• The semantics of the operations in REST is final and consists only CRUD (create, read, update, delete) on that resource.

In contrast, the semantic structure corresponding RPC methods that are called. The REST distributes state (represented by the resource data), compared to a report to be distributed in the RPC.

REST architecture is a service, which are of a smaller number of standards and their more efficient use. Basic standards are: HTTP, URI and XML (or JSON or XHTML etc.).Knowledge abovementioned the basic requirement and necessary condition for the use and communicate with REST services. The basic idea is that the URI defines the data you want to work and HTTP operation, the data we want to perform. At the present used two operations GET and POST HTTP standard they have several. Mention: PUT, DELETE, HEAD and OPTIONS. All these operations allows us to proposal holonic structures for other Holon.GET and POST operations obtain its popularity principally because is still used for standard web (GET to retrieve data from a page and send POST data from the form). In the design concept, we decided to Python for its multiplatform.

2. BOTTLE PYTHON REST WEB FRAMEWORK

Bottle is quick, easy and simple WSGI micro REST web framework for Python. It is distributed as a module consisting of a single file and does not use non-standard Python library. The proposed concept is the backbone to communicate with each Holon. The way Holon communicate and how that data is transmitted is on the implementation of the algorithm, which is also implemented in Python. Proposal communication method is based on the protocol CNIP. CNIP defines the framework for communication between the "moderator" (Holon providing communication with other Holon) and "initiator" (Holon providing its services).

http://localhost:8080/hello/world

```
from bottle import route, run, template

@route('/hello/<name>')
def index(name):
    return template('<b>Hello {{name}}</b>!', name=name)

run(host='localhost', port=8080)
```

Fig.1. Example of use Bottle

The final function is available from any place on the network at http.

The example represents a call remote functions and the set argument.. „<name>“. Holon[Fig.2] (layer HTTP server on Raspberry PI), evaluate the argument and the function returns its return value. In this trivial case illustrates the ease of use. The function can be connected to the OPC server device, fieldbus, database and share the required information Into the Holon local network.

2.1 .SOA vs. REST

The biggest difference between SOAP and REST is therefore mainly in how communicate with the server - what standards and how to use them. However, the method to be served by this request to the server is written in a different programming language, and can be very similar in both cases. It is necessary REST framework that builds on the URL to call the correct method. An interesting feature of REST is that the response that comes from the server can be written references to other data - represented by the URL. This way you know at the first answer to obtain additional information. This is undoubtedly a characteristic that the SOAP service is only difficult and it is also a step back to the classic site which is tied hyperlinks normal issue.

Fig.2. Example of practical use Bottle

3. CONCLUSION

REST services are no ideal solution for all cases. Although the benefiting from the simplicity and the fact that are more similar the classic site, there are areas where their use is not as simple as for SOAP services. These are for example the different process steps in the communication between client and server. An example would be the realization of a single transaction across multiple services, asynchronous operations, or complex security and communication requirements, which can serve WS -* standards. Nevertheless appears more efficient REST architecture than SOA architecture. Main benefit is its simplicity. It is in the software world where complexity can be one of the biggest problems, a very interesting feature.

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Assembly in the large, product design, development

Mária JANČUŠOVÁ*

ASSEMBLY IN THE LARGE: THE IMPACT OF ASSEMBLY ON PRODUCT DEVELOPMENT

Abstract

Article will deal with analyzing a product or product design from the point of view of assembly in the large. Understanding how an existing product works in detail. Further, the article deals about important decisions in early product design. These decisions define the product's basic functions, operating concept, architecture, and plan for manufacture and assembly.

1. INTRODUCTION

The theme of this article is to show how assembly influences, and is influenced by, product development and overall manufacturing strategy. As we know in article (Jancusova 2014) assembly is more than putting parts together. It is process of deciding how to deliver quality and functionality at the assembly level by designing and producing parts and subassemblies in a top-down fashion.

Assembly in the large is a set of design activities that takes place within the larger context of product design and development. This is the integration of all the different demands on any product that arise from marketing, financial, engineering, manufacturing, assembly, after-market service, upgrading, and recycling.

Manufacturers have become increasingly aware of the need to bring these constituencies together during product design and balance their often conflicting needs.

"Engineers are taught early on that design is an iterative process, but rarely are taught about the iterations between design and production, or between production and marketing. Perhaps this the cause of the traditional time separation between product design and manufacturing system design. The real concurrency of concurrency team work cannot be overemphasized. It is not too early to begin the process before there are engineering prototypes, because the essence of a sophisticated design can depend on careful choice of tolerances, materials, or novel fabrication methods that cannot be separated from the design of the manufacturing process." (Whitney 2004).

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2. PRODUCT DESIGN AND DEVELOPMENT DECISIONS RELATED TO ASSEMBLY

Products design and development involves determining customer needs and deciding how to meet them.

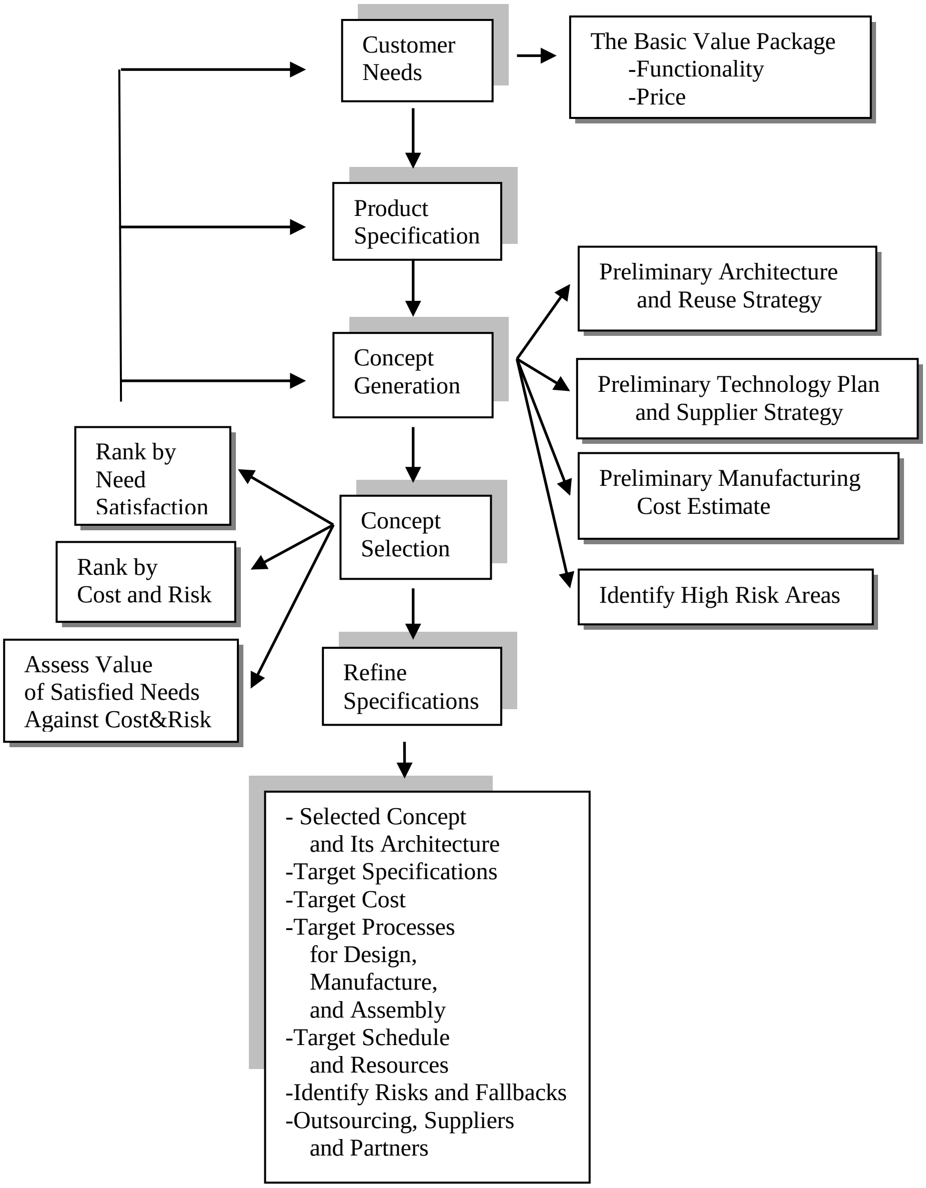

Fig.1. Important Decisions in Early Product Design

This includes the technical aspects of designing the product as well as business issues such as determining how many varieties will be offered, who will manufacture the product, where it will be made, how many units will be made per year, and whether the product is a member of a family that shares parts, processes, suppliers, and business practices.

A sketch of the early phases in a typical product development is given in Figure 1. This figure illustrates a market-driven process, in which means are sought to meet a set of existing or emerging customer needs. This is commonly called “demand pull”. Not shown is the complementary process of “technology push”, in which a visionary product is developed with the intention of generating a need for it. In either case, the needs must be converted into engineering specification, following which concepts are generated.

These decisions define the product is basic functions, operating concept, architecture and assembly. Technical and business issues are involved. Subsequent steps of detailed design, realization of the manufacturing plan, including design for manufacturing and assembly, plus integration of these plans, are not shown.

3. STEPS IN ASSEMBLY IN THE LARGE

Architectural and technology choices like those discussed in the previous few sections have large implications for how a product will be assembled. Any analysis of the product from a broad assembly/drives point of view will have to take these choices into consideration. Implicit in the discussion about concurrent engineering, however, is the idea that assembly analysis can reveal problems or opportunities that need to be considered when architecture and technology choices are being made. It is a two-way street. Product analysis that takes assembly in the large into account therefore needs to move back and forth between a wide range of issues. The steps in assembly in the large are business context, manufacturing context, assembly process requirements, assembly system design, and product design improvements.

The business context for a product includes the expectations of the market for the product as well as the expectations of the company producing it.

The manufacturing context includes the legal factors mentioned above but focuses more specifically on the factory or factories where the product will be made.

Design of assembly processes requires understanding alternate assembly methods. It also involves taking into consideration the issues mentioned above, such as model mix, volume fluctuation, facilities, and people. Often a similar product is already in production, or pilot production will be done.

An analysis as thorough as the one presented above will inevitably generate additional suggestions for design improvements to make assembly easier, more robust, safer, more flexible, more economical, and so on. Some improvements can be made by changing the assembly sequence, but a small design change may be necessary to permit the more desirable sequence.

The factors discussed above can be systematized by categorizing them according to whether they apply to the product or to the assembly system and according to whether they can be considered local or global (Table 1.). Local generally refers to decisions that primarily impact the item at hand, or which can be made without bringing in a wide range of constituents from other organizations.

Global generally refers to decisions that have implications beyond the item at hand or which have to be coordinated with similar decisions being made about items, or which must conform to larger goals or policies set elsewhere.

Tab.1. Clustering of the issues in assembly in the large into local and global categories related to product and process decisions

	Global	Local
Product Considerations	-Economic and market targets -Volume growth -Model varieties -Design volatility -Quality, reliability, safety -Make or buy decisions	-Assembly sequences -Type of operations -Geometric constraints -Characteristic of parts -Tolerances and clearances -Tests and inspection
Assembly Process and System Considerations	-Cost and productivity goals -Interface to the rest of the factory -Labor policies -Failure modes and repair policies -Space constraints	-System layout -Equipment choice -Task assignment -Part logistics and feeding -Buffer -Inventory control

4. CONCLUSION

Assembly in the large differs from assembly in the small in that economic, business, and institutional issues share an equal place with technical issues. Many aspects of product design and development are strongly related to assembly or make themselves felt when assembly-related issues are brought into the product design process. The most important of these is product architecture, which defines the physical relationships between elements of the product and relates them to the product's functions. A suitable architecture is an enabler of many important processes from product development to management of variety.

Either way, architectural decisions have great impact on how the product is designed, built, and used. Product architecture is about the relationships between the whole product, its parts and subassemblies, how those items are arranged in space, and how they work together to provide the product's functions. Product architecture is therefore a major force in assembly in the large.

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LEAN, 5S, standardization, visual workplace

Jozef KOVÁČ[*], Michal DEMEČKO[**], Jaroslava KÁDÁROVÁ[***]

IMPLEMENTATION OF 5S IN SELECTED WORKPLACES IN ARCELORMITTAL OSTRAVA, A.S.

Abstract

5S is a basic part of Lean manufacturing. Without maintaining order in the workplace there is no progress. This article is focus on implementing 5S in selected workplaces in ArcelorMittal Ostrava, a.s.. The main aim of the project is to provide better organized and visually labeled workplaces as well as establishment of standards for cleaning.

1. 5S

5S method is one of many within the industrial engineering. It aims to achieve a lean enterprise and include methods of continuous improvement. Method 5S refers to five basic principles of care for the workplace and team territory. By adhering to these principles in the company to secure sustainable purity and efficiently organized workplace in which each subject has its place. From the workplace all the sources of wastes are removed. Wastes effect tend to error, mistakes and accidents at work.

5S can be translated as Sort, Straighten, Shine, Standardize and Sustain.

2. ARCELORMITTAL OSTRAVA, A.S.

ArcelorMittal Ostrava, a.s. is a major manufacturer of cold rolled steel. Product portfolio represents steel deep-drawing and electrical engineering, but also galvanized grounding tape and wire. The company is among the 13 global manufacturers of transformer steel, of which is produced transformers. Their products in recent years, exports to 20 countries.

Our project includes the following workplaces selected for the implementation of 5S:

- Slitting and Packaging line - ŽĎAS,
- Decarburizing line - DL II.,
- High Temperature Annealing furnace – FURNACE.

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3. ANALYSIS OF CURRENT SITUATION IN SELECTED WORKPLACES

Before the implementation of 5S in selected workplaces admission audits were performed. Results of the admission audit are recorded in Tab.1.

Tab.1. Results of admission audits

WORKPLACE / Step of 5S	1S	2S	3S	4S	5S	Result
Slitting and Packaging line	2/5	2/5	1/5	1/5	1/5	7/25
High Temperature Annealing furnace	2/5	1/5	1/5	1/5	1/5	6/25
Decarburizing line	1/5	1/5	1/5	1/5	1/5	5/25

Results of the admission audits show clear deficiencies in all areas of 5S and in workplaces is at first sight visible waste. As a result of admission audit values went 5-7 points. The aim was adjusted result of 25 points, which is a full count. It means that the implementation of the workplace must comply with all parameters of 5S.

Based on the analysis of the situation in the workplaces they have found many deficiencies. Some are listed below:

1. Irregular maintenance,
2. The material is not properly marked,
3. The workers do not have awareness of 5S,
4. Often finding the tools,
5. The lack of labeling machines,
6. On workplace is garbage and objects that do not belong there,
8. Delayed maintenance items,
9. Oil stains.

All deficiencies have been recorded in the "Workplace card" and at the end of the audit ware sent to the foremen of lines and to the management of company. The following Tab.2 is shown the number of recorded deficiencies at individual workplaces.

Tab.2. Number of deficiencies in selected workplaces

	Number of deficiences
Slitting and Packaging Line	86
Decarburizing line - DL II.	115
High Temperature Annealing Furnace	48

4. THE PROPOSAL TO USE ELEMENTS OF 5S IN SELECTED WORKPLACES

Based on the above described analysis of the current status of the workplaces, we started implementing of the 5S method. Whereas workers have had awareness of 5S workshops that lead them prepared in advance, it was easier to introduce the objectives and procedures of this method.

After the implementation of steps Sort, Straighten, Shine, we have created a layout standards for cleaning of templates that are used throughout the company. We have also identified all areas relevant descriptive labels.

Results of the implementation of the first three steps of 5S are shown in Fig.1. and result of workplaces labelling is shown in Fig.2.

Fig.1. Sample of implementation first three steps of 5S

Fig.2. Sample of workplace labelling.

The result of fourth step of 5S method is visualization in the form of layout, which is show in Fig.3. Also cleaning standards were made.

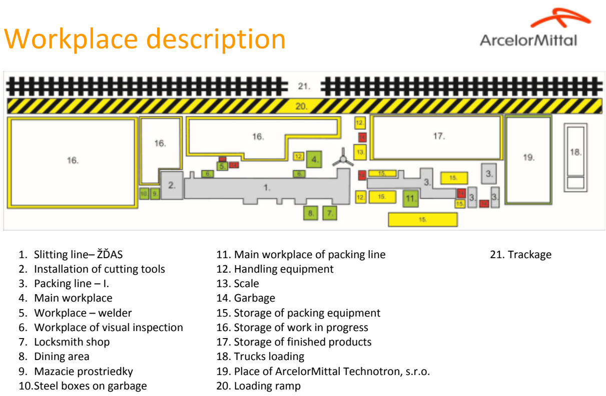

Fig.3. Sample of layout.

In summary for all workplaces were made 3layouts, 15 cleaning standards and over 50 labels. After eight months we have come back and did an audit of selected workplaces. The results of this audit is shown in Tab.3.

Tab.3. Results of final audits

WORKPLACE / Step of 5S	1S	2S	3S	4S	5S	Spolu
Slitting and Packaging Line	5/5	5/5	4/5	4/5	4/5	22/25
High Temperature Annealing Furnace	4/5	4/5	4/5	4/5	4/5	20/25
Decarburizing line - DL II.	5/5	4/5	4/5	4/5	4/5	21/25

We can assess that 5S method has been successfully implemented. After eight months the staff on workplaces maintain lines in order and regularly carried out so-called "Cleansings".

5. INPUTS VS. OUTPUTS

Overall implementation costs were estimated at 10.370€. Scrap-iron, which was collected during implementation of first three steps, was sold. Revenues from sale covered the entire costs of the 5S implementation.

6. CONCLUSION

5S method is the basis for any improvement program and is known as the cornerstone for achieving Lean Enterprise. 5S principles are aimed at maintaining a quality working environment with minimal waste. The implementation of 5S is in terms of time consumption and complexity different in many organizations. The results of implementing 5S was to create standards for cleaning and layouts. We believe that 5S method become, in ArcelMittal Ostrava, a.s., a daily routine of the working day.

This contribution is the result of the projects implementation: Project VEGA 1/0669/13 Proactive crisis management of industrial enterprises based on the concept of controlling.

