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CONTENTS:

TOYOTARITY. TERM, MODEL, RANGE

Stanisław Borkowski[1*]

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Resume
The Toyotarity and BOST term was presented in the chapter. The BOST method allows to define relations between material resources and human resources and between human resources and human resources (TOYO-TARITY). This term was also invented by the Author (and is legally protected). The idea of methodology is an outcome of 12 years of work.

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1. TOYOTARITY – term, model and elements

„Toyotaism is a term introduced by Toyoda Kiichirō. It means philosophy of actions in automotive industry, which included the following elements:

- *Delivery of cars for the whole society.*
- *Improvement of the automotive industry.*
- *Production of cars for reasonable price.*
- *Acknowledgement of sale's significance for development of production.*
- *Establishment of raw material base (TAIICHI OHNO 2008).*

TOYOTARITY is a notion invented by the author of this book and legally protected by date confirmation (BORKOWSKI S. 2012a).

The above document contains the following definition of TOYOTARITY:

Toyotarity is a scientific discipline examining human - machine and human - human relationships with consideration of a process-based approach, Japanese culture, especially of the Toyota, oriented to continuous improvement with use of knowledge.

This definition details two dipoles: human – machine and human – human. Human appears in three out of four components of the above definition thus underlining meaning of a human in a Japanese culture and consequently in the culture of Toyota. In the fundamental dipole human-machine, human pole means: originators, initiators, investors, chief management, leaders, who plan and realize human activity. In the other dipole human – human, one pole means: management, leaders – managerial staff, who during performance of human resources management has visual contact with them, it can be stated that they look into eyes of executors of processes, who are an element of the second pole of the human – human relationship.

The basic version of TOYOTARITY model is presented in the figure 1, while in the figure 2. depicts model of TOYOTARITY with consideration of a process-based approach.

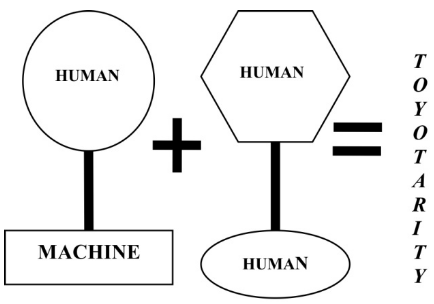

Fig. 1. Basic model of TOYOTARITY

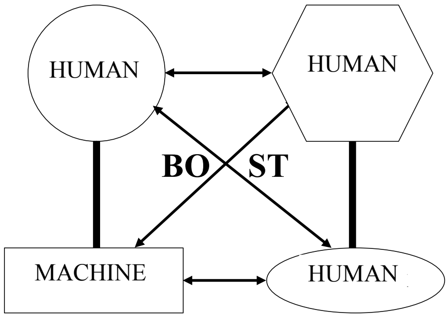

Fig. 2. Model of TOYOTARITY with consideration of a process-based approach

Selection of plane figures is not random:

- Circle as a symbol of a human in the human-machine dipole underlines significance of this group of people in organizing and functioning of an enterprise, companies providing services etc. Circle emphasises the fact, that this element of TOYOTARITY needs to treat all the elements of organization equally and to know exactly, what is going on around such organization (market behaviour, competition). Human is a mental shortcut of initiators organizing economic activities, investors, chief management, management on a strategic level, owners.
- The second element of analyzed dipole machine is presented as a rectangle, geometric figure with sharp corners, which can be associated with danger, something severe. Such are the historical premises for the notion of machine. In the above model machine means organization's material resources, including machines and devices. Significance of machines in management according to Toyota is underlined in a note of a Polish publisher (TAIICHI OHNO 2008).

Selection of plane figures of the second dipole of the TOYOTARITY notion can be justified in the following way: human – placed in a hexagon, honeycomb. This shape was created by living creatures. Honeycomb cell (its section has a shape of hexagon) fulfils two functions:

- It is a place of birth.
- It is a food container.

Similarly in economic activity this group is responsible for initiating birth of ideas, improvements. At the same time it collects (stores) information about processes by making appropriate decisions or by transferring them higher to its superiors. Label human in this case means operational management.

The second pole of analyzed dipole is human, inscription placed in a ellipse. This geometric figure has two focal points, symbolizing two elements in operators' work in the model. One element is conduct strictly according to procedures, information acquired during courses and trainings. This element/approach leads to routine in work. In fact, basing on procedural requirements an operator should in the course of time improve scope of his activities. It means continuous "moving" between focal points of this ellipse, because improvement becomes a standard in the course of time.

2. Toyota production system (TPS)

Toyota Production System (TPS) is based on scientific principles, which was confirmed in the next years. To sum up, it needs to be underlined that:

- The Toyota's management style has its origins in textile industry.
- Management in reference to automotive industry has elements of an American management (BORKOWSKI S. 2012b BORKOWSKI S. 2012c) with consideration of a Japanese culture.
- The Toyota's management style is based on scientific grounds.
- Management in the Toyota style applies not only to industry but also to services.

Toyota management principles structure is following:

Section I. Long-Term Philosophy

Principle 1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

Section II. The Right Process Will Produce the Right Results

Principle 2. Create a continuous process flow to bring problems to the surface.

Principle 3. Use "pull" systems to avoid overproduction.

Principle 4. Level out the workload (heijunka)

Principle 5. Build a culture of stopping to fix the problems, to get quality right the first time.

Principle 6. Standardized tasks and processes are the foundation for continuous improvement and employee empowerment.

Principle 7. Use visual control so that no problems are hidden.

Principle 8. Use only reliable, thoroughly tested technology that serves your people and processes.

Section III. Add Value to the Organization by Developing Your People and Partners

Principle 9. Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.

Principle 10. Develop exceptional people and teams who follow your company's philosophy.

Principle 11. Respect your extended network of partners and suppliers by challenging them and helping them improve.

Section IV. Continuously Solving Root Problems Drives Organizational Learning

Principle 12. Go and see for yourself to thoroughly understand the situation. (genchi genbutsu).

Principle 13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (nemawashi).

Principle 14. Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen).

The Toyota Production System bases on assumption, that all separate elements work well for the benefit of the entirety. One of its main goals is also supporting and encouraging employees to continuously improve their work. (LIKER J.K. 2005).

3. Characteristic of BOST method

The BOST method (this name derives from the first two letters of the author's surname and name, it is legally protected, BORKOWSKI S. 2012a) describes the Toyota's management principles with its characteristic factors. Their number depends on scope of such principle and varies between 4 and 10. Set of factors is called an area. Some principles are divided into two or even three areas. The Toyota's management principles are divided into four sections, while the BOST questionnaire has two versions: version for employees and version for superiors. Version for employees contains set of factors describing principles: 1; 2; 3; 4; 6; 7; 14 and elements of roof of the Toyota's house (quality, costs, lead time, safety, morale of personnel). Version for superiors contains set of factors describing all the Toyota's management principles and elements of roof of the Toyota's house. Presented questionnaire has a ranking scale. Respondents may assess significance of a given factor by placing one of numbers within the range of scale in an appropriate box.

After description of the main part of the BOST method its further elements will be outlined briefly.

The BOST method allows to:

- Assess significance of factors describing 14 Toyota's management principles
- Styles of management (with consideration of the Toyota's optimum).
- Leadership qualities of managers.
- Satisfaction of employees/customers.
- Commanding qualities of managers.
- Influence of managers.
- Perform team and self assessment.
- Create matrix 3x3 (competitiveness of a product/service, technological possibilities).
- Reputation of a manager.
- Significance of driving forces of improvement.
- Significance of factors allowing for achievement of goals.
- Acquire information about the structure of human potential with focus on: gender, education, age, seniority, mobility, type of employment.

Having considered Marx's principle concerning communicatively of expressions the

BOST survey was prepared for enterprises, hospitals, offices, shops, schools.

4. Conclusions

It should be underlined that the BOST survey also fulfils training functions. Toyota's management principles in the author's researches were described with appropriate set of factors. Selection of factors took few years of work, because they have to be clear for respondents/employees. Choice of individual features of respondents and their variants was also difficult. In the end the following features were chosen: gender (2), education (4), age (7), seniority (8), mobility/number of employers (6) and type of employment (3). They were used to determine structure of human resources, they are also exogenous variables (independent). Numbers in brackets represent numbers of variants. Apart from the Toyota's principles described with applied factors and respondents' features the set of research problems also contains elements of roof of the Toyota's house, which describe mission of enterprises.

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THE INFLUENCE OF WELDED JOINT QUALITY ON SAFETY AND RELIABILITY IN OPERATION

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Resume
The quality of welded joint is an assumption of long-term reliability in operation. On the contrary, defective work of bad quality welded joint leads to fracture and crashes of plants. In this paper the authors state that experimentally obtained causes of rails and pipes fractures were the result of bad realization of welded joint. Pores, blowholes, slags, lack of fusion, non-plastic non-metallic particles, cracks, shrink holes were the defects observed in the welded joint area. These defects substantially decreased the load-bearing cross section and the final result was fracture. The railway and high-pressure gas lines out of operation are undesirable and accompanied by considerable financial losses.

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1. Introduction

Useful properties, quality of components and construction are subject to chemical composition, microstructure, properties of used material and the technologies used for their manufacturing. Then, the system of their interaction is entered by economic parameters, mainly the costs of used material and technologies and it is important to point out the influence of the mentioned factors on the environment (PTÁČEK L. 1999, BORKOWSKI S. 2007, BORKOWSKI S. 2008, BORKOWSKI S. 2011).

Welding is the most economical way to non-rewirable joint metals and their alloys. It is the only way of connecting two or more components to one, non-rewirable corpus. The purpose of welding is to create a permanent joint, which has required properties. Usually, it is toughness, ductility, resistance to degradation processes, which can course during the whole time of the joint use, and resistance to sudden failure, which means safety, usually evaluated by fracture toughness and integrity of weld joint (HRIVŇÁK I. 2009, TURŇA M. 1989, MEŠKO J. 1999, SLÁDEK A. 2000).

The division and characteristic of individual methods of welding is mentioned in Hrivňák I. 2009. A separate group of welding methods is aluminothermic welding used for welding of rails. H. Goldschmidt laid the foundations of aluminothermic welding in 1899. The technical meaning was in the reaction of aluminothermic mixture where the reduction of ferrous oxides by aluminium occurs, which creates a highly overheated melted metal with a big thermal content. The melted metal is used as a source of heat and filler material for welded joint.

Aluminothermic mixture contains oxides of metals, aluminium and alloying elements. The temperature of ignition of this mixture is 800 ÷ 1100°C (special matches are used). The reaction of aluminothermic mixture lasts for a few seconds, while about 50 % of the steel is deoxidated and about 50 % is slag. Deoxidated welding metal is heated at the temperature of about 2100 ÷ 2200°C while exothermic reaction is created. As a result of this reaction overheated metal and liquid slag are created.

Out of 1 kg of aluminothermic mixture is obtained about 477 g of slag, 533 g Fe and 3353.04 kJ of heat. Optimal aluminothermic mixture contains 24.5 % Al and 75.5 % of ferrous oxides. In terms of thermal effect, the best oxide for this reaction contains 86 % Fe_2O_3 and 14 % FeO.

Depending on the type of Fe oxides (FeO, Fe_2O_3, Fe_3O_4), the deoxidation with Al occurs according to these relations:

$$3\,FeO + 2\,Al = Al_2O_3 + 3\,Fe$$

$$Fe_2O_3 + 2\,Al = Al_2O_3 + 2\,Fe$$

$$3\,Fe_2O_3 + 8\,Al = 4\,Al_2O_3 + 9\,Fe$$

The welding process is similar to casting welding (HRIVŇÁK I. 2009, RAILTECH INTERNATIONAL 1993 and 1994, SCHRUEDER L. C. 1984, SLÁDEK A. 2000, TURŇA M. 1989).

In engineering practice fractures sometimes occur near the welded joint during the operation of components and constructions caused by using wrong welding parameters. Failures of components and constructions occur accompanied by economic losses (BOKŮVKA O. 2000, LIPTÁKOVÁ T. 1997).

In this paper the authors provide experimentally obtained causes of rails and pipes fractures resulting from bad realization of welded joint.

2. Experimental investigation of fracture causes

The rails and pipes were damaged (fractures) in operation in the area of weld joint, see Figure 1 and Figure 2.

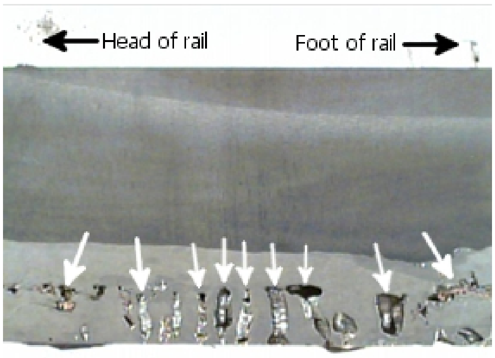

Fig. 1. Rail weld joint fracture, arrowhead notation - defects

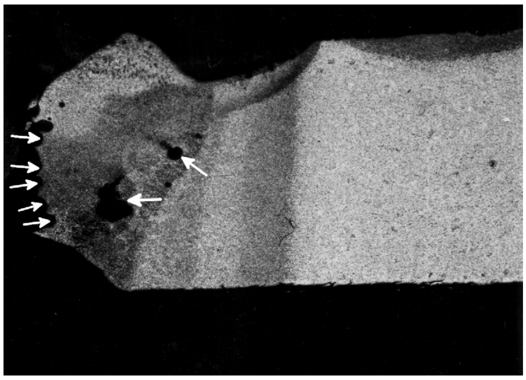

Fig. 2. Pipe weld joint fracture arrowhead notation - defects

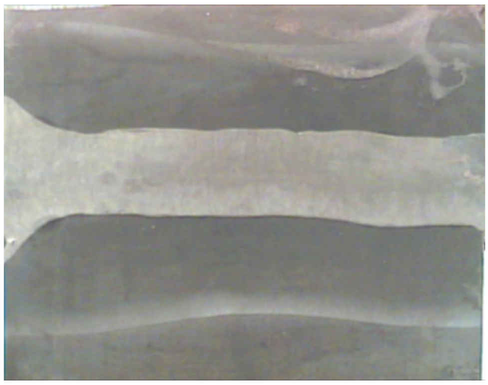

Fig. 3. Rail weld joint, outside of damage

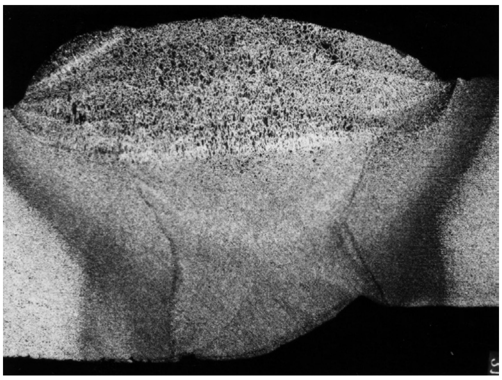

Fig. 4. Pipe weld joint, outside of damage

For the verification of basic material properties, including fracture causes, the selected experimental methods of physical metallurgy and threshold state of materials were used (SKOČOVSKÝ P. 2006, BOKŮVKA O. 2002, LEITNER B. 2003). The results of quantitative chemical analysis (Table 1 and Table 2), metallography and electron microscopy analysis (Figure 5 and Figure 6), tensile and hardness tests confirmed that the used structural material, structural steels correspond with the material used as rail steels (Table 1) resp. pipes of high-pressure gas lines (Table 2). The chemical composition and tensile strength are comparable, the microstructure is pearlite – ferrite with a very small portion of ferrite (Figure 5, rail steel) resp. ferrite and perlite with non–uniform polyedric grains (Figure 6, pipe steel). In the case of pipe steel there was a higher value of sulphur observed, which deteriorates the welding property of the material. (SKOČOVSKÝ P. 2000, SKOČOVSKÝ P. 2006).

The metallography analysis (Figure 2, Figure 7, Figure 8, pipe and Figure 1, rail) electron microscopy (Figure 9, Figure 10, rail) and radiography testing demonstrated considerable occurrence of pores, blowholes, slags, lack of fusion, non – plastics non – metallic particles, cracks, shrink holes, weld reinforcement, unfused root, irregular surface, spatter, defects in root and so on.

Table 1. Rail, chemical composition (in weight %) and tensile strength R_m (MPa)

Rails	C	Mn	Si	P	S	R_m
verification	0.686	1.01	0.36	0.014	0.012	1080
material standard	0.55 0.80	0.75 1.40	0.15 0.50	max. 0.050	max. 0.050	min. 950

Table 2. Pipe, chemical composition (in weight %) and mechanical properties (R_m (MPa), A5(%))

Pipe	C	Mn	Si	P	S	Cu	Ni	Cr	R_m	A5
verification	0.17	1.12	0.28	0.033	0.058	0.205	0.12	0.125	536.1	20.8
material standard	0.16 0.22	1.00 1.40	0.15 0.40	max. 0.04	max. 0.04	max. 0.30	max. 0.30	max. 0.30	460 550	21.0