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proactiveness, reactiveness, enterprise strategy

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PROACTIVENESS IN THE ENTERPRISE

Abstract

The aim of this article is the clarifying of the expression proactiveness and, above all, its description in relation to the enterprise behavior. It begins with the look on the reactive and proactive way of the enterprise behavior, with the main focus on the proactiveness. As mentioned concepts create rather continuous, than dichotomic complex, my attention is put also on their connection. The article ends with the description of proactive model, which consists of company's attitudes for the various connections of the reactive and proactive approach.

1. THE DICHOTOMY OF REACTIVE AND PROACTIVE BEHAVIOR

Expressions proactiveness and reactiveness are widely used within last decades in the literature from the field of strategic management. Significant part of the literature about the strategic behavior reflects the dichotomy between reactive and proactive strategic approach.

Reactive behavior can be called also as "developed". Instead of strategy formulation for unpredictable changes in the environment, enterprises react on changes only after they arise.

According to the systems theory, the reactive behavior can be called also as the regulation of mistakes, because it is focused on correction of harmony deviations between the company and the environment. According to the law of dynamic balance, if there appears any change in the environment, also the system changes, however only to such extent, which is necessary for preserving the harmony with the environment. (Fig. 1)

According to this model, the regulator can perceive the result arising from the change in the environment immediately after its creation. The regulator in this kind of reactive behavior represents monitoring, researching and corrective precautions of the enterprise system.

By the confrontation with significant changes, reactive enterprises fight for their survival. In slower modifying environment, they can deal with adaptation to the new situation. The problem of reactive behavior lies in usual need of the fast action, or in other words, lack of time and insufficient number of possible options. There lies the risk of such behavior, if it becomes the main tool of the enterprise risk management.

The analysis of the term **proactiveness** has not very deep roots. (Pro)active strategy was defined by Jauch and Glueck (1988) as a "*strategy, in which strategists act sooner, than they are forced to react on opportunities and threats of the environment.*"

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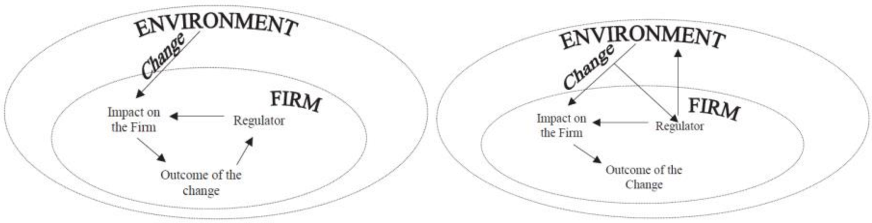

Fig.1. Reactive and proactive behavior in a firm

Therefore, it seems that the proaction is sometimes the reaction – it is not the reaction on changes of the environment, but rather on signs of future changes. Such behavior can be called also as anticipating regulation, of which objective is to compensate undesirable outcomes of disturbing stimuli in the result. Anticipation can be understood as a control of the present within the usage of information about the past, present and the future.

Aragon-Correa declared the strategic proactiveness as "*the intention of enterprises to initiate changes within their strategic tactics rather, than to react on events.*" It reflects the fact that the enterprise recognizes that it has some abilities for at least partial influence and formation of their own future.

Proactive behavior demonstrated on the Fig. 1 is based on the model of anticipation regulation in controlling systems. This indicates that also the regulator can influence the environment, by formation of changes in it for the purpose of achieving requested results.

It is relatively difficult to observe the proactivity, because it is mainly the thoughts´ process. However, there exists a lot of literature, mentioning its qualities. If enterprises want to be proactive, they have to:

- Actively collect information about people outside the spectrum of customers and competitors, and about possible changes in the environment,
- To be foresighted in the area of the subdivision – foresight is based on wider look into the future trends (in the area of lifestyle, technologies, demography and geopolitics), which can be used by rewriting of rules in the subdivision and by formation of new competitive area,
- Make an effort to be rather the leader, than to be the follower,
- Look and to move forward – the enterprise should form, and not to be formed by the change.

The concept of the proactiveness includes two different demonstrations – anticipation and influencing.

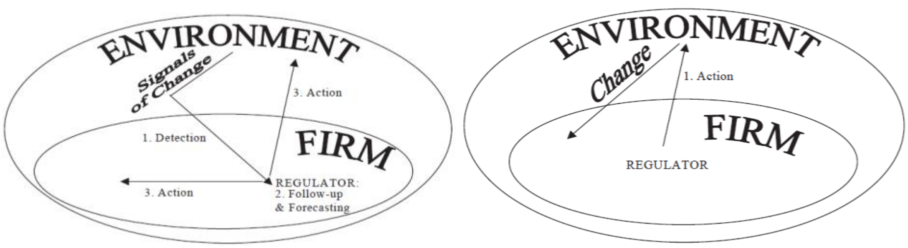

Fig.2. Anticipation and influencing of environmental change

Anticipation requires the assessment of signs of changes, their monitoring and forecasting of future changes, and to operate according to this (Fig. 2). The signs of changes can be recorded through the monitoring of the environment. Macro-monitoring of the environment can help the enterprise to record the social, technological, economical, environmental and political changes. It is clear that the sooner the enterprise records the change, the more options to act it has.

Formation or acceleration of changes can originate from the desire to surprise the competitors or to change the process of actions, within the business, for example, through formation of new standards – then we can talk about influencing the environment.

2. THE REACTIVENESS – PROACTIVENESS CONTINUUM

Proactiveness and reactiveness are considered to be decisive agents of particular groups of enterprises. Some authors point out the fact that both expressions have tendency to create rather continual structure, than dichotomic structure. The company can accept various degrees of proactiveness, to find its place in reactiveness - proactiveness continuum and in case of need, to change the position, in relation to one of extremes (Fig. 3).

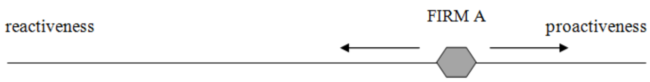

Fig.3. An example of a firm's position along the proactiveness – reactiveness continuum

The ability to change the position is important from the point of view of effective usage of company´s resources. Proactiveness is expensive. Monitoring of competitors and customers, long-term watching of the market and expensive lobbing usually cannot be separated from significant sacrifice of limited sources. It is clear that if it would be possible to wait and to react, the company would be in a temptation to prefer the reactiveness.

Consideration of the enterprise behavior as one of positions in reactiveness-proactiveness continuum can have the consequence in the form of excessive simplicity of so complicated and multidimensional problem, which is the organizational behavior. The option to use several continuums is described in the following part.

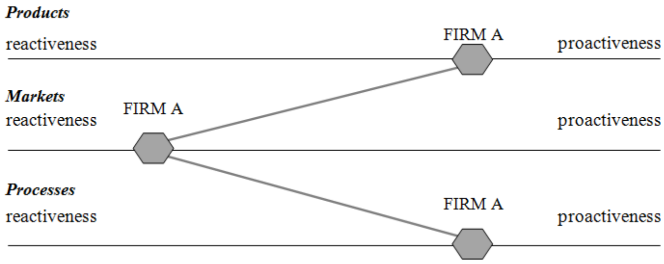

Fig.4. An example of a firm's positions on certain reactiveness – proactiveness continuums

Proactivity can be analyzed separately, in various functional areas of the enterprise, as for example in the R&D, finances, production, marketing, etc. Another option is to distinguish between proactiveness related to the product, market or process. There exist many reactiveness - proactiveness continuums and the company has to position itself on each of them.

Therefore, we should understand the degree of proactiveness in the company as a model, based from its positions within continuums. For example, the company A on the Fig. 4 seems to be proactive on the level of products and processes, but in the level of the market, it still remains relatively reactive.

Thinking about the enterprise behavior as a model, in the effort to find solutions of problems in companies, managers use to emphasize only the area of well-known alternatives. During the time, such activity will become the routine and as a result, the company can be cleverer in other areas (e.g. R&D); however, it will have insufficiencies in other areas (e.g. marketing).

3. CONCLUSION

Proactiveness represents the strategic option, which can be adapted by companies, with the aim to overcome the reaction itself. However, it does not mean that they have to stop suddenly with traditional responsive strategies. Proactiveness will not eliminate the need for enterprises to be alerted about customers´ needs or movements of competitors and other players on the market. However, the proactive approach proves that excessive focus on reaction can balance all enterprises onto the one level, which could lead into the overfilling of the market. The more are enterprises reactive to the market, the more similar they are to each other; the more similar they are to each other, the less differentiated they are. It means that each enterprise must reveal the best method, by which can be earmarked the area for proactive and reactive steps in their strategies.

This contribution is the result of the projects implementation: Project VEGA 1/0669/13 Proactive crisis management of industrial enterprises based on the concept of controlling.

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Lean, healthcare, implementation barriers

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LEAN HEALTHCARE – BARRIES AND CHALLENGES OF IMPLEMENTATION

Abstract

This paper focuses on Lean definition in healthcare, implementation process, barriers, challenges, enablers and outcomes of implementing lean production methods in healthcare. Lean production in healthcare is mostly used as a process improvement approach and focuses on three main areas: defining value from the patient point of view, mapping value streams and eliminating waste in an attempt to create continuous flow. Value Stream Mapping is the most frequently applied Lean tool in healthcare.

1. INTRODUCTION

Healthcare organisations are under strong pressure to improve. Society is aging, the demand for healthcare services is increasing, but financial conditions for healthcare systems are not improving or even worsening. In this millennium, healthcare systems are challenged to be as affordable, accessible, safe, thorough, efficient and cost effective as possible. There is a need to look for new and more efficient ways of providing care. Many healthcare organisations adopt the Toyota Production System as the performance improvement approach, often called the Lean Healthcare management system. The Lean approach seeks improvements within the framework of an organisation's existing processes. Lean production does not focus on substantial reorganisation requiring large-scale investments, but it gives healthcare organisations an alternative methodologyfor achieving improvements without high investments. There are many views of what constitutes Lean thinking. It is undeniable that Lean has its roots in the Toyota Production System (TPS). The first descriptions of TPS appeared in the late 1970s , but the book The Machine That Changed the World by Womack and Jones first popularised the approach under the name "Lean production". Nowadays Lean production is applied in various types of organisations all over the world. There has been considerable development of the concept over time and there is no consistent definition of the approach. Different authors have different opinions on which characteristics should be associated with the approach.

Womack and Jones were among the first authors to propose how Lean techniques could be applied to services and specifically to healthcare. They argued that the first step in implementing Lean thinking in healthcare is to put the patient in the foreground and include time and comfort as key performance measures of the system. The Lean principles as multi-

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skilled teams taking care of the patient and an active involvement of the patient in the care process were emphasised. Since then, many applications of Lean in healthcare have been published in academic journals e.g. 9, 10-17.

Young et al. (2004) argue that an obvious application of Lean thinking in healthcare lies in eliminating waiting times, repeat visits, errors and inappropriate procedures. Spear 16 emphasize empowerment of employees by providing them with the necessary tools to improve processes in their area of work. This means that all healthcare staff become focused not only on taking care of the patient, but also on finding better ways to take care of patients. Lean enhances process steps that are valuable and essential for patient care, while eliminating those that fail to add value. As a result staff members feel empowered to improve care processes and are more satisfied with their jobs.

1.1. How is Lean implemented in healthcare?

The literature was reviewed in search of implementation patterns for Lean Healthcare. The following key steps were identified:

- Conducting Lean training.
- Initiating pilot projects.
- Implementing the change.

The first step usually included training days in which the basic Lean principles, methods and tools were introduced. The basic idea was to facilitate widespread use of Lean tools and create a base for initial practical work. The target groups for training differed between cases. The training was either intended for all staff members or only for leaders or Lean facilitators that would be responsible for the Lean initiative in an organisation. In the second case leaders or Lean facilitators then received the responsibility to train a group of their peers. This approach assumes that those trained in Lean will train others and that learning will gradually disseminate across the organisation. Several authors stressed the importance of training their own Lean facilitators recruited from the healthcare organisations instead of employing external consultants. People's knowledge, creativity and commitment seem to be important for building a sustainable Lean organisation. Lean implementation shouldn't rely on consultants who tell how it should be done; instead employees should be trained in all Lean aspects to initiate and drive the improvement work.

The second step included testing ideas and initiating some pilot projects using Lean tools and methods. The pilot projects were sometimes part of the education program or were initiated in direct connection to training days. The idea was to let people try the ideas in organisations and create some quick results. The pilot projects usually included Value Stream Mapping. The healthcare staff was organised in cross-functional teams and performed analysis of patient flow, assessed the time required to perform process steps and identified value-added vs. non-value-added activities. The overall objectives included reducing lead time and waste elimination in processes. The primary focus of pilot projects was to engage frontline staff in identifying problems and to involve them in the improvement work. The outcome of this step was an action plan for change.

The third step is about driving the change processes with the full involvement of the employees. There are only a very limited number of cases, however, describing the practises. This step is a problem-solving process and may include the use of different Lean tools and techniques. A team of five to ten members, often including all professions and different organisational levels, analyses causes of a problem, generates and selects some solutions, plans for actions and evaluates results. This problem-solving process is referred to in some cases as Rapid Improvement Event (RIE) , Kaizen or Rapid Process Improvement Workshop.

There is no single correct way of implementing Lean in healthcare. Several authors stressed that Lean is not a one-time change of work processes, but a new way of thinking and working. There is little chance to succeed if Lean is implemented top down as a fully defined and complete concept for reducing costs and improving performance. It is difficult to take ideas from one culture and apply them in another, especially if these ideas involve people, behaviours, practices and ways of thinking. An appropriate implementation strategy is an adaptation-oriented approach with focus on finding ways that are consistent with the specific conditions and suit a healthcare culture. Healthcare units implementing Lean need to make a critical review of how the principles, methods and tools can be used in their own organisation and adapt the concept to fit their context. The active choices concerning values, methods and tools can improve the chances of achieving long-term sustainable improvements.

2. BARRIERS AND CHALLENGES OF LEAN IMPLEMENTATION.

The first barrier that needs to be overcome in Lean implementation is to convince staff that Lean can work in a healthcare setting . When talking about Lean in healthcare the usual reaction is that patients are not cars and healthcare organisations have completely different organisational settings than the automotive industry. However, when the training is provided, the staff gradually understands that there is a great amount of waste in the processes and applying Lean principles could provide great benefits .

The training itself is a challenge, however. There are few people in healthcare who have a well- founded knowledge of and experience in Lean production principles, methods and tools. There is a lack of qualified people inside healthcare to teach about Lean. Educators need to be hired from the manufacturing sector, but they often talk manufacturing language and lack relevant examples from the healthcare sector. This makes more difficult for healthcare staff to accept the ideas and requires longer assimilation periods.

Another problem is lack of clear focus on the customer. One of the basic Lean principles is to understand value as defined by the customer. The term of “customer” in healthcare is not straightforward, however. The primary “customer” in healthcare is the patient, but the patient is not a customer from the market economy perspective. The patient usually doesn’t pay directly for the service. Other customers, such as family members, caregivers, decision-makers, local communities and taxpayers, also need to be considered. To understand what is value added there needs to be a clear view of the customer without confusion of conflicting requirements and priorities from different stakeholders. The ambiguous notion of the patient as customer and the dynamics between the different stakeholders are seen as a barrier in the Lean implementation process.

Another factor perceived as inhibiting Lean implementation was the organisational structure of healthcare. Professional knowledge is organisational power. The healthcare structure is still very hierarchical, with physicians as the dominant decision makers. Physicians are highly trained individuals and they have been trained to act with autonomy. Lean culture requires teamwork, collaboration and good communication, skills that traditionally have not been emphasised in physicians’ professional training.

Several authors reported difficulties related to cooperation with other departments. Healthcare is a complex system with many interdependent units. One of the challenges is to improve the entire system, not just optimize the performance of individual departments. Improving value streams may require involvement of several healthcare units, which are not always ready to recognise, understand and acknowledge changes or simply lack the necessary prerequisites to perform the change. The risk is also that an improvement activity may fix some problems at one unit, but cause other problems at another unit. It is therefore important to take the holistic approach and consider the impact of the actions on other units, and not just shift the problems to other areas.

3. CONCLUSIONS

Lean is mostly used in healthcare as a process improvement approach. Value Stream Mapping is the most frequently applied Lean tool in healthcare. The process orientation is crucial, but still weak in healthcare organisations. However, many current problems of healthcare can be solved by applying process improvement approaches. Using Value Stream Mapping, all steps in the patient journeys are analysed as a whole from start to end: from diagnosis, through treatment, to discharge. This allows for reducing waiting times and duplicate work and ensuring that the interrelated steps connect. Many healthcare units work in silos and are not aware of the effects of their efforts outside their own departments. Problems and difficulties frequently appear in the crossings between different units. Lean Healthcare applied as a process improvement approach focuses on three main areas: defining value from the patient point of view, mapping value streams and eliminating waste with the effort to create continuous flow.

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assembly process, production strategy MTO and MTS, segmentation of products.

Radovan LIESKOVSKÝ*

ASSEMBLY PROCESS AND ADVANCE SEGMENTATION

Abstract

The assembly processes that are running in the environment of Make to Stock (MTS) or Make to Order (MTO) behave differently and they need a different sequence of steps to achieve competitive company results. In addition, in MTO environment there could flow various orders or products with significant differences in the number of assembly operations and product assembly time.

1. ASSEMBLY PROCESS

An assembly process is the final stage in the production process; it includes among others preparation support (cleaning, sorting, storage...), assistance and service activities. (JANČUŠOVÁ, M. – KUBA, J. – ARGALAŠ, J. Automatizácia technickej prípravy výroby pre beztriezkové technológie (Zlievanie a tvárnenie), 2014). An assembly process consists of assembly operations by connecting components to subassemblies (assembly units, subgroups and groups) and finished products that are running in specific technical, technological, organizational and economic conditions.

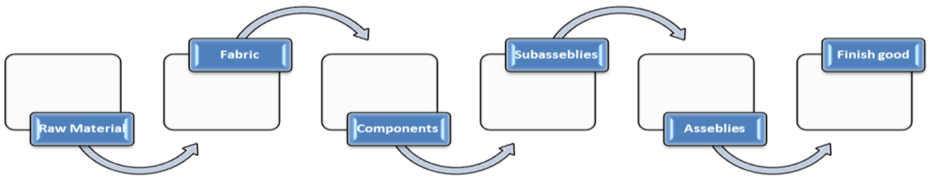

Fig.1. Flow of assembly process.