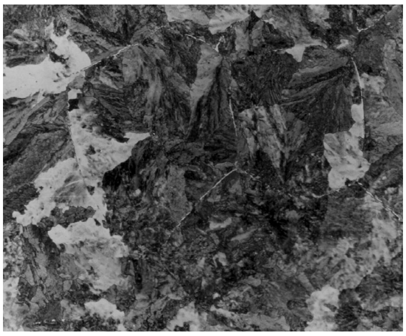

Fig. 5. Rail microstructure, mag. 500x, etch 3 % Nital

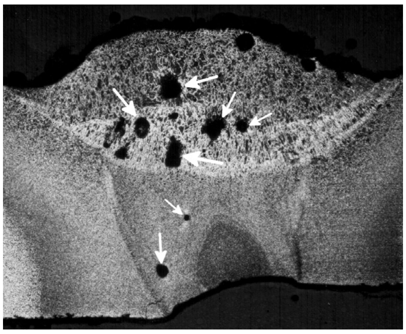

Fig. 7. Pipe, arrowhead notation - pores, mag. 6.3x, etch 1 % Nital

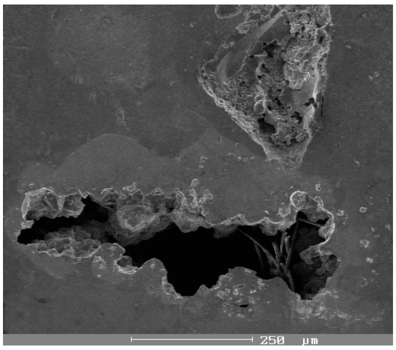

Fig. 9. Rail, shrink hole, SEM, etch 3 % Nital

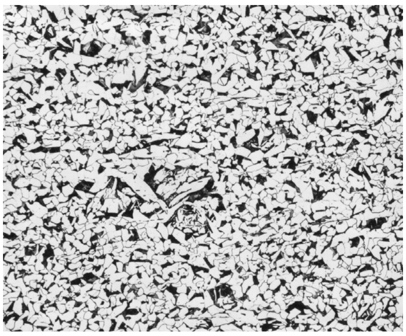

Fig. 6. Pipe microstructure, mag. 100x, etch 1 % Nital

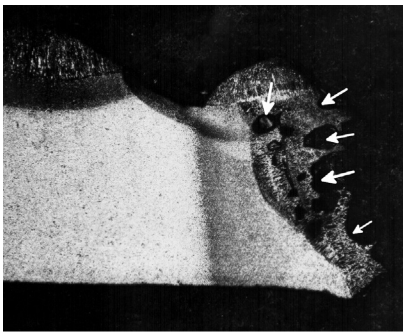

Fig. 8. Pipe, fracture, arrowhead notation – defects, pores, mag. 6.3x, etch 1 % Nital

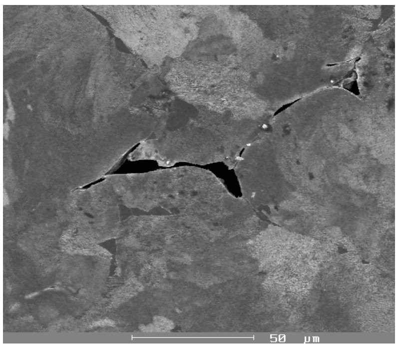

Fig. 10. Rail, cracks, SEM, etch 3 % Nital

The size and amount of defects in the rail increased in direction from the head of the rail to the foot of the rail (in the direction of the highest bending, loading), Figure 1, the defects covering a constituent part of the weld area, Figure 1, Figure 2 and Figure 8. As an opposite of the above, the weld of rail (Figure 3) and weld of pipe (Figure 4) beyond the area of fracture are shown. Very important is the fact, that the pipes of high – pressure gas lines and rails of railway lines are loaded not only statically but also dynamically (BOKŮVKA O. 2002, SKOČOVSKÝ P. 2006). These defects serve as initiation points for the start of the degradation mechanism, they have substantially decreased the load – bearing cross section. With regard to these facts, the final results are fractures and the railway and high – pressure gas lines are interrupted (SKOČOVSKÝ P. 2000, SKOČOVSKÝ P. 2006).

4. Conclusions

The quality of weld joint is determined by using exact welding rules prescribed by technological descriptions. The preparation of the welding place (for example, cleaning, grease removing with the aim to remove all kinds of dirt including corrosion products, drying out, heating before welding, etc.), weld manufacturing (human factor) and ex-post control of the weld (visual and with the use of defectoscopy methods) are the assumption factors of high quality weld joint. Breaking these rules leads to defects in the weld joint and, subsequently, to failure of components and constructions, which causes considerable economic losses. The observance of optimal rules in the chain chemical composition, microstructure and technology leads to high use properties, required quality of components and constructions.

Acknowledgements

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USING BOST METHOD TO THE CONCEPT DEVELOPMENT ESTIMATION

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Resume

The paper uses an innovative research methodology - BOST questionnaire. Based on the questionnaire, two Toyota's principles were evaluated. These were E2 and E2 areas. According to the results it is possible to state that the most important factors for workers are the following: customer's good (DK), followed by product innovativeness (IP), independence and accountability of employees (SP), formation of products stockpile (PZ), cooperation with partners (WK), technology development (RT) and corporate culture care (PR).

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1. Introduction

Assumptions related to the construction of a power station provide 12 energy blocks to work. The first block was put into operation on 29.12.1981. Brown coal mine operated from also contains other materials, such as peat, sand and gravelly quartz - feldspar, boulders, clays, flint-in aggregate, quartz sandstones, limestone. Power station coal, transported by taking calorie control, makes a raw material.

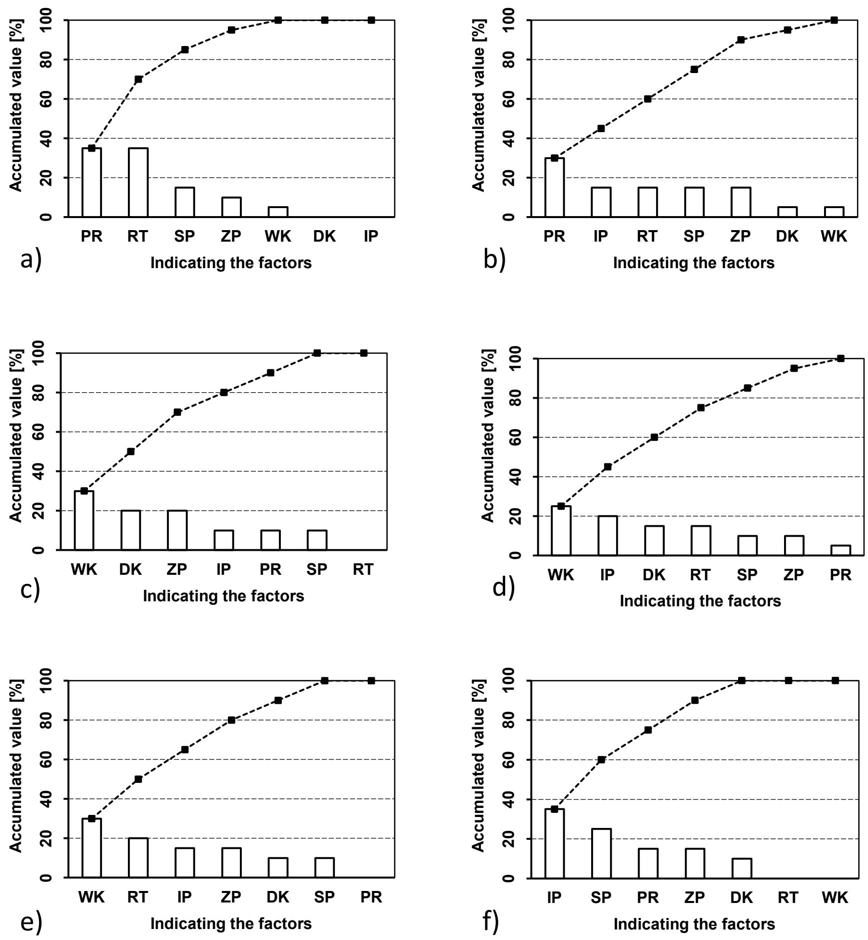
2. BOST method and Toyotarity

The BOST method allows defining the relations between material resources and human resources and between human resources and human resources (BORKOWSKI S. 2012a). Toyotarity is a scientific discipline examining human - machine and human - human relationships with consideration of a process-based approach, Japanese culture, especially of the Toyota, oriented to continuous improvement with the use of knowledge (BORKOWSKI S. 2012b).

This definition details two dipoles: human – machine and human – human. Human factor appears in three out of four components of the above definition thus underlining the meaning of a human in a Japanese culture and, consequently, in the culture of Toyota. In the fundamental dipole human-machine, human pole means: originators, initiators, investors, chief management, leaders, who plan and realize human activity. In the other dipole, human– human, one pole means: management, leaders – managerial staff, who during the performance of human resources management has visual contact with them, it can be stated that they look into the eyes of the executors of processes, who are an element of the second pole of the human – human relationship. The BOST method (the name derives from the first two letters of the author's surname and name and is legally protected, BORKOWSKI S. 2012a) describes the Toyota's management principles with its characteristic factors. Their number depends on the scope of such a principle and varies between 4 and 10. A set of factors is called an area. Some principles are divided into two or even three areas. The Toyota's management principles are divided into four sections, while the BOST questionnaire has two versions: a version for employees and a version for superiors. The version for employees contains a set of factors describing principles: 1; 2; 3; 4; 6; 7; 14 and elements of the roof of the Toyota's house (quality, costs, lead time, safety, morale of the personnel). The version for superiors contains a set of factors describing all the Toyota's management principles and elements of the roof of the Toyota's house. The presented questionnaire has a ranking scale. Respondents may assess the significance of a given factor by placing one of the numbers within the range of the scale in an appropriate box.