An assembly process is specified by:

- Assembled products (types, variability and volume).
- Level of pre-production processes (CAx ÷ CIM).
- Level of applied assembly technology (manual ÷ automatic).
- Planning system, organization of work and production strategies (MTS ÷ ETO.

An assembly process assumes some specific characteristics:

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- Connecting at least two components of the respective assemblies.
- Adaptation of prefabricated parts to a certain assembly process (expediency).
- Organization of the assembly process depends on the products which are carried out at different operating times.
- Combination of automatic and manual operations.
- Realization according to specified rules based on the structure of the assembled product.
- Characteristics of the assembled product are the synthesis of the properties of assembled components.
- Quality assurance - impact of previous technological operations and its own assembly operation.

In summary an assembly process could be distinguished among others also on the basis of the volume of assembled products in: mass production, serial production, type's production or only one piece production (MIČIETA, B. – KRÁL, J. Plánovanie a riadenie výrob.1998).

One piece assembly (order assembly) is known as organization in which in each step of production is produced only one different entity. It is also called individual production (for instance: industrial machine for special purpose like climate machines or UPSs). One piece assembly represents the case in the edge as a small-lot production like one piece production. The most common form of manufacturing or production strategy is MTO (Make to Order) and manufacture according to customer's special requirement ETO (Engineering to Order).

2. SEGMENTATION OF PRODUCTS

Because the order assembly is most often organized according to the principle of workshop production, some production scheduling issues typical for workshop production could be:

1. Scheduling assembly operations of product on shared equipment or several assembly lines (capacity).
2. Scheduling depends on when and which types of products to produce (segmentation).
3. Allocation of operators to individual assembly operations and moving them to other operations within the assembly line (flexibility).
4. Unstable consumption of time (operational time) for individual products (balancing, segmentation).
5. Optimization of sequence of product types by the possibility of assembly lines and staffing (capacity, segmentation, balancing).

Paragraph #1

Lacking of consistency of assembly scheduling into shared equipment may result in:
- Imbalance of production capacity (free or too saturated capacity).
- Frequent and sudden moving of operators between production positions.
- Increasing work in progress (WIP) because of deadlocks capacity or unwanted waiting for other subsequent assembly operations.

Paragraph #2 and #3

Lacking of consistency of assembly scheduling and thus the uneven distribution of operators may result in:
- Frequent conflicts of logistic, production capacity and termination of production (in the method of re-scheduling it's important to have the material and release of production capacity at the same time).
- Oscillating needs of operators at work (for time-critical order is consumption of employees higher, provided the same lead time of production and in less time consuming order the

demand of operators is low. This creates a high demand of flexible-moving operators – skilled, into heavy assembly operations or other assembly lines).

Paragraph #4

Similar problems can occur even with asymmetric time consumption on individual products. It is quite difficult because of the mix of products and their need to be scheduled in the production to provide the right tact of the assembly line for effective use of operators and achievement of due date.

Paragraph #5

Problem solving of scheduling, staffing and balancing different positions is based on the typical features of a MTO strategy, such as:

- Repeatability of the product.
- Size of product range (number of types).
- Work-content (time consuming) of the product.

If the repeatability of products is low and the size of the range of products is high, it is mainly Make to Order (MTO) production. Range of work-content of assembly labor (consumption of time for 1 product) may be on the order of hours, days and even months or years. It depends on the type of product, such are: consumer equipment, industrial machinery, aircraft, or even large-scale construction of residential and industrial areas. Labor intensity per product may be different. For example **the product of type V** (Table 1) contains 11.3 hours of consumption of assembly time, and the **product W** has a consumption of assembly time 7.5 hours. The difference may not only be in the length of operations, but also in the actual number of operations.

Tab.1. An example of presence and duration of various assembly operations into products V, W and Z.

Several assembly operations	**Product Z** (hours)	**Product V** (hours)	**Product W** (hours)
Assembly operation N.1	1.1	0.7	-
Assembly operation N.2	1.6	1.5	1.7
Assembly operation N.3	1.6	2.0	1.0
Assembly operation N.4	4.5	5.7	2.5
Assembly operation N.5	0.2	-	0.3
Assembly operation N.6	1.5	1.4	1.6
Assembly operation N.7	-	-	0,4
Sum of consumption time	**∑ 10.5**	**∑ 11.3**	**∑ 7.5**

The problem can occur when the planner is trying to schedule these similar types of products in one unique assembly line. He must face: how to determine the order in which the products are optimally combined and distributed over time. If this important role is not managed effectively, the following situations may happen:

1. The product with a longer assembly operations time blocks the flow of the assembly line because the previous operation creates fronts – increasing of WIP (Work in Progress), decreasing labour efficiency.
2. The products that are not containing certain assembly operations can run faster, but are blocked by products that contain more complex assembly operations – increasing of WIP, decreasing labour efficiency.

3. In this case "overpressure work" occurs in assembly operations that are difficult and "lack of work" occurs in operations that are less difficult or the products often do not contain them - decreasing labour efficiency and increasing frustration.

These situations may result in unbalanced assembly line, frequent regrouping operators in assembly positions, unbalanced output, worsening productivity and increasing labour costs.

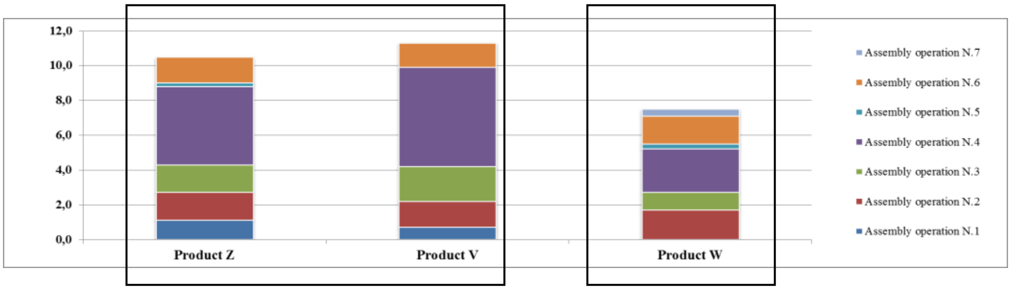

Fig.2. Assembly operations in various types of products (and 2 clusters).

3. CONCLUSION

1. Different assembly operations must be tried to spread into the other assembly operations for the same product to balance the line (balance the operations).
2. If some of those assembly operations do not allow shortening or distributing a part of them in various assembly operations, these products must be segmented into different clusters by **advance segmentation** (by operating time). When carrying out the segmentation of products, it is necessary to take into account also the length of each assembly operation for products. Products Z and V there are in one cluster and product W will go into another cluster (Fig 2).
4. These clusters are then inserted in various assembly lines as a family of products that are subject to specific rules.

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innovation, enterprise, SME sector

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INNOVATIVE POTENTIAL OF SMALL AND MEDIUM-SIZED ENTERPRISES IN POLAND

Abstract

Nowadays, innovations are regarded as a key factor in the development of an enterprise, which leads to both enriching the market with new products and services of high quality and organizational transformations within the company and its environment.

The purpose of the present paper is to characterize the innovation potential of the SME sector in Poland.

1. ESSENCE OF INNOVATION

Currently, innovativeness is one of the most crucial factors determining business competitiveness. The global crisis actually forces the necessity to implement changes in various fields of activity of contemporary enterprises.

Nowadays, innovations constitute the ultimate driving force of the development of economy. They form a specific tool of resourcefulness, which (when understood as a constant search for new combinations of productive factors) is in turn a driving force of economic advancement [4].

Changes that take place in the environment as well as forecasts show that in the future enterprises are going to be even more dependent on innovations. Such moderations force enterprises to look beyond production management and “aggressive” marketing. Companies must anticipate incoming changes by means of creating and implementing innovative solutions, which will help to improve the level of innovativeness and competitiveness on the market.

Successful companies tend to introduce innovations in all fields of their business activity. Those companies are able to produce new commercial products, react accurately to any changes taking place in the environment, as well as adapt their organization and tactics of action to these changes: in other words, they adapt and change.

In academic literature we can find many concepts of innovation, which are often discrepant.

The idea of innovation has been introduced to economics by J.A. Schumpeter, who has defined it generally as [5]:

- the introduction of new products or the improvement of products already existing,
- the introduction of a new method of production or an improved one,
- opening of a new market,
- the implementation of a new way of selling or purchasing,

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– the implementation of new materials or semi-finished products,
– the introduction of new production planning.

It is commonly said that innovation is „a novel solution contributing to the development and progress in the functioning of an organization. Usually, innovations concern modifications in processes, products, organization, management and sales, and work environment" [1].

In the interpretation of innovation, there are two dominant approaches, namely: innovation as a process, or innovation as a result. According to the former, innovation is understood as any processes of creative thinking aimed at the application and usage of improved solutions in technology, organization and social life. According to the latter, innovation means any changes in the field of production, which, in a consequence, result in new products.

2. INNOVATIONS IN SME SECTOR IN POLAND

The study of small and medium-sized enterprises carried out in 2013 by the Confederation of Leviathan shows that business philosophy should be about quick decision-making when there is a chance for development. Leviathan Confederation carried out research within the project "Monitoring the condition of the SME sector in 2010-2012" co-financed by the European Union under the European Social Fund (for the period April 26 - August 1, 2013 on a random sample of 1501 SMEs employing at least 1 employee). The study concerned businesses employing from 2 to 249 workers, where legal title is an open-ended or fixed-term contract of employment. The study included 9 sections of PKD (Code List of Classification of Business Activities in Poland): production, water supply, sewage and waste management as well as remediation activities, construction, wholesale and retail trade, transport, warehouse management and telecommunications, activities related to housing, food services, information and communication, real estate services, professional, scientific and technical activities. The study concerned companies in all 16 provinces. Interviews with respondents were carried out through direct interviews ("face-to-face") by CBOS (Centre for Public Opinion Research) pollsters [6].

Only 25% of the SME sector disagrees with this statement and claims that one should wait until others take the risk.

Openness to new opportunities manifested in high tendency to make decisions about their application, as well as acceptance of failures as something always present in the business landscape, will allow maximum use of these SME characteristics which were visibly formed in the period of economic decline. These characteristics are: adapting objectives to market possibilities, continuing search for opportunities, focus on quality rather than price (and in subsequent years on innovation based to a greater extent than today on internal R&D spending), and on external expansion, not merely into the familiar and "domesticated" but also to other markets. The characteristics of entrepreneurs which were clearly revealed, i.e. acceptance of failures and search for opportunities as well as quick decision-making to take advantage of these opportunities, may also increase the tendency for SMEs to benefit from external funding.

A dominant group of companies shows that the most important factor in building their competitive position on the market is the quality of products and services. Economic decline strengthened this direction of enterprises' activities. There was a decrease in the percentage of companies that base their competitive model on the market on the price - with more than 18% in 2012. to 10.4% in 2013. These results indicate that permanent changes occurred in the SME sector, allowing companies to concentrate not only on effective competition on the domestic market, but also about getting into foreign markets[3].

There was an increase in the percentage of companies that started export sales in 2013, which, with a slight fall in the percentage of SMEs that continued sales to external markets, gave a net increase in the number of companies operating outside the Polish market. More importantly, a greater percentage of companies are planning to start exporting their products over the next two years. Here, attention must be drawn to the fact that the SME sector is also recognized by the non-European markets - China, India, Brazil, Mexico, Indonesia. In 2012 only 0.1% of companies sold their products to these markets, whereas in 2013 it was 2.4% [3].

A significant factor in close environment affecting the tendency to undertake innovative activity of an organization is the stage of the sector development where the organisation operates. It turns out that organizations operating in sectors that are in earlier stages of development often implement technological and product innovations and actively use various sources of innovation. However, in mature sectors, changes in the mode of production is the most common innovation.

Small businesses are often effective in identifying the opportunity, but less effective in developing the advantages needed to obtain the proper value. An invention may be the effect of individual people's actions, but its commercialization requires resources and efforts of organizations that need to be managed.

The main problem of financing enterprises both in Poland and the European Union is the fact that we are dealing with refinancing of a part of investment outlay rather than direct financing of the works whose aim is to make a new, innovative product.

Modern and young businesses in Poland have little chance to acquire capital through traditional channels which include [2]:

- bank investment loans, long-term loans,
- issuance of bonds by the company and other long-term debt securities,
- franchising,
- leasing,
- short-term bank loans, loans,
- issuance of short-term debt securities,
- commercial credits and other liabilities.

SMEs show a low tendency to use external financing. There has only been a slight increase in the percentage of companies that benefited and benefit from credits and loans - it is still less than 1/3 of the total number of SMEs.

Low involvement and limited access to private capital undoubtedly affects the way of innovative projects funding. These limitations cause new innovative companies to have a limited impact on the absorption of new technologies and advances in productivity.

SMEs use both their internal and external sources to finance their activities. However, it is the internal sources that dominate the capital structure. Among the preferred internal sources, net profit is definitely dominant. This means that the SMEs generate profits that they can use to finance their own development. Particularly micro-enterprises make their development dependent on the financial surplus earned. However, they must remember that in the period of economic revival, this may be a barrier to development.

3. FINAL REMARKS

Micro and small businesses should to a larger extent concentrate on the sources of financing innovative development activities and choose those with the lowest acquisition cost. They may apply for the structural funds, where the most appropriate action is to support product and technological competitiveness, increase in competitiveness through innovation and the development of human resources.

Uncertainty of the expected changes in the economic situation still causes many enterprises to refrain from starting new projects, despite the lack of major barriers, as companies continue to see the investment climate as unfavourable.

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machinery, usage of machinery, legal requirements for machinery

Tomasz MAŁYSA*

SAFETY USAGE OF MACHINERY IN EUROPEAN UNION COUNTRIES

Abstract

The article presents the legal requirements which EU legislator imposes on the users and manufacturers. Legislations relating to the machinery and whose obligation results from the belonging to the European Union were subjected to analysis.

1. INTRODUCTION

European Union legislator identifies two types of requirements for machinery: machines used by employers at work and machines placed on the market and which are putting into service. The legal requirements were determined in the New Approach Directives 2009/104/EC and 2006/42/EC. Directives are legal acts addressed to EU Member States. The Member States are required to implement the provisions of Directives in a certain time usually from six months to two years, but it not determined forms of legal act, witch have to transfer those legal requirements. They also have the ability to choose the legal act, but the most common are the laws or regulations of relevant ministers.

The major aim of New Approach Directives is to harmonize requirements of laws and procedures for assessing the safety of products, placed on European market as well as to protect the health, life or property of citizens. European Union get into actions to improve working conditions, especially safety of workers, who usage of machinery. The primary objective in this area is elimination accidents at work because they generate economic and social costs. Therefore, the legislator imposes on producers and users of machinery the obligation to meet the requirements with are identified in Directives.

2. MINIMUM AND ESSENTIAL REQUIREMENTS

The Directive of the European Parliament and of the Council 2009/104 /EC [1] is exiting legal act in European Union countries in the field minimum safety and health requirements for the use of work equipment by workers. This Directive is an individual directive within the meaning of Art. 16 paragraph 1 of Directive 89/391/EEC [2] into introduction of measures to encourage improvements in the safety and health of workers at work. Directive 2009/104/EC includes for example: machinery, equipments, tools, technological installations, equipment for temporary work at height, especially ladders and scaffolding.

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This Directive [1] is addressed to employers. The employers are obligated to application necessary measures in order to provide that work equipment is safe for worker or properly adapted for that purpose. During selecting a use equipment employers should pay attention to the specific working conditions and hazards. Minimum requirements for work equipment have been specified in the first annex to the Directive [1].

In the case of minimum safety requirements employer should consider ergonomic principles, positions of the body during the usage of work equipment by workers. Also, in accordance with Directive [2] the employer provides employees necessary information, written instructions on the work equipment. Information and the written instructions should be comprehensible to workers and they should be include data relating to [1]:

- conditions of use of work equipment;
- atypical situation;
- results from experience in using work equipment.

The text of the provisions of national law are submitted by Member States to the European Commission. This text has been or will adopted in the field covered by the Directive.

The essential requirements for machinery was described in the directive 2006/42/EC [4]. In accordance with the Directive [4] Member States are responsible for the effectives implementation of the provisions of Directive in the country. The requirements of the Directive apply to manufacturers and their authorized representatives. In the Directive [4] the manufacturer means any natural or legal person who designs and/or manufactures machinery or partly completed machinery covered by this Directive. The next important concept is authorised representative who means any natural or legal person established in the Community who has received a written mandate from the manufacturer to perform on his behalf all or part of the obligations and formalities connected with this Directive [4].

The Machinery Directive [4] covers the following products [4,5]:

- machines;
- partly completed machinery;
- machinery for pesticide application;
- interchangeable equipment;
- safety components;
- lifting accessories;
- chains, ropes and webbing;
- removable mechanical transmission devices.

The products defined in the Machinery Directive [4,5] must meet the essential health and safety related to the risks associated with their usage. The necessity to meet the requirements of the Directive [4] exists only when there is a hazard, and manufacturers or their authorised representatives are required to complete a risk assessment. The manufacturer have to identify hazards and relevant requirements, which the list in terms of relating to various types of risks was presented in annex 1 of the Machinery Directive [4].

The Directive [4] imposes on the manufacturer an obligation put CE marking on the product - on all new products subject to Directives of the New Approach. In the annex III was presented a requirements for the CE marking. The CE marking is affixed by the manufacturer or its authorised representative who has got established in the Community. The marking CE should be after the completion of the manufacturing process and carried out the conformity assessment process. The assessment of conformity is based on eight main modules, eg. A-H. The use of different procedures for assessing conformity are required by the modules. The choice of conformity assessment procedures depends on the risk associated with the usage of the products (machinery). The conformity assessment procedures are designed to demonstrate that the product complies with essential requirements [6]. The machinery which was marked the CE mark and having the declaration of conformity is recognized by EU Member States as a conforming to the requirements of the Directive [4].

3. REQUIREMENTS FOR MACHINERY COMPLY WITH DIRECTIVES OF THE NEW APPROACH

Directives [1,4] have common areas related to ensuring safety. For these areas can includes, for example: control devices, used guards (interlocking guard, movable guard, fixed guard), moving elements of the machinery, stability of the machinery, deposited material, greenhouse gas, substances etc. These are basic technical aspects for which identify the hazards. The main objective of Directives is reduction the risks associated with usage of machinery, therefore the EU legislation determines, how the requirements must be met.

Tab.1. Safety requirements for machinery (for example)

No.	Minimum requirements	Essential requirements
	Employer/ User of machinery	Manufacturer/Authorised representative
Studied area: control devices		
1	- work equipment control devices which affect safety must be clearly visible and identifiable and appropriately marked where necessary; - control devices must be located outsider danger zones and in such a way that their operation cannot pose any additional hazard; - control devices must not give rise to any hazard as a result of any unintentional operation.	- clearly visible and identifiable, using pictograms where appropriate; - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity; - designer in such a way that the movement of the control device is consistent with its effect; - positioned in such a way that their operation cannot cause additional risk; - designer on protected in such a way that the desired effect, where a hazard is involved, can only be achieved by a deliberate action.
Studied area: lighting at the workplace		
2	- areas and points for working on, or maintenance of, work equipment must be suitably lit in line with the operation to be carried out.	- machinery must be supplied with integral lighting suitable for the operations concerned where the absence thereof is likely to cause a risk despite ambient lighting of normal intensity; - machinery must be designed an constructed so that there is no area of shadow likely to cause nuisance, that there is no irritating dazzle and that there are no dangerous stroboscopic effects no moving parts due to the lighting.

Responsibilities for employers and manufacturers in the studied area (control devices, lighting) was defined in Directive (it was presented in the table. 1)[1,4]. This is due to the fact that the manufacturer has to provide a higher level of safety by eliminating risks at source, using new technical solutions. The employer who adjusting the machinery may also take advantage of the arrangements provided for machinery manufacturers. An employer cannot interfere in the construction of the machinery. It would involve the responsibility transfer for the machine to employer and the obligation to meet the essential requirements which are defined in Directive [4]. EU legislator in Directive [4] also includes for example: machinery which used in the food, cosmetic, pharmaceutical, portable hand-held or hand-guided machinery. For this group of machinery were determined additional requirements which are appropriate for the given machinery.

Minimum requirements for work equipment by employer was shown only in directive [1]. These requirements must be met by work equipment, located in usage before joining a country to the European Union. The adjustment period for work equipment to minimum requirements ended in 2006.

4. SUMMARY

The common aim for the Members States, which is to mitigate the risk of machine was defined in Directive. The Directive [1] is addressed to employers. The employers must provide that machinery which are usage at work meets minimum requirements. In the case of Directive [4], the producer is responsible for the machinery which introduces on the European market. However, the most important element is the cooperation between employers and manufacturers to ensure the safety at work.

Directive [4] concerns not only the risks, which to be eliminated at the design stage. It take into also account the group other products (machinery), that should meet the requirements of the Directive. The annex of the Directive contains the list of dangerous machinery. In the directive was determined, how the conformity assessment procedures should be subjected the individual products (machinery). In the case of Directive [1] there is no conformity assessment procedures, but the machines usage in industry should meet the minimum requirements throughout their lifecycle.

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Humanoid robot, industrial robot, robot-human cooperation

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DESIGN OF PRODUCTION SYSTEMS USING THE SAFE COOPERATIVE ROBOTS.

Abstract

The article deals with the description of a new approach in the design of industrial robotic systems. The purpose of this research is to identify the safety standards for industrial robots, especially robotic co-workers. In spite of the fact that those robots are considered to be safe, risk assessment and risk minimization need to be performed. The reader will be introduced to the risk assessment of the co-workers.

1. STATE OF ART

More and more, flexible manufacturing requires robots, that are able to act within the personal space of a human and even make direct contact with human operators. To be useful, some robots may need to be powerful and therefore those robots are considered to be dangerous. Safety of the humans who interact with these machines is clearly a main concern in this paper. The safe operation of the robotic co-workers is a core foundation for humans to establish trust in them. [1]

2. TECHNICAL SPECIFICATION TS 15066

The scope of ISO/TS 15066 is "Occupational safety requirements for collaborative robots and their work places". The standard title indicates the new concept of "Occupational Safety" that should be a tool at disposal of workcell designer. It takes into account all parts of an industrial robot as an end-effector and other equipment necessary for performance of the work tasks, supplements or specifies the requirements for collaborative robot operation of EN-ISO10218. As other standards, TS 15066 does not apply to non-industrial robots although the safety principles may be useful in this field.

Basic principle consists on the necessity of a safe control system which provides the safety related performance for monitoring safety related parameters, e.g. speed, position, force etc. Once this condition is satisfied, collaborative robots can be used for collaborative tasks without

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fixed guards. Safe controller should be an essential contribution to the reduction of accidents. Main specifications listed in the TS 15066 concern three main collaborative tasks [2,5]:

- hand Guided,
- safe Separation Monitoring,
- power and force limiting.

2.1. Hand Guided

TS15066 establish various requirements for safety in the mode called “Hand Guided”. However they are similar to the ones listed in ISO1028. Basically, robot guidance is still considered as a low-risk task if a safe speed monitoring is activated. Human operation acknowledgement and the safety-three-position dead man allow this task to be faced also with actual technology. See the fig.1. [2,5]

Note:

“Safe Speed monitoring” does not mean that the velocity and/or positions are measured by redundant sensors but that the actual measuring systems are certifiable as PLd/SIL3 devices.

2.2. Speed and separation monitoring

TS15066 establish various requirements for safety in the mode called “safe and separation monitoring”.

Among them, it is important the identification of how calculate the minimum separation distance, and the procedure to establish maximum safe speed. Furthermore, various indications are listed for identification of potential collision. TS15066 foreseen also that robot controller has to implement methodologies to avoid potential collision, and to notify the collaborator about the robot state (hazards, warning, etc.). Furthermore, it indicates the safe position and velocity monitoring of the collaborators as an extremely useful instrument to preserve safety. See the fig.1. [2,3,4]

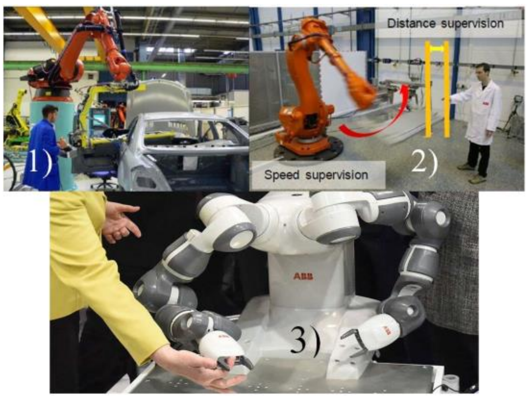

Fig.1. Examples of the cooperation modes: 1) Hand guided, 2) Speed and separation monitoring, 3) Power and force limiting

2.3. Power and force limiting

Section on power and force limiting is extremely full of interest. In fact it lists various important aspects, and among them the:

- Technological requirements
- Medical/biomechanical requirements
- Ergonomic requirements
- Marking and instructions
- Testing and validation
- Documentation of tests [5]

3. RISK ASSESSMENT AND RISK MINIMIZATION

According to the Machinery Directive, the machine builder is required to perform a risk assessment for the machine design and also include an assessment of all the work operations that need to be performed. [6]

3.1. Risk assessment

A risk estimation is made for each risk source, i.e. indication of the degree of risk. According to EN ISO 13849-1 the risk is estimated using three factors: injury severity (S, severity), frequency of exposure to the risk (F, frequency) and the possibility you have of avoiding or the injury (P, possibility). For each factor two options are given. Where the boundary between the two options lies is not specified in the standard, but the following are common interpretations (To calculate the performance level required - PLr) : [6]

***S** Severity of injury*

- S1 slight (normally reversible injury)
- S2 serious (normally irreversible injury or death)

***F** Frequency and/or exposure to hazard*

- F1 seldom to less often and/or exposure time is short
- F2 frequent to continuous and/or exposure time is long

***P** Possibility of avoiding hazard or limiting harm*

- P1 possible under specific conditions
- P2 scarcely possible

By setting S, F and P for the risk, you will get the PLr Performance Level (required) that is necessary for the risk source. Finally, the risk assessment includes a risk evaluation where you determine if the risk needs to be reduced or if sufficient safety is ensured. See the fig.2. [6]

3.2. Reduce the risk

If you determine that risk reduction is required, you have to comply with the priority in the Machinery Directive in the selection of measures:

1. avoid the risk already at the design stage. (For example, reduce power, avoid interference in the danger zone),
2. use protection and/or safety devices. (For example, fences, light grids or control devices),

3. provide information about how the machine can be used safely. (For example, in manuals and on signs).[6]

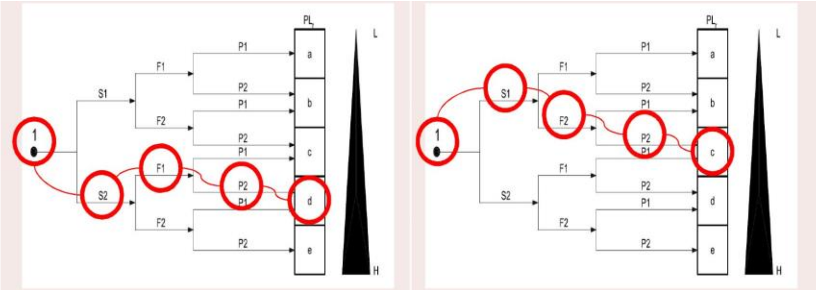

Fig.2. Risk estimation (left - conventional robots, right - robotic coworkers) [6]

4. CONCLUSION

The main goal of the article was to introduce to the reader a new approach of robotic workstation designing. As the reader could read in the article, industrial co-workers can cooperate with human that is the most important benefit of the usage of co-workers in the industry. To achieve the cooperation, designer of the maschine has to take into account the standards described in the article.

Note: This paper was made about research work support: VEGA 1/0559/15.

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ergononomic, work severity classification

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ENERGY EXPENDITURE ANALYSIS EXAMPLE

Abstract

Summary of the results determine the nature of work for each of the sensors in all test days are presented in Table 1. Generally the work was very hard or hard type. Position was without movement. This situation causes a pain and bad effects for health for the test person. The presented method allows analysis of employee nuisance for long periods of time. The Body Media Sense Wear allows to stamp the most intense hours of the working day. The method also allows identification a activity with the highest energy expenditure.

1. INTRODUCTION

All the European Union countries more and more put emphasis on the issue of the occupational activity in mature employees group. There is high activity in extending the period of remaining in the employment. The labor market must fit to the new reality of the rich diversity of staffs both in terms of the age as well as other features of the population.[4]

Work classification due to polish law based on a measurement of the energy expenditure. This knowledge determining whether the employee is entitled to drinks and preventive meals. These duty have influence in evaluation of the occupational hazard.[4]

2. ANALYZED JOB DESCRIPTION

In paper is analyzed one worker. The analyzed employee is an owner of a privately owned business enterprise conducted by oneself simultaneously what should have statistically a positive effect on get results. Static load felt by the analyzed person is evaluated in the week's It was usual the same for the entire period what during running of their business activity performs.

From many available methods for the measurement energy expenditure was chosen Body Media Sense Wear. A device used to examinations is a band containing accelerometers - devices measuring the movement, device counting the made number of steps - pedometer,

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sensors measuring the electrical conduction, registering changes under the influence of emotional incentives and sweat for and the thermometer built in is measuring the temperature of the skin. The device is also measuring the quantity of the central heating given off by the organism. Error of measurement of the energy expenditure - declared by the producer is taking out < 10%, error of measurement of the time < 5%. [1][2]

The best things of the applied device are dimensions, weight, place of made measurements (forearm) an interference in the course is lacking manufacturing processes (employees which are being subjected to measurements with using extended apparatus aren't working in the natural rhythm). Device is shown on the figure 1.[1][2]

Fig.1. Device used to the measurement of the physical activity -
The Body Sense Wear Media[2]
source: http://sensewear.bodymedia.com; 02.10.2014

3. BIOLOGICAL EFFECTS OF ENERGY EXPENDITURE

During the static work muscles are in tension, there are a hindered then inflow and an outflow of blood from muscles. Muscles aren't obtaining glucose or oxygen, and so are drawing them from their reserves.[3][4]

Impediments are appearing in carrying the lactic acid, and lying causes him pain which muscle tiring out is signaling. For them a circulation of used power is larger with it stopping the blood flow grows.[3][4]

In case of the equal value c 60% of the value of the maximum load, inflow of blood practically is terminating. In case of power taking out 15-20 % of maximum power the blood supply should not be handicapped. During the dynamic work the muscle receives from 10 to 20 times of more blood than retired.[3][4]

4. SUMMARY

Summary of the results and determine the nature of work for each of the sensors in all test days are presented in Table 1. Generally the work was very hard or hard type. Position was without movement. This situation causes a pain and bad effects for health for the test person.

Tab.1. Week work classification evaluation

Date	2014-10-15	2014-10-15	2014-10-16	2014-10-16	2014-10-17	2014-10-17	2014-10-18	2014-10-18	2014-10-20	2014-10-20	2014-10-21	2014-10-21	2014-10-22	2014-10-22
Day	wed	wed	Thu	Thu	Fri	Fri	Sat	Sat	Mon	Mon	Wed	Wed	wed	wed
Measured [kcal/8h]	1274	1243	2137	1903	1404	1264	1709	1551	1903	1407	1618	1500	2121	2236
V. hard [kcal/8h]	1147	1119	**1923**	1713	1264	1138	1538	1396	1713	1266	1456	1350	**1909**	**2012**
Hard [kcal/8h]	1210	969	2030	**1808**	1334	1201	**1624**	**1473**	**1808**	1337	**1537**	1425	2015	2124
Medium [kcal/8h]	**1338**	**1305**	2244	1998	**1474**	**1327**	1794	1629	1998	**1477**	1699	**1575**	2227	2348
Light [kcal/8h]	1401	1367	2351	2093	1544	1390	1880	1706	2093	1548	1780	1650	2333	2460
Interpre-tation [kcal/8h]	1321		1866		1401		1549		1643		1556		1961	

Scope of the performed work. Person who was evaluated was man 57 years old, employee from 15 years old, connected with the industry of the machining for 42 years, 5 years person in charge of his own business activity.

Work in the analysed week it is a work interspersed on different positions in the own enterprise - among others the lathe, the milling machine, grinders of different kind, knife sharpeners, the assembly needed for the completion of an order and packing the product, the service of the test-bench, the plant maintenance and the maintenance of machines, rearming the machine and adapting tools of needed works to do, work on the computer. In subjective feeling the person subjected to the measurement works only constituted the 10% of the time at the operation of the computer, 10% the installation and rearming machines, 80% of the analysed time was connected directly with the productive labour. In the course of the analysed week lifting heavy objects appeared - raising the body of the machine, taking the pump of the machine out, where each of elements picked up weighed 30-50 kg. Weightlifting was carried out by hand, without applying the help.

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Deon, Element, Self-assessment

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DEON

Abstract

Deon is Nemak´s global diagnostic standard to achieve operational excellence through definition, coaching, assessment and development of desired behaviors. Deon is used to identifying the current baseline towards Operational Excellence by evaluation behaviors on 4 dimensions across 5 level. Based on results of DEON self-assessment are established concrete projects. This projects are intended by management of NEMAK.

1. DESCRIPTION

DEON is Nemak's global diagnostic standard to achieve operational excellence through definition, coaching, assessment and development of desired behaviors.

DEON focus is towards behaviors and systematic improvement versus traditional tool-oriented focus. The depth of the transformation of one organization in Operational Excellence is reflected on its maturity towards principles. We move our Company forward by everyday use of different activities and tools into improvement.

2. DEON AND NEMAK´S PROCESSES

DEON integrates into Nemak current processes to add Knowledge, Skills and Behaviours into ongoing business strategies.

DEON's strength relies in the focus towards behaviors to drive a culture of Excellence in the organization. The systematic approach in collective behaviors helps in developing a working culture within the organization. This helps boost and accelerate progress as time goes by.

DEON works together with current continuous improvement initiatives. The combination of these approaches provides a stronger cultural focus to the organization.

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DEON identifies the current baseline towards Operational Excellence for our organization. Through gap analysis sets the areas of opportunity which need to be worked on and appoints projects which will focus in these required areas. Thus, DEON helps the organization to continually move from a current state to a desired state.

DEON is strategically present in all management cycles to continually work in developing desired behaviors and achieve a cultural transformation. Constant monitoring and action takes place throughout different levels of the organizational structure.

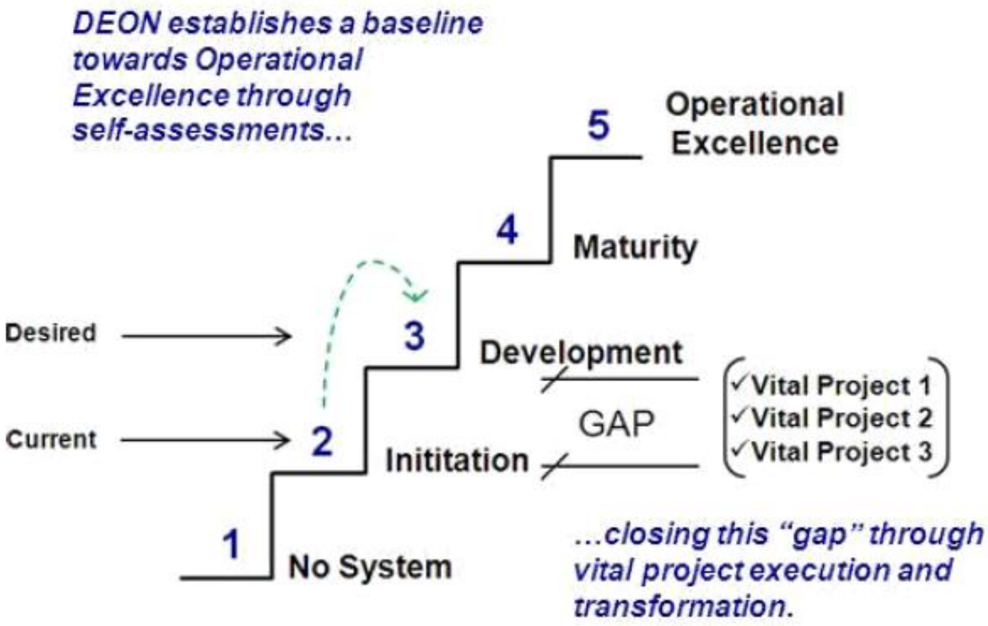

Fig.1. *DEON focused on closing the gap in the operational Excellence journey*

3. DEON AND NEMAK´S PROCESSES

The measure of progress in Operational Excellence is done by evaluating behaviors on 4 dimensions across 5 levels. The current DEON document has 45 DEON elements. On figure we can see an example and explanation of a DEON element.