3. Research method

The BOST method (the name comes from the first two letters of the author's surname and name and is legally protected) (BORKOWSKI S. 2012a) describes the Toyota's management principles with its characteristic factors (BORKOWSKI S. 2012b). Their number depends on the scope of the principle and ranges from 4 to 10 set factors known as areas. Some principles are divided into two or even three areas. Toyota's management principles are divided into four sections, while the BOST questionnaire has two versions: a version for employees and one for supervisors. The version for employees contains a set of rules that describe factors: 1, 2, 3, 4, 6, 7, 14 and elements of the roof of the house of Toyota (quality, cost, delivery time, safety, morale).



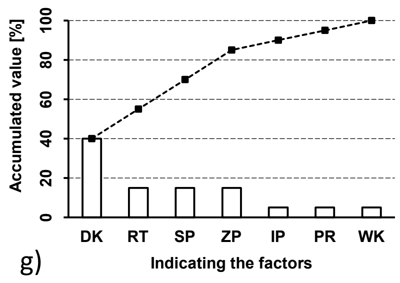


Fig. 1. Principle 1. Pareto-Lorenz diagrams of validity factors of E2 area for evaluations: a) „1", b) „2", c) „3", d) „4", e) „5", f) „6", g) „7". Concerns the production of electricity

The superior's version contains a set of factors describing all Toyota management principles and elements of the roof of the Toyota house. The scale survey has shown variation. The respondents in the right pane were asked to assess the validity factor by inserting one of the numbers within the limits of the scale. In the tested company, the staff and managers were polled with BOST survey (BORKOWSKI S. 2012a BORKOWSKI S. 2012b). The study was subject to the second and the fourth principle of Toyota. In fact, in the second principle the respondents were asked to answer the question:
What factors decide about the concept development of your company? In the box, type 1, 2, 3, 4, 5, 6, 7 (7 crucial element).

DK		Customer's good
IP		Product innovativeness
WK		Cooperation with partners
SP		Independence and accountability of employees
ZP		Trust in relationships with employees
PR		Corporate culture care
RT		Technology development

The presented set of factors describes the first management principle of Toyota. (BORKOWSKI, S., ROSAK-SZYROCKA, J. 2011a). In the case of the third Toyota management principle the respondents were asked to rate the following areas: **E4a. The organization of the production system provides:** In the box, type 1, 2, 3, 4 (4 the most important element).

DZ		Deliveries to the customer's "demand"
MM		Maximum utilization of machines, people
PZ		Formation of products stockpile
BS		Without storage system

The presented set of factors describes the third management principle of Toyota (BORKOWSKI S. 2012a).

4. Results and their analysis

Figure 1 shows the Pareto-Lorenz diagrams of importance factors of E2 area (BORKOWSKI S. 2012b, BORKOWSKI S. 2012c). By analyzing Figure 1a it can be seen that in the case of evaluation 1 two areas dominated: *corporate culture care* (PR) and *technology development* (RT). These areas are in the description of the importance factors that determine the concept of the least development of the company. Estimation 1 was observed for the *customer's good* area (DK) and *product innovativeness* (IP). By introducing a new system in a company set to create a new culture it is possible to get a lower score of occurrence of such an assessment. Analyzing the evaluation 2 appearing in Figure 1b it can be seen that the frequency of its occurrence was the highest for the areas *corporate culture care* (PR) and *product innovativeness* (IP).

5. Conclusions

The paper uses innovative research metho- dologies based on a BOST questionnaire (BORKOWSKI S. 2012d). Chosen areas of Toyota were taken into consideration, namely E2 and E4. E2 area assessment is determined by evaluation factors referring to the concept of development that affected the respondents while E4 area concerned the organization of the production system.

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USE OF THE TOYOTA MANAGEMENT PRINCIPLES FOR EVALUATION OF THE COMPANY'S MISSION

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Resume
In the paper there were described the elements of the Toyota roof. Electroacoustic products were characterized. Immaterial resources of the company were analyzed. To do so, the BOST survey, whose questionnaires were filled in by employees of the chosen enterprise, was used. Particular attention was paid to the following factors: quality, costs, lead time, work safety and personnel morale.

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1. Introduction

The resarch was conducted in a company which produces electroacoustic goods. Electroacoustic products called the electric appliances band whose purpose is to process acoustic signals into electrical signals and vice versa (SEREDA J. 1981). The main groups of electroacoustic products are microphones, sound recorders, audio players, audio amplifiers, speakers and speaker units that significantly affect the subjectively perceived sound quality. With the current level of digital audio recording and high-quality players, there are not many problems with the poor quality of the source audio as it was in the case of magnetic or analog media. So the quality of the speakers and the speaker teams significantly affect the quality of the reproduction of their sound. The main element of the speaker system is the same speaker, the electroacoustic transducer, whose task is to change the electricity supplied to the amplifier into an acoustic wave. It uses a coil placed in the magnetic field of the permanent magnet pole piece through which alternating current flows via the amplifier, causing the speaker cone excursion in both directions from the equilibrium position. Cone excursion causes air thickening before the membrane and retraction causes dilution resulting in a wave of sound that reaches the ear of the recipient (KRAJEWSKI J. 2003).

2. Research methodology

Information on the importance of quality and its control has been obtained on the basis of surveys conducted in the area of E1 among employees. A set of factors for E1 area for the principle one of Toyota management (BORKOWSKI S., KRYNKE M. 2011, BORKOWSKI S., KNOP K. 2010). Respondents in the E1 answered the following question in the survey BOST (BORKOWSKI S. 2012a, BORKOWSKI S. 2012b, BORKOWSKI S. 2012c):

What is most important in your company? In the box, type 1, 2, 3, 4, 5 (5 the most important factor).

JA		Quality
KO		Costs
CR		Lead time
BP		Work safety
MZ		Personnel morale

Tables 1 and 2 show the numbers and percentages of factors statement in validity assessment area of the roof of the Toyota house in the enterprise engaged in the production of sound equipment (BORKOWSKI S. 2012a, BORKOWSKI S. 2012c, LIKER J.K. 2005).

Table 1. Numerical combination of the factors importance evaluation for area of the Toyota roof elements

Evaluation	Indicating the factors				
	JA	KO	CR	BP	MZ
1	0	0	0	0	23
2	0	0	0	23	0
3	5	3	15	0	0
4	4	16	3	0	0
5	14	4	5	0	0

Source: own study

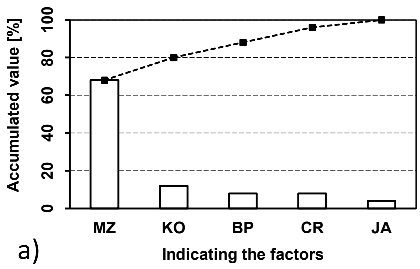
Table 2. Evaluation structure [%] of the factors importance for area of the Toyota roof elements

Evaluation	Indicating the factors				
	JA	KO	CR	BP	MZ
1	0.0	0.0	0.0	0.0	100.0
2	0.0	0.0	0.0	100.0	0.0
3	21.7	13.0	65.2	0.0	0.0
4	17.4	69.6	13.0	0.0	0.0
5	60.9	17.4	21.7	0.0	0.0

Source: own study

3. Validity of ranks

In Figure 1 there is presented the importance of each factor using Pareto - Lorenz diagrams (BORKOWSKI S. 2004, SELEJDAK J., BORKOWSKI S. 2004).



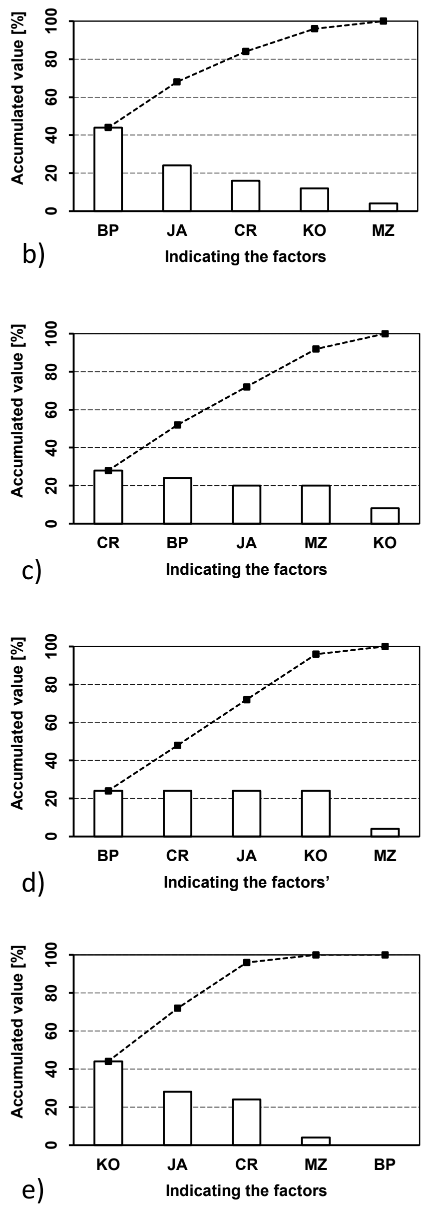


Fig. 1. Pareto-Lorenz diagrams of the factors importance area of the Toyota roof elements for evaluations: a) „1", b) „2", c) „3", d) „4", e) „5". Applies to company manufacturing electroacoustic equipment

Source: own study

The least important factor for the staff was *personnel morale* (MZ). 68% of the lowest ratings coincided precisely for this factor. The rest of the factors shared values between 4% and 12%.