ELEMENT 1	6.1 Workspace Organization Across the Facility (5S)	Area	6 Floor Administration 2		
1. 5S is a systematic approach to waste elimination. 3 2. 5S step process – Sort, Set in Order, Shine, Standardize & Sustain 3. Training roll out on a regular basis to cover all employees (including leased employees) 4. Indicators and results are well established & published (displayed) on a regular basis 5. Periodic audit process in place					
Progress Chart 4					
Observable Behaviors	**Level 1** **No System Available**	**Level 2** **Beginning**	**Level 3** **Development**	**Level 4** **Maturity**	**Level 5** **Continuous Improvement**
Methods	• No system in place • Poor understanding of concept	• 5S system is defined and implementation in a pilot area	• Standards exist for 5S maps, audits & reviews • Evidence of use of all steps across 50% of the facility • Audit frequency - Quarterly	• Standards updated on a regular basis Evidence of use of all steps across 75% of the facility • Audit frequency - Monthly	• Evidence of 5S is a" way of life" across the facility. • 5S is an integral part of continuous improvement. • Audits happen on a monthly basis
Scope	• No 5S training in place	• Standard training plan & material available. • Training imparted in pilot areas 5	• Training Implementation covering all operational areas and some support areas	• Standard training implementation across the entire facility	• Total implementation across the organization • Training covers 100% of employees (includes leased)
Cross functional integration	• Practiced only at sporadic, individual levels. • Limited to housekeeping activities	• 5S system and audit responsibilities rest with a small group of people	• 5S system is integrating cross functional teams and is evident in 50% of the production and support areas • Evidence of cross functional audits occurring	• Cross functional teams are identifying and correcting abnormalities. Cross functional audits happen on a continuous basis	• Cross-functional teams are proactively identifying abnormalities and impact on continuous improvement is significant. (> 20% impact)
Results	• No system – No result	• Standard indicators for tracking defined. • Results available for pilot areas	• Evidence of audit findings and action plans in place. • Scores and trend lines are visually displayed and communicated regularly	• Audit results and scores show positive trend lines. • All audit observations closed before the next audit	• Team goals, objectives & results align with plant / BU targets and being achieved consistently • Consistently achieve benchmark 5S scores

Fig.2. *DEON Element (Example)*

DEON Element Structure:

1. DEON Element Name. Name of the corresponding DEON element.

2. DEON Section. Section from the general DEON document to which the element belongs.

3. DEON Element Ideal Status. Verbal description of the ideal state (level 5) of the particular DEON element.

4. DEON Element Levels. Levels 1 through 5 for the corresponding DEON element (Increments happen every ¼).

5. DEON Element Level Content. Describes the desired observable behaviors of the particular DEON element for every dimension-level.

4. DEON APPLICATION PROCESS

During DEON application important activities are required to perform a successful application (Refer to figure 3).

Based on results of DEON self-assessment are established concrete projects. This projects are intended by management of NEMAK. Time horizon of the project is defined for 1 year and for monitoring and visualisation of results are using A3 format. The control of these projects are periodically and mostly two times per year.

Fig.3. Main DEON Application Activities

4.1. Results of DEON

During the self – assessment participants must provide an individual score for every DEON element. Once the Performance Team has completed evaluation of all DEON element.

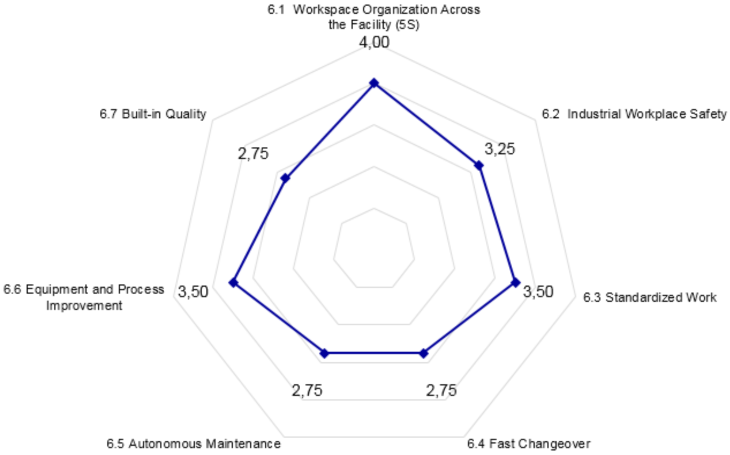

Fig.4. Results of DEON for one Element 6 (Examples)

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manufacturing subsidiary, global industrial corporation, external risks, risks factors, risks management methods, industrial engineering methods, probability impact, threat probability.

Anton ONDREJ*

MANAGING EXTERNAL RISKS AT THE MANUFACTURING SUBSIDIARY (MS) OF THE GLOBAL INDUSTRIAL CORPORATION (GIC)

Abstract

External risks of the MS of the GIS have their own characteristics resulting form global and local factors, which mutually correlate. Managing business risks is the key feature of the overall management of the organization. The risks management tools are different for each type of the business organizations and their levels. To determine the methods of risk management of the MS of the GIC it is necessary to analyse available scientific methods for the societal events and processes and to select methods and tools from the science area of Industrial engineering. Effective governance of the GIC is reached through the interconnections of the individual types of management and efficient use of resources of the organization.

1. EXTERNAL RISKS IN THE MS OF THE GIC.

Practical experience and analysis of the problems of management of external risks in the manufacturing subsidiary of global industrial corporation shows that external risks of the MS have their own characteristics that are affected mainly by the following three factors:

The primary and fundamental factor in determining the specifics of external risks, in particular, is the cultural and other social and political environment of the region in which the MS operates.

The second factor is the behavior and administration of the MS in a particular territory by the headquarters of the GIC.

The third factor are the global external risks that affect the GIC as a whole and subsequently the MS. Schematic overview of the external risks affecting the MS is shown in the figure below.

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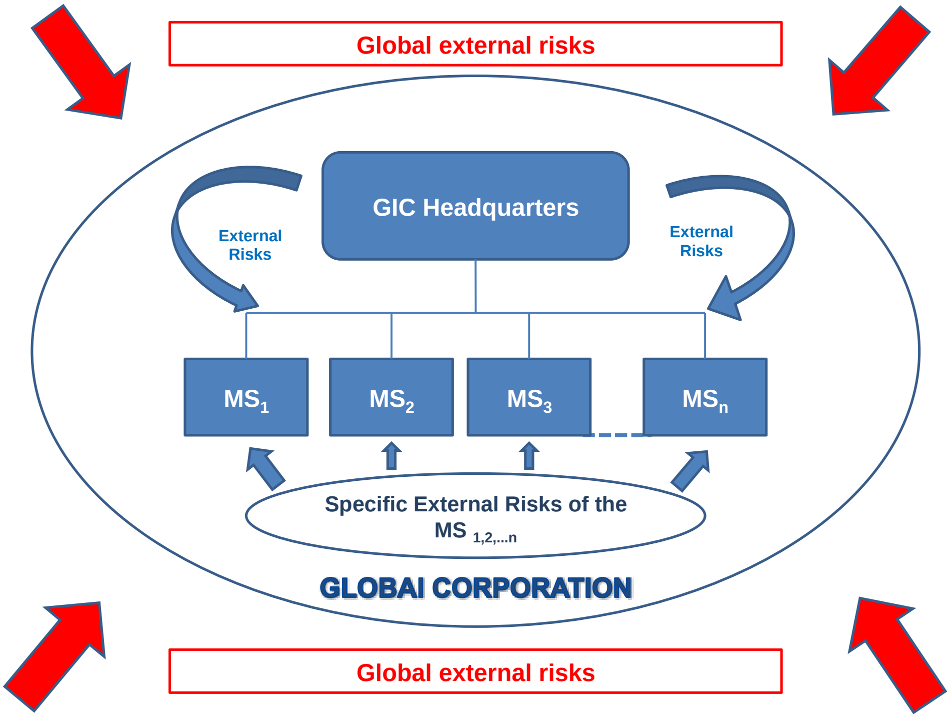

Fig.1. Structure of the external risks affecting the MS (Anton Ondrej).

This relationship can be expressed as follows:

$$RSM1 = SER\ MS1 \pm ORGIC \pm GOR \quad (1)$$

Where:

RSMJ1 - is a cumulative outside risk of the MS of the GIC,
SERMS1 - are specific outside risks of the MS of the GIC resulting form specific operation environment of the MS,
ORGIC - is outside risk of the MS of the GIC resulting form management of the GIC,
GOR - is the global outside risk affecting GIC as a whole.

External risks of the MS of the GIC are the risks, which affect the management of the GIC as a whole. Specific external risks of the MS are the risks that derive from the specific operation of the MS in a particular territory, but also from the markets, which affect its operation. External risks of the MS arise from the management style of the GIC and from organization structure and relationships within the GIC.

2. MANUFACTURING SUBSIDIARY RISKS FACTORS.

The structure of external risks of the MS of the GIC, and the identification of these risks cannot be based only on a global external environment, but must include environment of the MS itself and risks arising from management style of the GIC in relation to the MS. These risks may affect the operation of the MS in the long, medium and short term. Accordingly, it is possible to determine the tools and means for the response to the risks incurred. Then there are measures of strategic, tactical and operational nature. All three types of risks mentioned in the equation 1.1 above may be of the strategic, tactical and operational nature.

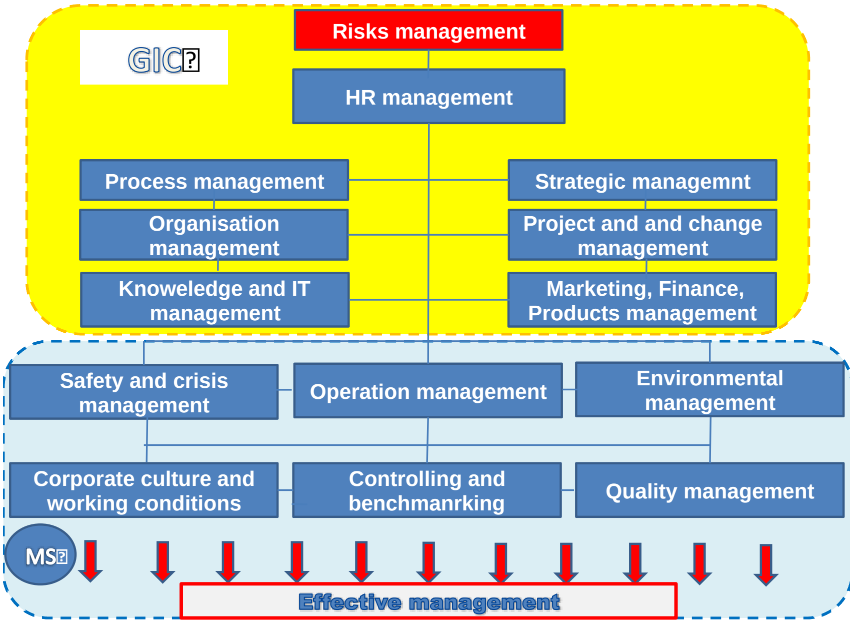

Fig.2. The management structure of the GIC and MS in relation to the risk management (Anton Ondrej)

Managing risks is the part of the overall management of the organization. Its components are shown in Fig. 2. The risks management tools are different for each type of the business organizations and their levels. Effective governance of the GIC is reached through the interconnections of the individual types of management and efficient use of resources of the organization.

The analysis of the outside risks proves that for the determination of the risk management method of the GIC it is necessary to identify, to analyze and to synthesise mainly the following factors:

(a) Cultural, social and political entities, which affect the management style of the GIC and the MS,

(b) Characteristics of the industry, its trends and development on the global scale,

(c) Characteristics of the management style of the processes, as specific management styles.

3. MS RISKS MANAGEMENT METHODS.

To determine the methods of risk management of the MS of the GIC it is necessary to analyze available scientific methods for the societal events and processes and to select methods and tools from the science area of Industrial engineering.

Janíček (2007a, p.45) defines the generalised algorithm of the problem solving, which reflects the system approach. The specific science task belongs to the problem solving of the society systems. Social systems, which are called „the soft systems“, are characterised by complex features, which make definition of the research targets difficult. In general it is possible to set up a system of methods, which can be used for problem solving in technical and social systems.

During the last decade of the 20th century the management of business risks was developed from the intuitive management to the standardised management. For risk management the international standard ISO 31000:2009 is recommended.

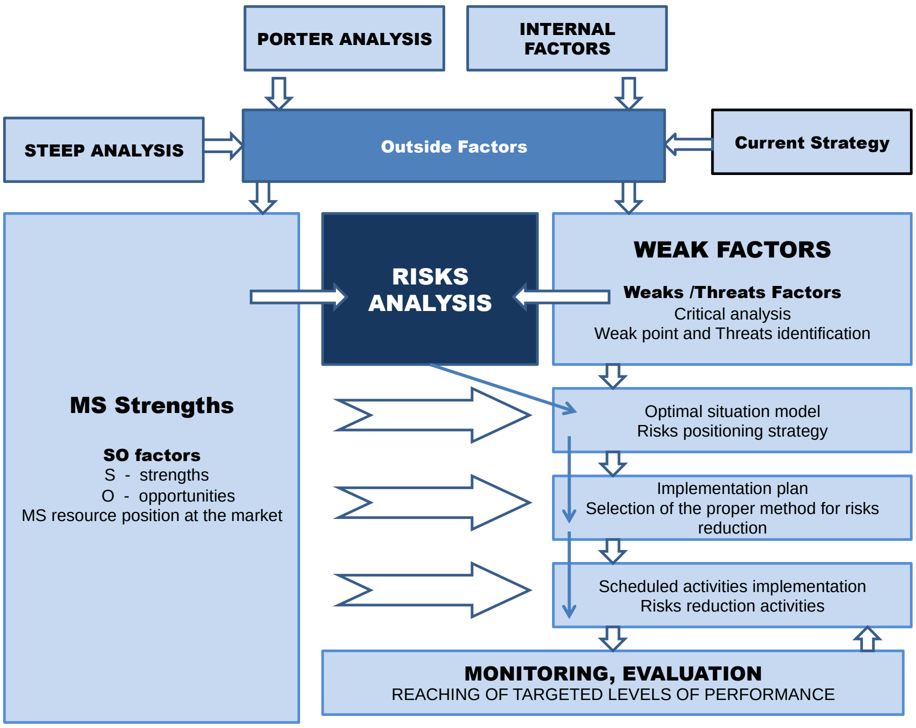

Fig.3. Method of risk analysis, using the methods of strategic management. (V.Smejkal, K.Rais, 2010, p. 78)

For risk analysis in the risks management system it is possible to use methods of the industrial engineering commonly used in the area of strategic management. The process showing the way, how to develop the risks analysis is shown at the Fig. 3. The process is using SWOT analysis as the framework, combined with the STEEP analysis for identification of outside risks and also the Porter method to determine the effects of the competitive forces.

The key point is the risk analysis, as the interaction of the subsidiary strong and weak points. This method of risk analysis sets the basis for determining of the risk degree **R**. For the determination of the **R**, which stems form the risks analysis the risks matrix can be used, which correlates two variables, the ***a*** as the impact of the real threat and **h** as probability of the threat.

The equation is as follows:

$$R = f\,(\boldsymbol{a}, \boldsymbol{h}) \qquad (2)$$

While the specific risks can be listed in the matrix.

$$f = \begin{pmatrix} f_{11} & \dots & f_{1n} \\ \vdots & \ddots & \vdots \\ f_{n1} & \dots & f_{nn} \end{pmatrix} \qquad (3)$$

The method of risk determination is based on combination of the quantified and prognosed risks, which are derived form the date of particular MS, but also from the experts prognosis and their estimation. The risk scope degree is the basis for the MS risk management strategy.

Tab.1. The system of the MS outside risks determination in three industry sectors (Anton Ondrej).

Research entity	*Research subject*			Research method
Global corporation in Slovakia	**GLOBAL MULTINATIONAL CORPORATION**			Corporate strategy
Industry	**Consumer electronics**	**Steel**	**Passanger cars**	Industry outlook
Headquarters location	**ASIA**	**NORTH AMERICA**	**EUROPE**	Regional characteristics
RISK	CUMMULATIVE OUTSIDE RISKS OF THE MANUFACTURING SUBSIDIARY			Identification. Analysis, Synthesis. Risks levels
	SPECIFIC	SPECIFIC	SPECIFIC	Identification. Analysis, Synthesis. Risks levels
	GIC management style	GIC management style	GIC management style	Identification. Analysis, Synthesis. Risks levels
	Global risks	Gllobal risks	Global risks	Identification. Analysis, Synthesis. Risks levels

4. CONCLUSION

In summary, risks of the MS depend mainly on industry sector in which the MS operates and on the region in which the MS headquarters is located. In determination of the MS risk degree there is a need to analyse the strategy of the global multinational corporations and to identify the status and prognosis of the industry sector, in which the global corporation operates. At the same time the culture framework and specific risks arising from the social and technical aspects of the region in which their headquarters is located needs to be analysed and assessed. The determination method is summarised in the Tab. 1 above.

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Lean thinking, healthcare, waste, model, changes, implementation

Marko PEDAN*, Milan GREGOR**, Patrik GRZNÁR***

LEAN IN HEALTHCARE

Abstract

Lean is one of strategy used for quality and safety improving in industry and also in healthcare. This methodology, derived from the Toyota Production System, is applied as a way how to struggle against the problem of crowding, queueing, delaying and errors. This article describes the principles and application of Lean philosophy in healthcare and also it serves an examples of its successful implementation.

1. LEAN PRINCIPLES IN HEALTHACARE

Lean thinking is a philosophy that aims to eliminate waste, or non-value adding elements of processes, to streamline the flow of patients, so the customer gets more value. The value and flow are the key concepts or elements of lean thinking. The value in healthcare is represented by activities that improve the quality of care and that support patient in order to achieve the best result. Value is valuable at the moment when it meets the patient needs and requirements, for certain costs, at the right time. Therefore, from patient perspective, a certain value is created when the waste is removed. Waste is something that does not add value for the customer. For example, if the patient is a customer at emergency department, for patient, waste may be waiting for examination, test duplication and blood tests duplication. Once the waste is eliminated, goods (or patients) are flowing smoothly and without errors from one step to another.

After the work is done in one step, patient is not pushed to the next step; the patient should be pulled and driven when next step is ready to process him. This will avoid the queueing.

Fig.1. Lean tools

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1.1. Types of waste from Lean perspective

Although Lean is conceptually simple approach, it is not easy to define. The core of the lean philosophy is continuous improvement of the process by removing steps or waste that do not add value. The problems that arise in the process need to be immediately identified, understood and appropriate solutions have to be applied. Taiichi Ohno, the father of Toyota Production System, defined the model of seven wastes in the manufacturing environment (Tab. 1.). But these original wastes have been transformed into today's eight. It is not easy to convert these "wastes" of large-recurring production to low-volume environment or even to service sector. NHSI Institute for Innovation and improvement (NHSI) made examples of "healthcare wastes". Waste in healthcare can be defined as any activity that does not help the patient to process to the next step of treatment. The examples are given in the second column in Tab. 1.

Tab.1. Transformation of wastes from manufacturing industry to healthcare sector.

7+1 wastes defined by Ohno	*Examples of waste in healthcare (NHSI)*
1. Transportation: Moving products that are not actually needed to perform the operation.	**Transportation:** Walking and movement to the other side of room to pick up notes and results. Central warehouse equipment for general use instead of placing the equipment on the place of usage.
2. Inventory: All components, WIP, and unfinished products.	**Inventory:** Excess of inventory in warehouses that are not used. Patients waiting for discharge. Waiting lists.
3. Movement: People or equipment moving more then is necessary and required for process fulfillment.	**Movement**: Excess movement of workers seeking documents (regulations not returned to the place), storage of syringes and needles at the opposite side of the room. The absence of basic equipment in the office.
4. Waiting (delay): Waiting for the next production step.	**Waiting for:** Patient, results, regulations and medicines. Doctors, the patient discharge.
5. Overproduction: Production in excess of demand.	**Overproduction**: Requiring unnecessary tests. Performing the same test several times.
6. Overprocessing: Positive or inappropriate processing: Arising from the wrong tool or product design.	**Overprocessing**: Duplication of information e.g. requiring and obtaining patient information several times. Repeated fetching of patient.
7. Errors: The efforts made in checking, finding and fixing defects and errors.	**Correction**: Readmssions due to unsuccessful discharge or adverse effects. Repeat tests due to the lack of provision of correct information.
8. Underutilizing talent of people: Underestimating and a lack of understanding of human talent, skills and knowledge.	Ignorance and staff omiting, poor listening and support. Employees may feel burned out and stop sharing ideas for improvements.

2. HEALTHCARE LEAN MODEL

Model of Lean in healthcare (Fig.2.) suggests that (a) Lean affect patient care and staff indirectly by changing the working structure and processes, (b) Lean affect employees directly, (c) changes in staff and patient care may influence each other, and (d) Lean is implemented in a specific context, and that the success of Lean is dependent on how the actual implementation of Lean fits into a local context.

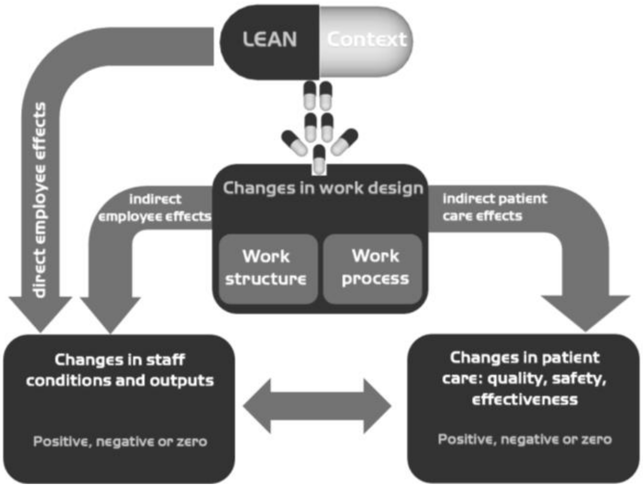

Fig.2. The healthcare lean model.

Understanding how Lean transforms working structure and the process is important because the transition will determine the quality and safety of patient care indicators, such as the length of stay, medication errors, and patient satisfaction. Even if Lean affects patient care, even indirectly, through structure and process changes, but in the end it determines the success of Lean. The logic of Mehta and Shah model (Fig. 2.) says that the results, outputs employees, affect or are affected by "organizational results" as "productivity" and "power". In addition to the effects on the staff, the "lean" changes, referring to the current work can also be forthright manner how Lean affects employees. For example, the goal is to change employees only from doing its work to seek ways how to improve their work and strengthen the staff on the design and implementation of changes. Likewise, also, changes in motivation, information, and social status, result from the simple worker involvement in Lean projects, regardless of job changes resulting from specific projects.

Lean effects on workers result in a higher or lower motivation, satisfaction, anxiety or task management. In patient care, patient outcomes are either improved or worsen.

3. CONCLUSION

Lean management is not a new and not the only production concept, in its design and in its implementation, but for healthcare it is relatively new and unique. Nevertheless, there is still a kind of opposition and distrust of this approach, many hospitals, whether in Europe or the United States have implemented this philosophy in its management. Leaders of these organizations emphasize that it is important to create an organizational culture that is willing to accept this philosophy first. The basic Lean principles are interpreted and adapted by individual organizations in its unique local context. So the effects of lean depend on how and where it is implemented. Without susceptible and supportive staff the principles of this culture will fail. Health National Institutes around the world believe that the managerial and operational tools from other sectors and industries, can and will be used in healthcare in order to reduce and eliminate waste of time, money and energy. Lean philosophy and its implementation in the various European institutions health systems is one way how to replace the weak and expensive health care system by a modern, financially valuable and successful system.

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Lean manufacturing, kaizen costing, management

Dariusz PLINTA*, Monika BANACH**

SAVINGS COME FROM KAIZEN

Abstract

Market is demanding for competing organizations in present days. The heads of companies have to manage their enterprises on high level and in different way than their competitors. There are many management's tools to use by managers. These tools belong to philosophy called lean manufacturing. These tools bring many profits, but they must be used in correct way and constantly. One of the profitable method is kaizen - the tool which brings just benefits by small steps.

1. KAIZEN PHILOSOPHY

Implementation of different management methods is necessary to be competitive company in present days. One of the profitable method is kaizen.

"Kaizen is Japanese name for continuous improvement" [1]. The guru of this method is Imai Masaaki. He said kaizen (jap. kai – change, zen – good) consist of several guiding principles. These elements are:

- questioning the rules – "standards are necessary but work rules are there to be broken and must be broken with time",
- developing resourcefulness – "it is a management priority to develop the resourcefulness and participation of everyone",
- try to get to the root cause – "try not to solve problems superficially",
- eliminate the whole task – "question whether a task is necessary",
- reduce or change activities – "be aware of opportunities to combine tasks" [1].

Kaizen can be introduced in all area in the company – in production lines and in offices. It is necessary to observe environment around to see areas to improve. This method can be used by itself or it can come up from different tools, for example from TPM workshop.

The necessary thing is to measure all needful indicators. It helps to count benefits from introducing all improvements. It can be improved many things such as health and safety, reducing a cycle time and breakdowns time and scrap, decreasing customer complain, etc.

Kaizen can be introduced in standard way – suggested by Imai Masaaki or individually by company. The figure 1 shows steps of kaizen history according to Masaaki.

The history of kaizen (each implementation) is necessary to show how important was this implementation, how much the company profits, what kind of standards can be introduced, etc.

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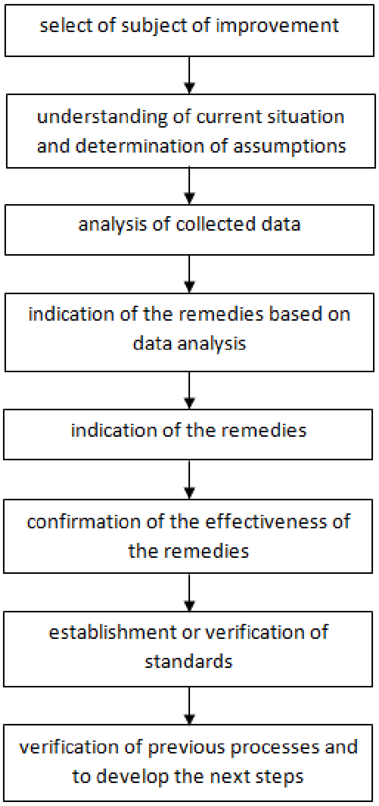

Fig.1. Steps of kaizen history method according to Masaaki

2. KAIZEN IN PRACTICE

Kaizen is methodology of small steps. The small steps (small improvements) can bring a lot of benefits for company. It is important to measure indicators which say what is the problem in the company. The easiest monitoring is in production line where every day it is measured OEE (eng. Overall Equipment Effectiveness). This indicator shows efficiency of eac production line. There are three elements consist of OEE: efficiency, availability and scrap. Monitoring these three elements, engineers can see the area of any problem.

It was created the form to count profit or loss of proposed improvement (Fig.2).

Analyzed improvement is in company which produce safety systems for cars. This company is world class manufacturer of vary and high quality systems for cars. Head of the company takes care to keep product on the highest quality level and decrease costs to have competitive price for manufactured safety systems.

IMPROVEMENT FORM				
	Description and formula	**Calculations BEORE**	**Unit**	**Calculations AFTER**
Parameters				
A	Mean cycle time (MCT)		hour	
B	No. of production operators			
C	Cost of final product		€	
D	Cost of a maintenance operator		€	
E	Cost of a production operator		€	
Breakdowns ☐ (tick, if applicable)				
F	Time of breakdown		hour	
G	No. of maintenance operators			
H	Cost of spare parts		€	
I	Cost of production operators (B * E * F)		€	
J	Cost of maintenance operators (D * G * F)		€	
K	Cost of lost final products during breakdowns (F / A * C)		€	
L	**Cost of breakdowns (H + I + J + K)**		**€**	
Scrap and defects ☐ (tick, if applicable)				
M	No. of defects			
N	Cost of production operators (B * E * A)		€	
O	Cost of scrap		€	
P	Cost of defects (M * N)		€	
Q	**Cost of scrap and defects (O + P)**		**€**	
Cycle time ☐ (tick, if applicable)				
R	Established production time per shift		hour	
S	**Cost of cycle time ((R / A) * C)**		**€**	

Fig.2. Improvement form

One of the reducing costs method is kaizen tool. Each employee have to report minimum one improvement per year (this applies to different areas).

The modification showed below is reducing cycle time on machine where it was defined bottleneck. The cycle time was 43 seconds. The process on this machine is easy – to tighten cover. The difference in process is showed at Fig.3. The modification was made only in PLC program. It cost just the work time of automatics – it was done during his working time. As it is seen at Fig.3 the cycle time was reduced by 3 seconds.

BEFORE		AFTER	
DESCRIPTION	**TIME**	**DESCRIPTION**	**TIME**
1) Load detail		1) Load detail	
2) Close detail		2) Close detail	
3) Barcode scanning, data analysis	**4 sec.**	**3) Head running during barcode scanning and data analysis**	**4 sec.**
4) Head running	**3 sec.**	4) No change in next steps	
5) No change in next steps			

Fig.3. Steps of process on bottleneck machine

IMPROVEMENT FORM				
	Description and formula	**Calculations BEFORE**	**Unit**	**Calculations AFTER**
Parameters				
A	Mean cycle time (MCT)	[43 sec.] 0,0119	hour	[40 sec.] 0,0111
B	No. of production operators	6		6
C	Cost of final product	100	€	100
D	Cost of a maintenance operator	-	€	-
E	Cost of a production operator	-	€	-
Cycle time ☐ (tick, if applicable)				
R	Established production time per shift	7,5	hour	7,5
S	**Profit/loss of cycle time ((R / A) * C)**	**62 790,70**	**€**	**67 500,00**

Fig.4. Calculation of modification

3. SUMMARY

The aim of each company is earn money by manufacturing as many high quality products as company can.

The cycle time before modification was 43 seconds and during one sift (7,5 hours of working time) it could be manufactured 627 details. After modification the cycle time was reduced by 3 sec, so cycle time equals 40 sec. It can be produced 675 parts with this cycle. It is 48 parts more per shift. All calculations is shown at Fig.4.

There is saving from this modification, which it equals 4709,30 €. This amount is counted per shift.

The example shows that small modification can bring a lot of benefits for company. This modification did not need any investment, but there are some modification where it is essential to invest. It is important to calculate if the improvement can bring profits or losses.

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risk analysis, pFMEA, assembly, automotive

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RISK ANALYSIS OF CAR SPOILER ASSEMBLY PROCESS

Abstract

The paper presents the key issues related to the fourth revision of the ISO 9001 standard. The authors focused mainly on changes to the process approach, in particular, on a risk-based approach. Also the methods and tools of risk management in enterprises have been described. On the example of the automotive industry, the analysis of the risk of defects in the assembly process of back spoiler with the use of the PFMEA method has been presented.

1. INTRODUCTION

This year, for the fourth time, a revision of ISO 9001 has been planned. This time, in contrast to small changes in the 2008 standards, International Technical Committee planned significant changes in the standard. These changes have important implications for most major operating organizations - primarily due to the harmonization of future management system standards that will facilitate their integration. The new project also aims to adapt the quality management system to the current challenges of the modern, rapidly changing environment. Given that the popularity of the ISO 9001 standard unabated for 25 years direction of changes is very important (for compliance with this standard more than 1.1 million organizations worldwide is certified, including more than 10 thousand in Poland [6].

The most important changes in the new ISO 9001:2015 relate to a particular emphasis on the process approach. Attention is drawn to the determination of inputs and expected outputs of the process, assigning responsibilities and functions to the processes - the definition of process owners to determine opportunities for improvement of processes, as well as the risks associated with them. These activities are designed to enable a consistent process management in an organization. The aforementioned risk and risk management, can be described as a risk-based approach, and is considered the new standard in the context of the whole organization. It is defined as *"a result of the uncertainty of the expected result and referencing it to potential events or consequences or a combination of them"*. The standard will require from

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organizations planning efforts to eliminate the risks and taking advantages from the opportunities that have been identified. Any action that the organization decides to take, should be proportional to the potential effects of non-compliance [2,3].

To summarize the basic information about the FMEA, it can be said that it is a structured method for measuring the size and criticality of potential errors and identifying the sources of their formation. It is important to assess the links between the different causes of damage, and the risks that may cause certain losses. Knowing these relationships analysis of real effects of their occurrence cannot be overlooked (not every error means catastrophic loss, such as financial and company perception by customers). FMEA is in fact the final assessment of the impact of risk in the processes of the organization. Each potential error is also analyzed in order to identify the most effective measures to prevent or minimize its occurrence.

Fourth edition of the textbook "Failure Mode and Effects Analysis" does not recommend the use of the threshold values used to determine the RPN needed to take action [5]. Following the manual "Failure Mode and Effects Analysis" is required by the IATF (ang. - International Automotive Task Force), which includes members of the OEM: BMW Group, Daimler AG, Fiat Chrysler Automobiles, Ford Motor Company, General Motors, PSA Peugeot Citroen, Renault and Volkswagen AG and National Associations: ANFIA, AIAG, FIEV, SMMT and VDA [1]. Until recently, many companies in the automotive industry carried out the FMEA analysis solely on the needs of customers - once at the beginning of the project, without any subsequent changes. Currently, more and more often it is observed that the FMEA is a living document - in the course of the project complaints about internal and external customer feedback, changes of process are also added. FMEA sheet illustrates how project evolves and provides the knowledge base for the company.

The automotive industry, which refers to the analysis presented in the article, for many years conducted an analysis related to assessment of risk. ISO/TS 16949, which is valid for the automotive sector suppliers throughout the logistics chain, is an extension of the requirements of ISO 9001 on the requirements of the industry. One of the mandatory methods for determining the risk of defects, exactly as described in the reference manual developed by leading car manufacturers in the world, is the method FMEA (ang. *Failure Mode and Effect Analysis)*, that analysis the causes and effects of defects, which in both theoretical and practical approach is presented in this article.

2. FMEA

FMEA is an analytical technique used primarily in the design phase, before the set of potential errors and related causes appears. It allows to establish links between causes and effects of defects, as well as searching for creative solutions and optimal preventive measures. There are two basic types of FMEA: for the structure (the product) and the process. The first of these is used in order to achieve the required product quality and to verify it at the stage of construction, the other is an analysis of possible factors that may cause interference or even prevent the realization of the intended process [4]. In both main types of the FMEA analysis it is important to determine the RPN rate (RiskPriorityNumber), which is the product of three numbers estimation (1):

$$RPN = S * O * D \tag{1}$$

where: S - Severity, O - Occurrence, D - Detection.

RPN index indicates in which area actions should be initiated to enable prevention of potential defects. FMEA success depends on many factors, which can be divided into organizational factors (provision of resources, planning, commitment, awareness of the needs, the effective implementation of requests) and the factors associated with the level of qualification for this type of analysis (ability to apply the FMEA sheet, the ability to work in a group, qualifications of team moderator). Whilst keeping in mind that the FMEA is essentially a highly subjective method, operating procedures should be developed, which aim will be to align the assessment of the risk of defects during the analysis conducted by various experts. Since October 2013, the update *"Rules for Achieving IATF and Maintaining recognition"* increased the rank of FMEA. The amendment introduced the item on the relationship between the Control Plans and FMEA and effective implementation of the changes in the documents - changes in the FMEA should be reflected in Control Plans. Also adding the area of risk management for the *"Rules for Achieving IATF and Maintaining recognition"* is consistent with one of the basic principles of quality management - continuous improvement.

3. PRACTICAL EXAMPLE

In the presented example the automotive company production line has been divided into 10 sections. Each of the sections contains from 12 to 25 posts, which runs from 1 to 3 employees. The scope of the analysis refers only to the position 9.8. - assembly of the rear seat and spoiler. Part of the assembly line on which assembly operations are conducted has been implemented into Arena simulation software system (Fig. 1) and experiments were conducted.