In the case of evaluation 2, the dominance is not as clear. *Work safety factor* (BP) was 44%, *quality* (I) 24%, *lead time* (CR) 16%, *costs* (KO) 12%, *personnel morale* (MZ) 4%.

For the assessment of "3", the values are more aligned, most of the factors received around 20% of the vote. Only factor *costs* (KO) was 8%.

All the factors except *personnel morale* (MZ) received 24% of ratings "4", *personnel morale factor* (MZ) got 4% of all rated "4".

For the assessment of "5" factor *costs* (KO) has a big advantage over the other factors. Quality factor (I) received 28% of votes, while the execution *time factor* (CR) 24%. *Personnel morale factor* (MZ) received only 4% of the highest ratings, and *the work safety factor* (BP) showed no assessment of the fifth

Analysis of Pareto - Lorenzo diagrams has revealed that the most important factors in the company are *quality* (JA) and *costs* (KO). Execution *time factor* (CR) is also often chosen as important, but smaller number of people considered it to be the most important.

The data presented in Figure 1 was used to build the ranks of the validity factors for the area of elements of the Toyota roof:

- **rating "1"**

$$MZ > KO > (BP, CR) > JA \quad (1)$$

- **rating "2"**

$$BP > JA > CR > KO > MZ \quad (2)$$

- **rating "3"**

$$CR > BP > (JA, MZ) > KO \quad (3)$$

- **rating "4"**

$$(BP, CR, JA, KO) > MZ \quad (4)$$

- **rating "5"**

$$KO > JA > CR > MZ > BP \quad (5)$$

- **average**

$$JA > KO > CR > BP > MZ \quad (6)$$

4. Summary

The object of the research was a company producing electroacoustic products. BOST testing confirmed a high awareness among employees regarding quality as an important parameter. A large number of employees also acknowledge the importance of costs. These are quite optimistic conclusions as the crew seems to be aware of the new developments, changes and shows a greater desire for training. However, it may be disturbing they ignore the fact of safety. After all, in the company there are used quite dangerous tools that can easily lead to accidents, and consequently, ruin the health of workers. It would be worthwhile to draw employees' attention to work safety and take steps to reduce the risk of accidents.

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PROCESS OF QUALITY IMPROVEMENT IN THE COMPANY PRODUCING BUILDING MATERIALS

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Resume

The aim of the study was to identify the problems and improve the production of cement in a ball mill in terms of technology and management associated with the use of known methods and techniques to improve quality. A detailed analysis helped to explain the process which affects the efficiency of grinding cement and which is the most common cause of disturbance and incompatibilities in the process of milling, how the production process is managed and controlled in order to obtain the required grain size, which is the main parameter influencing the quality of the manufactured product. To manage the change of the process there has been used a value stream map for analysis of the intermediate process of cement production, transport to the silos, bagging and selling. Based on the research some proposals of the process improvement have been designed that might have a chance of implementation and execution.

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1. Scheme of cement production

Basic components for the production of cement are: clinker, blast furnace slag, silica fly-ash and binding regulator (synthetic or natural gypsum, sand fluid).

The tanks over the mills gripper gantry are filled with basic components: clinker and binding regulator, and appropriate tank additives depending on the type of cement (a mixture of slag or ash and slag). Mineral admixtures can be divided into two main groups. The first group of these additives includes those improving the quality of the produced portland cement, to the second one belong additives which are designed to lower the cost of cement production by reducing the percentage of expensive cement clinker and replacing it with artificial or natural mineral raw materials (AHRENDS I., CIEŚLIŃSKI W. 1956).

The scheme of the cement production process with a numerical list of the equipment is shown in Fig. 1.

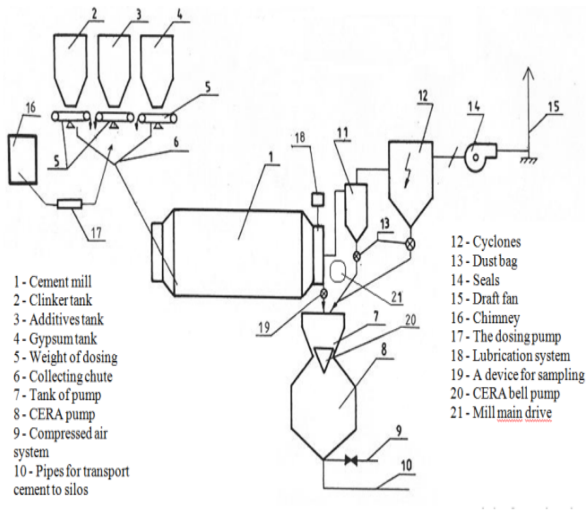

Fig. 1. Scheme the cement production process and equipment list

In the mill the components are fragmented to the appropriate grain size during the movement inside the mill; the air flow through the mill ensures the appropriate speed of the movement of the material inside the mill. Tiny grey powder obtained by milling the clinker is called the portland cement. The quality of the produced cement and the unit of energy consumption in the milling process are mainly determined by: the grain size of the clinker fed to the mill, the temperature and humidity of the clinker, the clinker milling ability, the degree of added additives and the degree of the cement milling (AHRENDS I., CIEŚLIŃSKI W. 1956, SYGUT P., KRYNKE M., MIELCZAREK M. 2012, BORKOWSKI S., SELEJDAK J., SALOMON SZ. 2006.).

2. Production of cement in terms of technology

The production process of the finished product in terms of technology is shown in Fig. 2. The presented process of production of cement concerns the same milling.

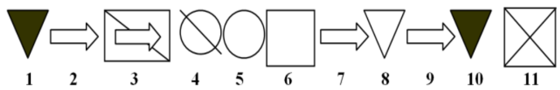

Fig. 2. The structure of cement manufacturing process in terms of technology

where:

1 – storage of raw materials (intermediates) in the hall,
2 – grab crane transport (filling baskets with raw materials),
3 – transportation of raw materials (gypsum, clinker, slag) dosing weights to the mill, quantity control (set to the mill feed),
4 – pre-milling in the first cement mill chamber,
5 – milling in the second cement mill chamber,
6 – appropriate control (determination of the relevant area, CaO and SO_3),
7 – transport to the pump CERA,
8 – storage (on the line) in the pump CERA,
9 – pneumatic transport from CERA pump to cement silos,
10 – cement storage in silos,
11 – final inspection (periodic test strength).

3. Improving working conditions in the cement plant using 5S practices

One of the many tools are Toyota Practice 5 S (BORKOWSKI S. 2004, PAWLAK W.R. 2000). The aim of 5S is to introduce and maintain order and discipline in the workplace. 5S practices are one of the foundations of creating a work environment conducive to the pro-quality activities, harmonious work and continuous improvement of human relations, which translates into an effective organization.

In the cement plant under analysis what is being done to serve the purpose of ordering, simplifying and improving safety of the work environment is not seen as 5S practices. However, each employee as well as visitors to the plant have noticed significant changes in recent years. The employee performs his work in a friendly and less burdensome environment for him. The operator of the process does not have red cards, but knows what tools should be in the workplace, and what should be removed. The mechanic of the repair squad after completing his work removes unnecessary parts and materials leaving good order. The most needed consumable parts are arranged on the shelf at the end of the hall and at any time can be taken in order to prevent accidents or carry out fault clearing. In addition to regular cleaning there are installed new, more efficient and energy-saving lamps, dusty equipment is sealed and dust extraction equipment is mounted on them. According to the schedule of inspections, inspection of machinery and equipment is carried out and documentation is updated. Standardization is a daily habit of activities performed in the workplace. Employees use procedures that describe the rules of conduct at the workplace. They are located in a visible place and for everyone to understand. Self-discipline is a stage of maintaining a high work discipline. In the cement plant this is seen through increased productivity, improved product quality, reduced costs, reduced levels of stocks, increased productivity and increased safety. The most important benefits that result from the use of these practices is harmonizing the activities of the organization and, consequently, the development of each employee, greater commitment and desire for innovation, improved quality and increased individual and team productivity.

In order to achieve all that, the following steps should be taken (BORKOWSKI S., SELEJDAK J., SALOMON SZ., 2006):

1. Choose a location for the implementation of practices (in the analyzed company - milling plant department).
2. Photograph the place to be arranged, and after positive changes, re-take a photo.

3. Organize the "red cards" action involving determination of necessary and unnecessary things.
4. Eliminate unnecessary things from workstations.
5. Tidy and clean out all the necessary items and equipment.
6. Place everything you need in such a way that you can quickly and easily find and apply them.
7. Mark traffic routes, racks, shelves and cabinets.
8. Assign responsibilities to each team brigade for organizing cleaning and maintaining order and cleanliness in the workplace.
9. Pay attention to cleanliness and order.
10. Use constant supervision of the development of 5S practices in order to improve discipline among employees and to develop the habit of caring for the order and its enforcement.