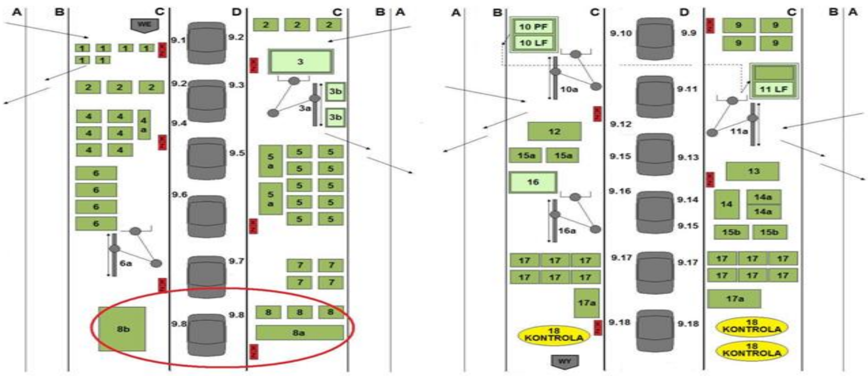

Fig.1. Assembly line section of the chassis (steps 9.1-9.8) with the analyzed operation

3.1. pFMEA analysis

In the first stage of the analysis 10 types of defects that may occur when installing the spoiler have been identified. On the basis of the number of cases of non-compliance and the number of their appearance Pareto diagram and Lorenz curve have been prepared. As a result of this analysis, the factors that most strongly impact on discrepancies appearing in the assembly process of the rear spoiler have been found. In the example of defectiveness in the reporting process to the greatest impact had the defects numbered 9 (scratches), 6 (cracks) and 7 (other mechanical defects without scratches). Sample analysis exhibits that for a single operation a number of problems, which can be divided into many types can be defined. For example, for the operation *9.8. Spoiler assembly - spoiler assembly bolts* several types of errors can be defined - no holes, improper position of the holes, the lack of all the screws after the process. During analysis of the operation *9.8.Spoiler assembly* it can be observed that during the analysis both the impact of machinery - a problem with the screwdriver (tightening torque) and worker – i.e. lack of knowledge or ignorance of the instruction were taken into account. The analysis also enables the discussion of functional (assembly – inaccurate spoiler assembly) and visual defects (control - spoiler scratched). In the analyzed example "Severity" in no case was at a level ordering action - according to the FMEA Manual 9 - 10 points.

In FMEA Analysis all complaints and information from customers are also placed. In this analysis one piece of information from the customer has been reported. Information from the customer concerned spoiler scratches. Scratches occurred both during the transportation of spoilers to the work station as well as during the assembly process. Verification of scratches is possible during the operation *9.8. Spoiler assembly – self-control operations* on the work station *9.18. Control*. Scratches belong to the group of visual non-compliance and thus Severity is at 5 points. As a corrective action to improve appropriate quality objectives assembly and trolley operators were additionally trained.

4. SUMMARY

ISO 9000 standards had a huge impact on the dissemination of quality management throughout the world. They've provided a platform and a common language for the management of more than one million organizations worldwide. The introduction of risk management requirements in many aspects of the organization (among others presented in the article, process management area) very clearly shows the need to include this issue in the contemporary management of the organization. Such activities allow primarily early elimination of potential drawbacks of the process, which directly translates into lower manufacturing costs.

Changes in the new ISO 9001: 2015 certainly can be considered as crucial for businesses to adapt to the new economic reality. The experience of world leaders, primarily from the automotive industry, where risk analysis in the form of FMEA method applied is mandatory for years, indicate that the authors chose the correct standards, though essential and demanding, the direction of change.

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Computer simulation, Casting alloy AlSi5Mg, AlSi7Mg

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NON FERROUS SOFTWARE AS AN INNOVATIVE APPLICATION FOR SIMULATION OF THE Al-Si CAST ALLOYS MICROSTRUCTURE

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. Computational methods may consider all of these assumptions and help to obtain high-quality castings.

1. INTRODUCTION

Computer simulation is one of the basic tools in the process of quality management in the company. Computer-aided design, simulation of the casting process, stress analysis in casting are apprised to an effective improvement of the quality of the product [1].

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 paper shows the results of the computer simulations using the Nonferrous module attached to the MAGMA 5 software and their experimental verification.

2. SIMULATION IN THE NONFERROUS MODULE

A study was carried out in the framework of the research project No PBS2/B5/28/2013 financed by the Polish National Centre for Research and Development. MAGMA 5 software equipped with Nonferrous module is able to simulate microstructure of Al-Si alloys in as-cast condition. The simulation results are both qualitative as well as quantitative. The calculations are conducted on the basis of introduced boundary condition parameters. However, these

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parameters, such as chemical composition, have to be introduced in the predefined range. In other cases, the calculations are possible, however, they may result in inappropriate simulation. During the investigations, simulations were conducted on the casting show in the Fig. 1. The simulations were done for AlSi5Mg and AlSi7Mg alloy.

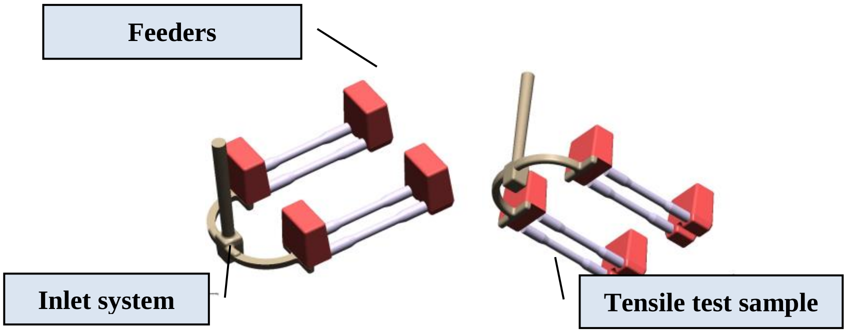
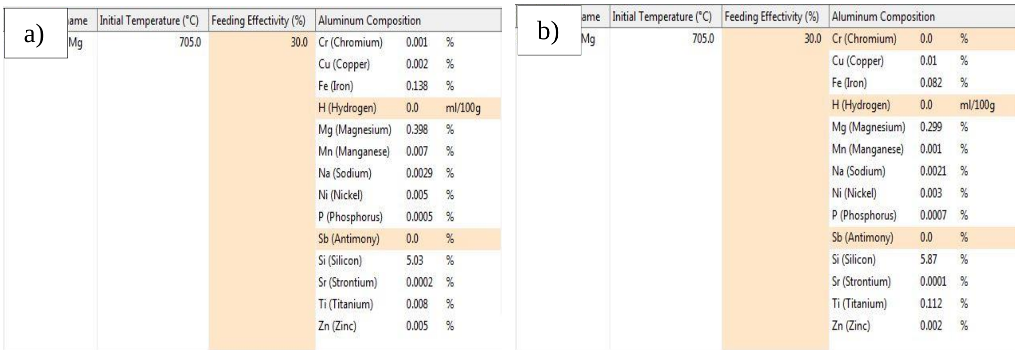


Fig.1. Sample model for the simulation.

The main introduced boundary condition parameters are chemical composition and metallurgical quality of the alloy (hydrogen content). The parameters have to be carefully introduced, each disagreement with real parameters will cause faulty calculation process. For accurate analysis of software capabilities, simulations were done on two Al-Si alloys with vast range of alloying elements content. The introduced parameters are shown in Fig. 2.



a)

[N]ame	Initial Temperature (°C)	Feeding Effectivity (%)	Aluminum Composition		
Mg	705.0	30.0	Cr (Chromium)	0.001	%
			Cu (Copper)	0.002	%
			Fe (Iron)	0.138	%
			H (Hydrogen)	0.0	ml/100g
			Mg (Magnesium)	0.398	%
			Mn (Manganese)	0.007	%
			Na (Sodium)	0.0029	%
			Ni (Nickel)	0.005	%
			P (Phosphorus)	0.0005	%
			Sb (Antimony)	0.0	%
			Si (Silicon)	5.03	%
			Sr (Strontium)	0.0002	%
			Ti (Titanium)	0.008	%
			Zn (Zinc)	0.005	%

b)

[N]ame	Initial Temperature (°C)	Feeding Effectivity (%)	Aluminum Composition		
Mg	705.0	30.0	Cr (Chromium)	0.0	%
			Cu (Copper)	0.01	%
			Fe (Iron)	0.082	%
			H (Hydrogen)	0.0	ml/100g
			Mg (Magnesium)	0.299	%
			Mn (Manganese)	0.001	%
			Na (Sodium)	0.0021	%
			Ni (Nickel)	0.003	%
			P (Phosphorus)	0.0007	%
			Sb (Antimony)	0.0	%
			Si (Silicon)	5.87	%
			Sr (Strontium)	0.0001	%
			Ti (Titanium)	0.112	%
			Zn (Zinc)	0.002	%

Fig.2. Alloys chemical composition used for the simulation) AlSi5Mg; b) AlSi7Mg.

3. RESEARCH RESULTS

Volume fraction of the eutectic mixture, primary phase and intermetallic phases as well as dendrite arm spacing and grain size were simulated for both alloys. Exemplary simulation results for the AlSi7Mg alloy are shown in the Fig. 3.

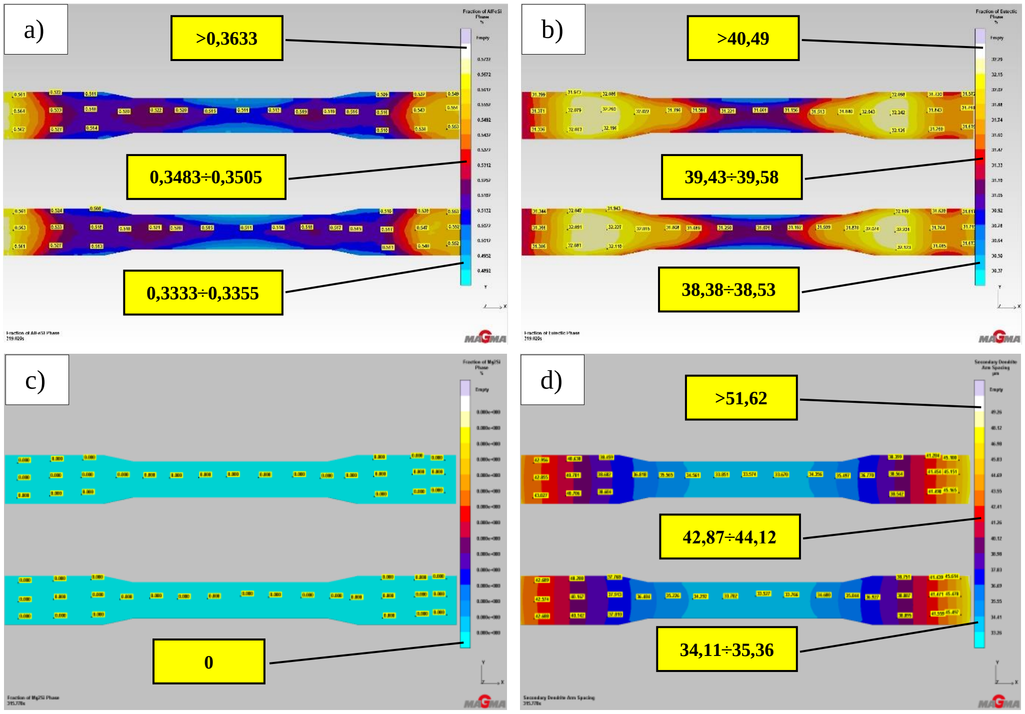
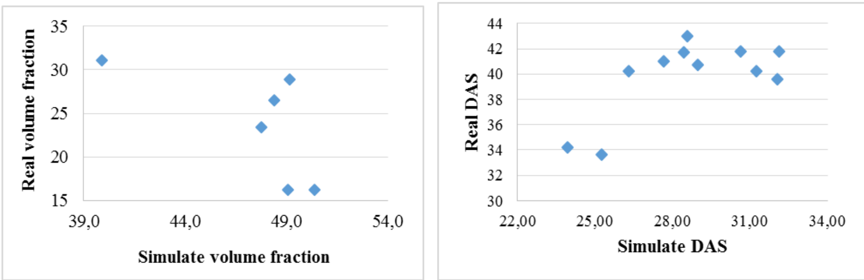


Fig.3. Exemplary simulation results for AlSi7Mg alloy a) AlFeSi phase arrangement; b) Eutectic arrangement; c) Mg_2Si phase arrangement; d) Dendrite arm spacing.

3.1. Discussion

AlSi5Mg alloy chemical composition was beyond the predefined range, while AlSi7Mg alloy composition was within this range. The differences were mainly in Si content. In the case of AlSi5Mg alloy, in which Si content is about 4.5%. The software predefined range of Si content for Al-Si alloys is 6.5%-12.5%. During introducing of the chemical composition into the MAGMA5 software, Nonferrous module pointed the inappropriate value, however, the calculations were still conducted.

In both cases, the results of the simulations were far from the experimental ones, obtained during the verification of the calculations (Fig.4).The main problem were inappropriate calculated mechanical properties of the alloys and faulty quantitative evaluation of the existing phases parameters. Moreover, the software can not simulate presence of the non-equilibrium phases, observed in the real alloy. In some cases, the calculations resulted in zero content of some primary, equilibrium phases, present in the alloy. This is clearly visible for the Mg_2Si observed in the cast alloy. Simulations done on the exactly the same introduced chemical composition resulted in zero content of this phase (Fig. 5). The last problem is simulation of the Fe-containing phases. In the real alloys, there are at least three types of these phases: two containing only Al, Fe and Si, one type containing also Mg. The software is able to calculate only the cumulative volume fraction of so-called “AlFeSi” phase.



a) b)

Fig.4. Comparison of simulation results with the results obtained during the verification for AlSi7Mg: a) Eutectic mixture volume fraction; b) Dendrite arm spacing.

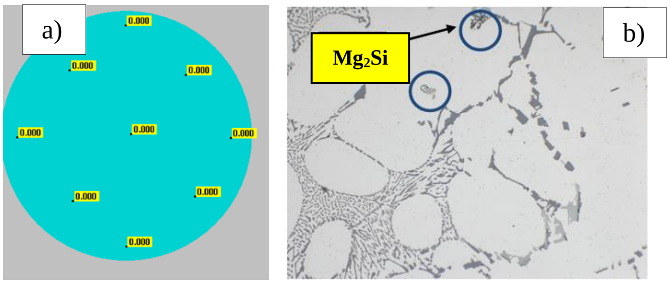


Fig.5. Mg_2Si phase arrangement: a) Simulation results equal 0%, b) Mg_2Si observed in the microstructure.

4. SUMMARY

Investigations done on real specimens did not reveal agreement with simulation results. In the present state of development, Nonferrous module attached to MAGMA 5 software may only show overall tendencies in forming microstructure and mechanical properties. Detailed simulations and their experimental verification may be however useful for further development of the software. The calculation algorithms should be modified for better prediction of the forming microstructure, both in qualitative and quantitative ways.

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motivation of employees, performance measurement, performance of operators of the manufacturing enterprise,

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THE PERFORMANCE MANAGEMENT OF THE OPERATORS OF THE MANUFACTURING ENTERPRISE

Abstract

The article discusses a design of a new performance management system with a challenging aim to reach and manage a high performance level of operators of the manufacturing enterprise. The new management system enables to manage the performance of operators of small, mid-sized and large-sized manufacturing enterprises.

1. INTRODUCTION

The performance management system is a control system with a closed loop feedback, which represents on one side the policy and strategy of the organization and obtains feedback from various levels of the organization and on the other side supports a continuous improvement and efficient management of the organization. The performance management of the operators is an information system. It is a heart of the performance management system of the manufacturing organization. The performance management system of the operators of the manufacturing enterprise plays an important role in the target setting, evaluating of the achievements, determines future improvement activities, and supports strategic decisions of the organization.

The operators are the largest group of employees of the manufacturing organization. They perform direct and indirect manufacturing activities, operate and maintain production lines and other equipment of the manufacturing enterprises. The performance of the operators has therefore a significant influence on the overall performance of the organization. The operators of the manufacturing enterprise can be both core employees of the organization and leased employees as well.

The production line operators are employees of the organization who perform direct production activities to operate and monitor production lines and other equipment according to specifications and instructions.

The service operators are employees of the organization who perform indirect manufacturing activities such as transport of raw materials and semi-products to and between production lines and other equipment, and perform various services to the production line operators.

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The maintenance operators are employees of the organization who support direct and indirect production activities by maintaining the production lines and other equipment of the organization.

2. DEVELOPMENT OF PERFORMANCE MANAGEMENT SYSTEM

The development process from the idea through concept up to the implementation of the performance management system is a process that can take months or even years of editing and fine tuning before expected goals are achieved. It is important from the very beginning to ensure that the system follows and meets key requirements and specifications of the organization and measures the performance of operators with respective accuracy.

2.1. System approach in defining new solutions

A new modern performance management system today more than ever requires a utilization of latest technologies, knowledge and experiences of employees in the area of performance management. The main objectives of a modern performance management system should be focused on and support the following:

- quality assurance,
- flexibility of operators,
- further development of operators,
- flat hierarchical structure,
- teamwork and development of the team-based organisation,
- total efficiency of the organization.

The operators and their behavior significantly affect the achievement of objectives and the performance of the entire organization. The production line operators, the service operators, and the maintenance operators are in a hierarchical structure of the organization at the same level. There are strong connections and relationships between these three groups of operators and they have a direct impact on fulfillment of tasks and achieving objectives of the organization.

A high performance culture of the organization today and in future is and will be based on a teamwork. The key factors of an effective teamwork of the operators are: transparent and balanced workload, and objectivity of performance evaluation and related award. Both key factors must be systemically addressed to the four elementary outcomes based on which the performance of individuals or teams will be evaluated and awarded:

- quality,
- quantity and assortment of products,
- costs,
- time.

2.2. The basic principles of the new solution

A summary of theoretical knowledge, research results, experiences with performance management and the latest development of complexity of manufacturing environment resulted in a design to assess the performance of operators in a new way, which is based on:

- inclusion of the time needed to setup the production lines into the value-added time,
- deduction of the extraordinary interruption time from the total working time,
- clear specification of the working time,

- thorough verification of the sum of the total value added time and total losses against the total working time.