Preparation and carrying out of these activities take time but can be reduced if there is appropriate involvement of management and all employees of the department. Positive implementation of 5S in this department will be an example and the beginning of the implementation of these practices in other departments of the cement plant. 5S method is relatively easy and cheap due to its simplicity, it is a tool for improving the organization, resulting in better understanding of the changes taking place in the company. Thus, while it may seem obvious, even with rules and good manners, 5S practices should be implemented, and formally and procedurally defined.

Please note that the improvement of the production process does not end with the implementation and achievement of its objectives, but it is a continuous process (KRUCZEK M., ŻEBRUCKI Z., 2008).

4. Conclusion

The object of the study was portland cement fly ash-slag produced in ball mills, which are already close to 50 years of age. The main customers of the company are engaged in manufacturing and construction services as well as distributors supplying individual customers

Improving conditions in the workplace, the maintenance of order and discipline in the workplace can be achieved through the introduction of 5S practices and the principle of 5W2H. Despite quite positive effects that lead to the improvement of the organization of the company in question it is advisable to introduce 5S practices and 5W2H principle in their continuous development. The most important benefits of their implementation will include harmonizing the activities of the organization, and thus the development of each employee, greater involvement, increased innovation, improved quality, and increased individual and team productivity.

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AN EVALUATION OF REALIZATION OF THE PRODUCTION PROCESS IN THE CEMENT MILL

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Resume

In this chapter there were presented the characteristics of the research object (cement mill) and the description of the enterprise products. There was introduced an analysis of the results obtained on the basis of the BOST questionnaire survey and there was made a statistical analysis concerning principle 4 of the Toyota. The structure of evaluation was determined and importance series were built.

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1. History and quality policy in the cement mill

The main raw material for the production of cement is limestone. The location surroundings of the workshop have rich deposits of limestone. For that reason in 1959 the authorities of the state made a decision about building a cement mill in this area. The fact of the beneficial location was an additional factor helping a new investment on the coal trunkline Silesia – the Baltic Sea Coast. In the seventies of the 20th century the cement mill was built by the Conglomerate concentrating a few production plants with similar businesses in one organizational structure, i.e.: two units producing cement, two units dealing with the production of calcium and one producing agricultural limestone.

The eighties of the last century is a period of crisis for the cement mill and of political transformations on a national scale. New owners invested in the modernization of two rotary furnaces. The modernization depended on replacing the so-called wet method with the dry method in the production of clinker. It resulted in productivity growth of the clinker with simultaneous lowering of energy consumption and technological fuel. Fig. 1 shows a modernised technological line for the production of clinker.

Fig. 1. Modernised lines for the production of clinker

According to the declared policy on quality the cement mill is a producer of cement for the Polish market as well as foreign ones. The applied systems of quality management are still being developed and a possibility to improve them in the future is being sought. It is realized by effective managing of basic processes which, thanks to investments, are supplied in more efficient technologies and modern devices. The quality control of products in the cement mill is based on the Integrated System of Management in accordance with norms PN-EN ISO 9001:2001, PN-EN ISO 14001:2005, PN-N 18001:2004, AQAP 2120: 2003. In December

2009 the Company Laboratory received accreditation of the Polish Accreditation Centre in accordance with norms PN-EN ISO/IEC 17025:2005.

2. The preliminary presentation of results

2.1. Combination of results

A valuable supplement of carried out examinations is the interpretation of BOST questionnaire results (BORKOWSKI S. 2012a). It allows a better look at the enterprise through the eyes of workers. In order to form an opinion it is essential to know the opinion of workers of different ranks in the enterprise. In the analysis there was used a question from E5 area (BORKOWSKI S. 2012b). The question that was analysed read: "What elements are the most important in the realization of a production process?". The person who fills in a questionnaire is to judge the following factors (BORKOWSKI S. 2012c):

- *Short series of products* (KW).
- *Steady duty of machines* (RM).
- *Steady duty of workers* (RO).
- *Rhythmicality of supply* (RD).

This question in the BOST questionnaire is in accordance with the 4th principle of the Toyota (BORKOWSKI S., ROSAK-SZYROCKA J. 2011). In table 1 numerical combination of evaluations has been presented.

Table 1. Principle 4. Numerical combination of the factors importance evaluation for E5 area

Evaluation	Indicating the factors			
	RO	RM	KW	RD
1	1	0	32	2
2	20	2	2	11
3	6	20	1	8
4	8	13	0	14

Source: own study

2.2. Statistical analysis of the results from the BOST questionnaire

Making statistical analysis of the studied area six statistical tools were used: arithmetic average, variance, standard deviation, the coefficient of variation, skewness and excess coefficient (Fig. 2)

The average level of the measurable feature was presented with the help of the average (KONSTANCIAK M., BORKOWSKI S., JAGUSIAK M. 4/2011). While analysing Fig. 2a concerning the result of the average it was taken into account that the majority of respondents judged the response concerning *steady duty of machines* (RM) on the level 3.31.

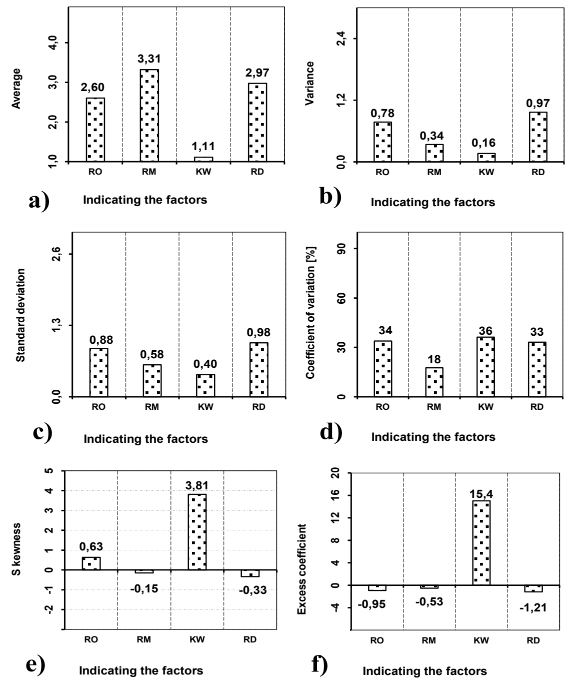

Fig. 2. Principle 4. Comparison: a) averages, b) standard deviation, c) variance, d) coefficient of variation for 5 area factors

The reply concerning *rhythmicality of supply* (RD) reached 2.97. The next statistical tool is a variance. From Fig. 2b it results that the maximum value of variance amounting to 0.97 concerns the reply on *rhythmicality of supply* (RD). The minimum value 0.16 received the answer *short series of products* (KW). Fig. 2c shows determined standard deviations. It results from them that *short series of products* (KW) has the smallest standard deviation. The fourth analysed statistical measure is coefficient of variation (Fig. 2d). The biggest diversity can be observed for *short series of products* (KW).

The reply concerning *steady duty of machines* (RM) was more explicitly judged by respondents. Skewness (Fig. 2e) is the simplest measure of the asymmetry for the factors in the researched area (BORKOWSKI S., MIELCZAREK K., BARTELEWSKA A. 2011). After analysing the results it was stated that the replies concerning *steady duty of machines* (RM) and *rhythmicality* *of supply* (RD) have the disintegration left-side oblique, however for the reply *short series of products* (KW) and *steady duty of workers* (RO) the disintegration is positive which means that is on the right-hand side oblique. The last factor for analysis is kurtosis (Fig. 2f). It determines the measure of distribution and concentrating the results in the surroundings of the average (BORKOWSKI S., KNOP K., PLUTA M. 2011). The measures for *steady duty of workers* (RO), *steady duty of machines* (RM) and *rhythmicality of supply* (RD) show flattened distribution and the value for *short series of products* (KW) - slender distribution.

2.3. Importance series for factors describing the fourth principle of the Toyota

In order to analyze the structure of the answers for the purpose of getting the importance of features for the analysed area, they were assessed with taking into consideration the value assigned to determined factors (BORKOWSKI S., KNOP K., BARTCZAK M. 2011). On the basis of the received results there were presented importance series of factors for evaluation "1 ÷ 4". Formula 1 shows an importance series of factors for evaluation "1". On the basis of received results it was found that *short series of products* (KW) received mostly evaluation "1".

$$KW > RD > RO > RM \quad (1)$$

Steady duty of workers (RO) received mostly evaluation "2" .

$$RO > RD > KW > RM \quad (2)$$

On the basis of received results it was found that *steady duty of machines* (RM) received mostly evaluation "3" (57.1%).

$$RM > RD > RO > KW \quad (3)$$

Similarly to evaluation "3", the factor *steady duty of machines* (RM) received evaluation "4" the most.

$$RM > RD > RO > KW \quad (4)$$

Formula 5 shows a series for the average.

$$RM > RD > RO > KW \quad (5)$$

The factor *steady duty of machines* (RM) is the area which was regarded as the most important one in the realization of the production process. The last place was taken by the factor *short series of products* (KW).

3. Conclusions

The data obtained from BOST analysis allowed us to get to know the opinions of a representative group of workers in the topic of functioning of the enterprise in relation to a competent organization of the production process and its influence on the quality of produced goods. The respondents were with long professional experience and for the majority of them it was their first work place. The results from the analysis made it possible to state that according to the respondents the most important element in the realization of the production process was the factor *steady duty of machines* (RM).

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NON-DESTRUCTIVE METALLOGRAPHY & REPLICA METHOD FOR INSPECTION CONNECTING ROD MATERIAL AND CRACKS DETECTION

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Resume

Testing of materials properties is usually a discipline for the quality assurance during manufacturing processes. In condition monitoring, certification or upgrading of existing plants and in failure analysis similar benefits from non-destructive testing of materials properties can be achieved. Another benefit from the Non-Destructive Metallography (NDM) is that the test can be made on-site. NDM is a well established and proven tool to help determine the integrity of generator and hydro turbine components during their life-cycle in power plant environments. On-site metallography of components makes it possible to evaluate the microstructure of materials. It allows microstructural analysis of large components that are difficult to move or not permitted to be destructively tested, enabling rapid evaluation of the material. Here are monitored the microstructural changes and crack detection in St 35 connecting rod steel after approximately 15 years in service. The paper includes a short description of the replica method as a technique for microstructural examination of components by using non-destructive testing method.

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1. Scheme of water turbines

Water turbines are machines that convert hydraulic energy into mechanical energy. This conversion is possible in a complex harnessing called a hydro power plant (HPP). Usually, the mechanical energy is further converted into electrical energy, in the same harnessing with the use of electrical generators.

There are three basic types of hydro turbines:

impulse,
reaction and
submersible propeller.

All produce clean energy or green energy - power from renewable resources.

There are low-, medium- and high-head turbines. They are also classified as having a vertical or horizontal orientation. A schematic view of a Hydro Power Station is shown in Fig. 1.

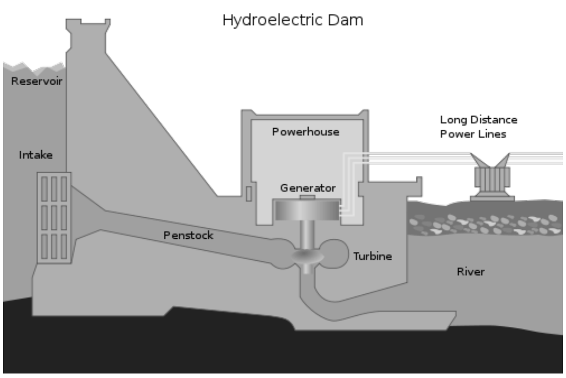

Fig.1. Schematic View of a Hydro Power Station, vertical orientated turbine. The connecting rod is between the turbine and the generator

Such an equipment is of crucial importance for all consumers of electricity in the country.

2. Connecting Rods forging

For certain purposes, the machine components should be forged. The hammer exerts compressive pressure on a relatively small area. During a forging process a high degree of crystal grains refinement is obtained. The importance of finishing temperature at hot-forging as in other hot-working deformation processes is well known. A lower finishing temperature at hot forgings is sometimes caused by the presence of brittle ranges in a material. A low finishing temperature may lead to cold-working effect(s), which is indicated as a high value of the ratio of yield stress to ultimate stress, either at static or alternate loads.

For producing a long forged piece, a hot-working deformation is obvious. At forging of a large piece, a deformation is localized. A high rate of forging also permits great deformations, while the temperature drop must be kept in close limits. Hammering between flat dies may lead to causing compression stresses. At the cold edge, an additional (even tensional) stresses may be introduced by fast & irregular cooling or similar technological factors.

Medium carbon steels are available for forgings for general engineering purposes, such as: turbo-electric rotors, die blocks, gears, large hydraulic pistons, etc. In order to work those products large ingots are necessary, and a large press must be used.

3. Experimental results

A hydro-power generator plant is always complex in structure. A connecting rod is just a part in such a structure. A hydro-power plant, water turbines and similar parts/components of the equipment are available for analysis from many viewpoints. Here are monitored the microstructural changes that have taken place in the connecting rod material, after being in service over a quite long period of time, about 15 years.

The use of the replica method for monitoring the microstructure quality makes sense only by periodic investigation and comparison of the results with those previously obtained.

At the moment of forging production of a new part it is clear that all the consequences that may arise from the servicing conditions are simply not predictable or visible. Here are described some examples of cracking of one hydraulic piston, when all the parameters of mechanical or chemical requirements are satisfied at the moment of production, but in spite of this, the piston failed in servicing.

Such discontinuities could not be explained by regular working conditions of a hydraulic component, but just from the point of view of quality of the forged and heat treated product.

Melting and refining regimes, also forging, are responsible for obtaining those irregularities on the surface just near the square part of the forged connecting rod, but machining (either turning or milling) operations cannot be responsible for detected faults.

A sketch of connecting rod and places for replica R1 and R2 monitoring are shown in Fig. 2.

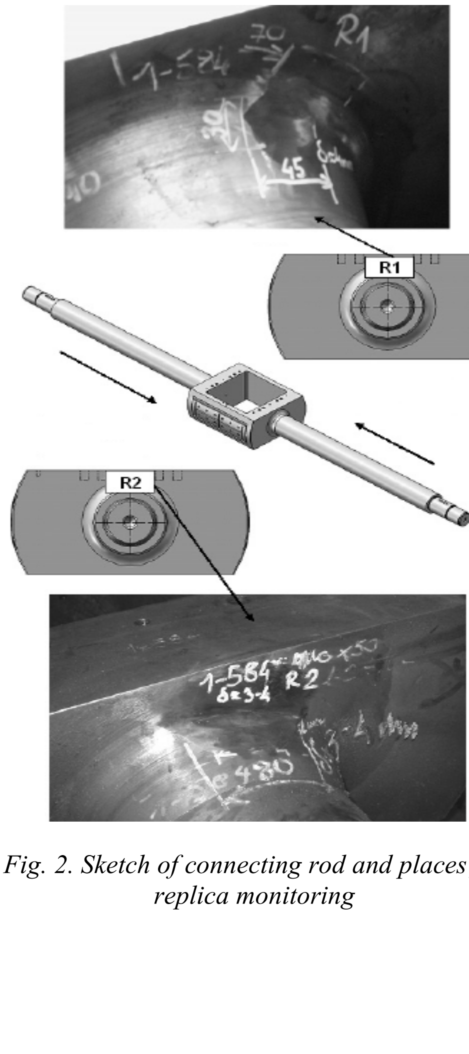

Fig. 2. Sketch of connecting rod and places for replica monitoring

In the areas where replicas R1 and R2 were taken, there were also determined chemical composition and hardness measurements.

The microstructure of the investigated material (Fig. 3) before exploitation consists of ferrite and pearlite, with small non-metallic inclusions.

The changes in the microstructure of connecting rod material must be also of great importance. Those processes are: decarburization, corrosion, micro- and macro-cracks, etc.

A wide variety of degradation processes are possible to discover with the use of replica metallography.

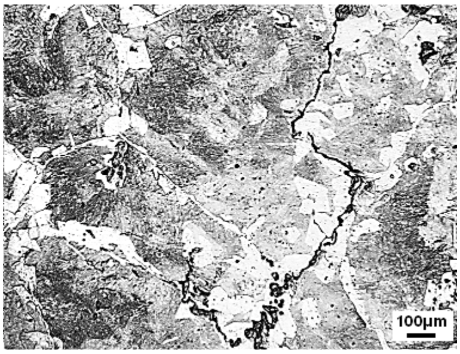

Fig. 3. The microstructure consists of ferrite, pearlite and some bainite. Micro- and macro cracks observed under optical microscope. 4% natal

4. Conclusion

The role of the connecting rod in a hydropower plant is of great importance.

The NDM techniques offer a possibility of detecting materials damage at an early stage and thus prevent dangerous and costly failures.

Plants that are notoriously exposed to gradual degradation will be safer and live longer if areas of the highest degradation rate are located and possible damage repaired at an early stage.

The changes in the microstructure of the connecting rod material must also be of great importance. A wide variety of degradation processes are possible to discover with the use of replica metallography. Those processes are: decarburization, corrosion, micro- and macro-cracks, etc.

The above results led to a direct recovery of the connecting rod of the water turbines in the area of identified macro-cracks, and after repeated tests, it was determined that it was not necessary to replace it.

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VISUAL CONTROL AS A KEY FACTOR IN A PRODUCTION PROCESS OF A COMPANY FROM AUTOMOTIVE BRANCH

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Resume
This article presents a theoretical basis for one type of control in enterprises – visual control. It presents the meaning of visual control in the Toyota Production System and BOST researches as a tool of measure, among other things, the importance of visual control in production companies. The level of importance of visual control usage as one of the production process elements in the analysed company was indicated. The usage of visual control is a main factor in a production process of the analyzed company, the factor which provides continuous help to employees to check whether the process differs from the standard. The characteristic progression of production process elements was indicated and the SW factor (the use of visual control) took the third place, PE factor (interruption of production when it detects a problem of quality) turned out to be the most important one, while the least important was the EU factor (granting power of attorney down). The main tools for this evaluation : an innovative BOST survey - Toyota's management principles in questions, in particular, the Pareto-Lorenz diagram, radar graph and series of importance as graphical interpretation tools, were used to present the importance of each factor in relation to individual assessments.