Then the performance of the operators of production lines using the new principle is calculated as:

$$performance\ (\%) = \frac{value\ added\ time + time\ to\ set\text{-}up\ production\ line}{working\ time - extraordinary\ interruptions}\ x\ 100 \quad (1)$$

For the calculation of performance of the teams consisting of production line operators who manufacture products of various types and make set-ups of production line during their working time is suitable a following refined calculation formula:

$$performance\ (\%) = \frac{\Sigma\ (value\ added\ time) + \Sigma\ (time\ to\ set\text{-}up\ production\ line)}{\Sigma\ (working\ time) - \Sigma\ (extraordinary\ interuption)}\ x\ 100 \quad (2)$$

than:

Σ *(value added time) = (number of production units x standard time x number of operators)*

Σ *(time to set-up production line) = (number of set-ups x standard time x number of operators)*

Σ *(working time) = (working time x number of operators)*

Σ *(extraodrinary interuption) = (interruption time x number of operators)*

One of the requirements for the new system is to address the qualitative aspects of the production processes and link them with the performance. The motivation of operators for a quality is resolved the way that only production units which meet specified requirements (marked "1A") are taken into calculation of the total value added time

$$\Sigma\ (value\ added\ time) = (number\ of\ production\ units\ 1A\ \ x\ \ standard\ time\ \ x\ \ number\ of\ operators) \quad (3)$$

Another requirement for the new system is to incorporate an actual performance rate of the operators influenced also by inaccuracies arising from the methods of setting the work standards. This can be solved by adjusting the calculation principle and using a correction factor „performance index“. The final formula for calculation of the value added time is as follows:

$$\Sigma\ (value\ added\ time) = (number\ of\ production\ units\ 1A\ \ x\ \ \frac{standard\ time\ \ x\ \ number\ of\ operators}{performance\ index} \quad (4)$$

This performance calculation proposal together with its principles resolves a significant part of analyzed shortcomings and weaknesses of existing solutions. It is important to note that this new principle is applicable on calculation of performance of individual operators or on group of operators organized in teams.

A substantial change in the philosophy of the new system is the approach how to define, collect, monitor, evaluate and verify data:

- work standards will only include the time of direct and indirect operations related to the production of semi-product or product,
- interruptions related to value added processes and non value added processes will be monitored all and in every detail.

Transparency and objectivity of the new performance management system will be achieved by thorough implementation and fulfilling of the above principles.

2.3. The experimental model

The principle of simulation is based on a simplified representation of the real system in an experimental model, which will focus on verifying the proper functionality of proposed solutions and confirm or rule out the hypotheses.

The experimental model was designed in the Microsoft Excel application with the active cooperation of the key users of the new performance management system: Industrial Engineering, Manufacturing, Controlling and Plant Management, and was implemented in selected areas of the big-sized manufacturing enterprise.

3. CONCLUSION

After four months of testing and fine tuning of the experimental model, reviewing of data collection and evaluation processes, reviewing and correction of existing work standards, creating new work standards for set-ups of production lines, reviewing and redesigning the teams and especially by performance results achieved the management of the manufacturing enterprise decided to develop and implement a new performance management system in a professional relational database management system and to roll-it out to all areas of the manufacturing enterprise. The decision was influenced by confirming of all hypotheses and overachievement of expectations of the organization from proposed solutions.

When comparing the performance of the manufacturing enterprise before and after the implementation of the new performance management system principles the productivity of the manufacturing enterprise has been increased by 93% within two years. This increase was achieved by implementing another improvement measures as well but the contribution of the new performance management system on creating a high performance and team culture in the manufacturing enterprise was substantial.

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Shop floor management, Coaching, Implementation, People development

Jozef SEDLÁK*

IMPLEMENTATION SHOP FLOOR MANAGEMENT

Abstract

The article solve the implementation of Shop floor management (SFM) into the manufacturing companies as an opportunity to increase competitiveness. They are also processed the basic reasons for the implementation of SFM. Then it describes the reason of the introduction of SFM, so that the whole process would be as effective as possible, implemented in the shortest time and at the same time for a long term sustainable. In the article are explained the principles and tools thanks to them is possible to improve the functionality of SFM. It also describes the draft of control mechanism to ensure the functioning in the long term.

1. SHOP FLOOR MANAGEMENT FEATURES

Effective solution of operational problems directly in production, immediate monitoring and evaluation of results, indicators, followed by development and adaptation to emerging conditions is the biggest challenge for today's management working in a turbulent environment. To gain the direct support from workers at the workshop on day to day basis so that they are involved in improving the production process is the role of specific methodologies and tools that are necessary for the successful management of situations.

Although the „shopfloor management“ is described in literature well enought in many technical publications its represented mostly by just foreman possition itself. Foreman is often responsible for operative tasks connected to planning and management of production in production hall or just some part of production. He solves problems connected to management of people, equipment, products and of course tasks he is given by his superiors. Longer he is responsible for all of these activities he becomes irreplaceable because he has the best information and methods how to solve day-to-day problems. It is really complicated to find surrogate to this person.

One way how to solve this situation is implementation of Shop Floor Management (SFM). By its implementation the whole model of work of lower management is changing. Things which were before solved in hurry will be solved in advance and better. In the beginning its connected just to „easier changes“ for example move of office of foreman (teamleader) directly to shop floor to his team. Then all activities are concentrated on change of mind-set from individualist to team player. Thanks to these changes it will be ensured that foreman spends all the time on shop floor with his team and he can immediately react to all changes and problems which appear during shift and help them to solve it in long-term.

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SFM also helps to involve operators to solve long-term problems in production. Whole system is founded on motivation of operators to give proposals for improvement of problems /areas of improvement in production, proposals how operator imagines solution of the problem/. Beside hearing about how nothing is being done situation switches to proactivity for example: „Which solution would you suggest?”. Like this all the responsibility of situation in production and achieved results are moved from management to each operator who is co-responsible for everything what is happening in the production. By this change we can increase efectivity of proposed solution.

2. ACHIEVING EXCELLENCE IN SHOP FLOOR MANAGEMENT

Implementing of SFM helps in online tracking of indicators connected to production on machine, assembly line, etc. This tracking of performance indicators ensures immediate reaction to existing situation and reduces time of reaction of responsible person whom is able to decide, by setting escalation model of problem solving. Another advantage of this tracking is displaying of results on production table. These results can be seen by anyone who wish to see the current production results on the machine, on the section, on the line.

Implementation of SFM brings further options as clearly defined escalation plan which is used in case of some problem appears. If this problem is not being solved by some defined time, the escalation plan defines which person (on higher position) should be informed to help to solve this problem. Another advantage of SFM is starting with Daily Walks . These represent repeated meetings on shopfloor with all involved people from production, support services aiming to present results of performance indicators from the previous day and plan activities for another day. Also presents problem solving solutions which appeared in production and need the decision to be taken to solve these problems.

Essential condition for effective work of SFM in practical use are abilities and experiences of leaders on this low management position. Part of these employees had foreman position before implementation of SFM. But the other part was working as operators in production directly with machines or on assembly lines – by time passing they showed good results on their previous positions and that’s why they are good candidates to participate in SFM efforts.

SFM expects leaders to be able to solve operative problems in production, to communicate with operators on various levels (not just with their own team members but also with their direct superiors, operators from support services and visitors etc.) It’s efficient to know various management styles of communication and know how to use them in different situations. Also to know ways of effective planning of own work. Know methods of motivation of operators, evaluate and set targets in order to achieve better results.

As result of analysis of status described in text above we can assume several facts which need to be solved before implementation of SFM.

- Chosen leaders are on different skills, experiences level in leading other people, communication and other conditions needed for this position:
    - Some entirely new need training for this position
    - Some leaders have some experiences from their former position of foreman however they need to adjust to new demands of leaders position in SFM
    - Some have enough experiences and skills in professional area but they need help in problem solving

- Training of all leaders in the same time, the same way doesn't have to bring wished results (each of three mentioned groups need specific training) as somebody needs to learn some more theory, somebody needs to see situation in shop floor etc.

To prepared and started process of implementation of SFM the best way of support improvement of chosen leaders seems to be the couching. Couching improves theoretical skills of leader which he gained from training, reading books, observation of his superior directly in work performance. Couch has a role of support to couched person in this process while finding possible solutions to the problem. He can pass his own look on the problematic, gives the feedback to improve skills of couched person.

Increase knowledge, skills and abilities of managers in enterprises usually realized by a combination of several methods. First theoretical courses on the topic and practical implementation of learned topics into practice through coaching. Synergy of selected course of development the skills brings positive results more often during the course of the development program.

3. DEVELOPING A PROGRESSIVE ORGANIZATION

Improvement process of leaders is usually dividing into 3 basic phases:

1. Phase – Couching: While this phase several skills of leaders were improved:
    - Communication
    - Assertiveness and conflicts solving
    - Leading of people
    - PDCA – system of improving processes using PDCA
    - OEE and SMED – focus on productivity and performance increase of operators
    - 5S – how to achieve better results thanks to set standards of order and cleanness on the workplace

The course of development skills in these topics is based on a combination of theoretical basis (refresh) and then practical implementation through individual coaching. Refresh focuses on mastering basic theoretical methodologies, and technologies. For managers, especially new managers, but refresh introduction to the topic of the subject.

After theoretical introduction leaders start to be couched. Couching is led on meetings where they individually speak about their problematic situation which occur in their professional life. Support of couch helps leader explore new ways how to solve these situations. This couching is often happening directly on the workplace of the leader while his shift. Like that the couch can personally see the problem and give his uninvolved opinion how the leader should solve the situation. Then they set action plan how to manage situation and they define steps of improvement.

After finishing the topic leader summarises his results to his direct superior who then takes over the improvement process of his employee. While this presentation set target is introduced also action plan and realised activities are presented to the superior.

2. Phase – Monitoring: While this phase leader is monitored how is he proceeding in set trend. Superior of the team leader on short meetings checks results of tasks set during couching. In case that tasks and action plan activities are not achieved, they discuss how to achieve these activities. If all activities are successfully realized new problem is being found and solved.

This phase is finished by audit of couching and monitoring. During this audit examines the state of the transposition process of coaching and development of skills of manager.

3. Phase – Continuous improvement – leader and his direct supervisor have a tool how to continuously improve skills of leaders. The secret is in repetition of steps shown while couching and monitoring. This ensures that leader will be able to solve any problematic situation which occurs while his shift by himself or with help of his superior.

This set process of improvement of skills leading employees using couching brings many advantages:

- More efficient implementation of SFM in practical use – leaders gain competences and skills needed for leading people in SFM.
- Problem solving mostly thanks to employees themselves.
- Connection of improvement of production with performance indicators.
- Increase of motivation of team leaders and their team members to perform better
- Possibility of continual improvement of each team member and so improvement of whole company

First thought of managing production team by team leaders was implemented in practical conditions and has potential to continually improve company results by using its best resources – its employees.

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Quick Response, Customer, Value, Supply Chain

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STRATEGIC METHODS IN SUPPLY CHAINS

Abstract

This paper is focused on Quick Response method. Recently, the value for customer lies not only in technical quality of products, but also in speed of delivery. Companies have to be excellent in speed and flexibility to maintain their market share. Quick Response method is method which is used to make flexible supply chain that can fast meet customer needs. The main component of Quick Response is transformation supplier-customer relationships in to the partnership. The second important issue is to integrate and share information. Using Quick Response method brings a lot of benefits, which leads to the increase of customer satisfaction.

1. INTRODUCTION

The effect of the entrance of many companies to global market environment is a hypercompetition, which means still worse conditions for business from the view of each individual company. Companies have to cope with soaring prices of materials, energy and labour costs. Speed and flexibility become a critical factor for business. The only chance for success is fast and flexible reaction of company to new changes, speed of development and implementation new products to the market, fast reaction of meeting customer needs and requirements while increasing efficiency. This success can be reached by the company when the company chooses adequate market strategy.

2. VALUE FOR THE CUSTOMER

The creation of future opportunities to growth lies in offering of valuable customized products, mainly for key customers. The way of creating unique offers for each customer has to be such that the customer value is reflected in the value created for the company.

Only technical quality of products does not create value for the customer. Requirements and preferences of customers and ways of distribution are changed. Technical quality is not sufficient to maintain a significant market share or rather to maintain a significant share in the segment or share of expenses with key customers. Technical quality is important when the company wants to be on the market, but it is not sure that the company gets orders. Key question is not only „what to supply" but also „how to supply". Time and quality for adequate price are important in current competitive market environment.

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To meet customer needs is important to supply right packed product in required technical quality with perfect pre-sale, sale and after-sale services, in required time. It is needed to constraint customer waiting time to minimum. Speed factor is especially important. In high-competitive market environment customers do not want to wait for ordered items, which are for them not available, if they can get these items from competitors faster.

When there is a greater ability to meet customer requirements faster, so there is little possibilty of his departure to the competition, or to reduce its quest to obtain benefits from a competitor. Many manufacturers have already realized that delay in response to market demand may lead to a deterioration of the market position. If the supplier responds quickly to customer requirements, creates in them a feeling that he cares about them, that strains all forces to satisfy their requirements. The result is then increased customer satisfaction.

3. QUICK RESPONSE METHOD

One of the methods, which can help desired way of realization process of creating and delivering customer value is Quick Response (QR) method. It allows to build lean and flexible supply chain and continuously increase its performance, even when the forecast demand is not enough accurate, what can become the basis of competitive advantage of the enterprise and whole supply chain.

Key component of Quick Response strategy is partnership in supply chain. Partnership is necessary assumption of realisation of the programmes based on QR. QR requires transformation of traditional supplier-customer relationships, which are often motivated by opportunism, on the relations based on partnership cooperation. In this system of cooperation the customer does not perceive their business partner as barriers in increasing market share and achieving lower costs, but as partners in increasing of efficiency in whole supply chain. The objective of retailers, involved in to the partnership for QR realisation, is to develop customer-oriented business. The benefit for the retailer is creating of the confidence, which becomes the basis for his preference as a supplier. Simultaneously, the customer service costs decreased as a result of sharing information, integration of logistics systems, etc. Application of cooperation based on QR encourages retailers, manufacturers and suppliers to closer cooperation in order to achieve higher customer satisfaction by effective way.

An important tool to achieve Quick Response is inter-enterprise integration of information systems, which creates assumption for the integration of material flows. Every part of the chain share information about sales, orders and stocks with other parts, while partnership relations in the chain are multilateral and include all parts from producers to retailers.

Whole system is based on application pull strategy of the stock management rather than push strategy, where trigger point of pull of the raw material in to the chain is actual sales rather than traditional customer’s prediction.

Figure 1 shows the essence of the management of supply chain relations based on QR. From the figure it is clear that the pulses for the operation of the entire chain coming from the market. Current customer requirements are found out at the end of supply chain through retailers and become shared information.

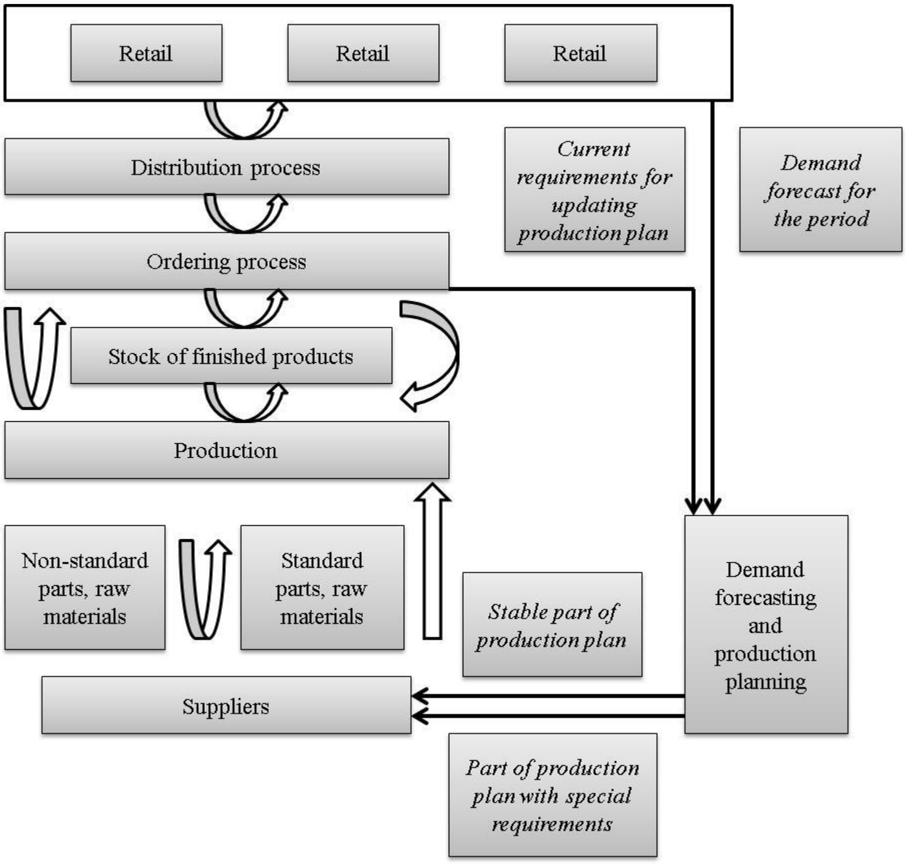

Fig.1. Planning and forecasting in Quick Response system [1]

4. RESEARCH OF BENEFITS OF QUICK RESPONSE

To demonstrate real results of the implementation of this method it is possible to use the findings of research conducted by Sullivan and Kang. Research carried out in small, medium and large clothing enterprises. Table 1 shows benefits, which was perceived by these enterprises.

The effects of implementation QR are:

- increase of logistics processes performance and performance of each part of supply chain and supply chain as a whole,
- improvement of economic results of company as an effect of efficiency company operations increase.

Tab.1. Benefits of Quick Response

Benefits	% respondents*
Market share increase	91,7
Period of handling order decrease	85,2
Profit increase	84,0
Period of return on investments decrease	81,8
Inventory turns increase	80,0
Reduction of applying discounts	76,0
Inventory level decrease	74,1
Increase of inventory productivity	72,0
Reduction of the number of orders that cannot be completely satisfying	69,2
Work-in-process decrease	63,3
Manufacturing costs decrease	57,7

* % of respondents, who rated the benefit with at least one point from the scale 0 – non-beneficial, 5 – very beneficial.

5. CONCLUSION

Choosing an appropriate strategy to satisfy the still increasingly customer requirements is very important for the survival of the enterprise. In this time, customers are demanding mainly on delivery time, which has to be minimal. Delay of the ordered goods can cause loss of the customer and his leaving to the competition. One of the methods used to ensure minimum period of delivery is called Quick Response. This method is based on pull principle in stock management. In this method is very important to share the information in whole supply chain. It is also important to transform supply chain relations in to the partnership. The implementation of QR can bring a lot of benefits to whole supply chain, for example increasing market share, shorter handling order time and much more.

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