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1. A visual control and its meaning in the Toyota Production System

Visual control (visibility management, management by visibility, management by sight) is any communication device used in the work environment that tells us at a glance how work should be done and whether it is deviating from the standard. Visual controls are designed to make the control and management of a company as simple as possible.

The techniques of visual control include: *5S principle, light signaling (the so-called andon), sign of the floor, sign boards, the border examples of products, Kanban cards, working instructions* (Fig. 1). The best visual indicators are right at the work site, where everyone can jump out at you and clearly indicate by sound, sight, and feel the standard and any deviation from the standard. Visual control focuses on the principle that "picture says more than 100 words."

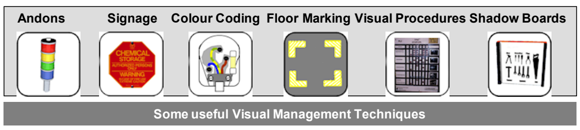

Fig. 1. Examples of the visual control tools most commonly used

A visual control is a basic principle and element in many modern management and production and quality improvement conceptions, f.ex. *LEAN MANUFACTURING*, *GEMBA KAIZEN* and production systems in many of the biggest production companies in the world, among others, in *TOYOTA PRODUCTION SYSTEM*.

Visual control has a special place in the Toyota Motor Company. It is one of the production techniques that is connected with company's perfection and integrated with the process of increasing added values. The Toyota Way recognizes that visual control complements humans because we are visually, tactilely, and audibly oriented.

Visual control is an essential tool in the Toyota Production System. The 7th rule of the Toyota management claims: *"Use visual control so that no problems remain hidden*."

Visual control brings the Toyota Motor Company measurable results:

- increasing productivity,
- reduces defects and errors,
- helps in meeting deadlines,
- it facilitates communication,
- improves safety, lowers costs and
- generally gives employees more control over their own environment (LIKER J.K. 2005, BORKOWSKI S., KNOP K. 2012).

2. BOST researches and visual control evaluation

The BOST researches - the Toyota management principles in questions - is a tool, exactly the survey which allowed MEASURING, among other things, the importance of visual control and its elements in a production and service company.

The BOST researches allow bringing answers to questions like:

- What is the meaning of individual elements of visual control?
- How the importance (of elements) of visual control is perceived by production workers and their supervisors?

There were constructed E3 and E7 questions in order to find answers to those questions (Fig. 2).

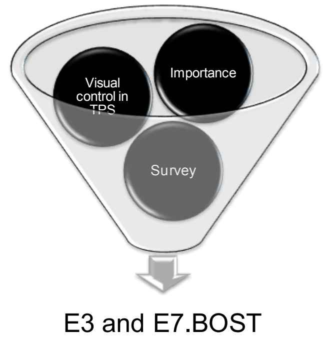

Fig. 2. Results of a filtration process – questions in the BOST researches concerning evaluation of visual control elements

The content of the E3 question is as follows: *What element is the most important one in the production process? Put 1, 2, 3, 4, 5, 6 (6 stands for the most important factor).*

CP		The continous system of problems disclosure
PE		Interruption of production when it detects a problem of quality
SZ		Standard tasks , processes , documents
EU		Granting power of attorney
ST		Use only reliable technology
SW		**The use of visual control**

The content of the E7 question is as follows: *Which element of visual control is the most important? Put 1, 2, 3, 4, 5, 6 (6 stands for the most important factor).*

CS		Cleanliness	UP		Participation in production places
EP		Flow	ME		Monitoring
TI		Signboard	GW		Graphic presentation of results

The estimation of these factors should be undertaken by production workers and their supervisors in order to find characteristic relations (BORKOWSKI S. 2009, BORKOWSKI S. 2012D, BORKOWSKI S., KNOP K., RUTKOWSKI T. 2011).

3. Results of visual control importance evaluation

A series of production process factors in the company of the automotive branch was determined. The E3 survey questions were sent and answers were received from 45 production workers and 15 managers of the audited entity. The question included in the BOST survey is of E3 area: *" What element is the most important one in the production process?"*. Respondents were asked to answer this question by making prioritization of six factors of the production process using a 1-6 scale.

Table 1 shows numerical and percentage (parentheses) juxtaposition of importance assessment for the factors of the E3 area (BORKOWSKI S., KNOP K., CHORYŁEK K. 2011).

Table 1. Numerical and percentage juxtaposition of importance assessment for the factors of the E3 area

Evaluation	Factors					
	CP	PE	SZ	EU	ST	SW
1	15 (25.0)	6 (10.0)	5 (10.0)	15 (25.0)	7 (11.7)	11 (18.3)
2	5 (8.3)	10 (16.7)	12 (20.0)	13 (21.7)	13 (21.7)	7 (11.7)
3	12 (20.0)	7 (11.7)	8 (13.3)	12 (20.0)	9 (15.0)	12 (20.0)
4	6 (10.0)	14 (23.3)	17 (28.3)	7 (11.7)	6 (10.0)	10 (16.7)
5	14 (23.3)	12 (20.0)	9 (15.0)	6 (10.0)	12 (20.0)	7 (11.7)
6	8 (13.3)	11 (18.3)	8 (13.3)	7 (11.7)	13 (21.7)	13 (21.7)

Basing on Table 1 the Pareto-Lorenz graphs were made to show the importance of the factors referring to the third principle of the Toyota manegement (WOLNIAK R., SKOTNICKA B. 2008) (Fig. 3).

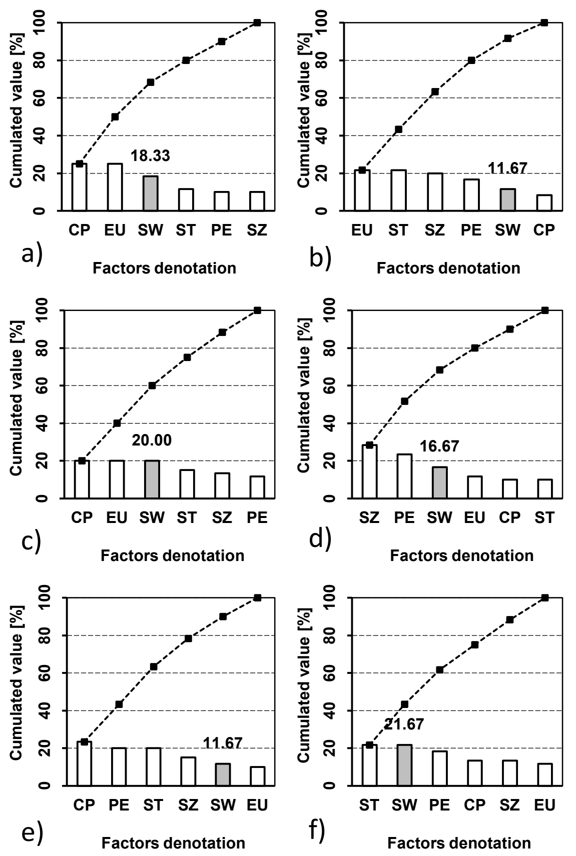

Fig. 3. Pareto-Lorenz graphs – evaluation structure for: a) "1", b) "2", c) "3", d) "4", e) "5", f) "6"

Figure 3 shows that the area of *the use of visual control (SW)* is an important factor in the production process of the analysed company, in total, the highest rating "4", "5" and "6" were indicated by 50.01% of the respondents. Taking this factor into account most of the ratings were at the level of "6" – 21.67%, while the minimum ratin was "2" – 11.67% of the responses.

According to the workers the *interruption of production when it detects a problem of quality (PE)* is the most important element of the production process; most of the respondents gave this factor the highest rating "5" and "6", respectively 36.66% and 53.33%.

Use only reliable technology (ST) is the second important factor of the production process, according to the respondents' opinion. 21.7% of responses give this factor the highest rating "6" and 20% give rating "5". The workers knew that the use of only reliable technology improves the production process, ensures high quality of the manufactured products and increases the comfort of work.

Standard tasks, processes, documents (SZ) for only 13.3% of the respondents had a big influence on the production process. The "5" rating gave 15% of the respondents; a similar proportion was noted for "3" rating – 13.3% of responses gave this rating. So we can state that *standard tasks, processes, documents* (SZ) are of average importance for the production process.

The continuous system of problems disclosure (CP) was not an important factor of the production process. The highest rating "6" was given only in 13.3% of the responses, whereas the least important "1" - in 25% of the responses. These ratings could speak well about a low consciousness connected with the importance of this factor and its influence on products quality.

Granting the power of attorney (EU) is the least important factor of the production process according to the employees. The percentage of the lowest ratings – "1" and "2" – amounted to 46.7%. Only 11.7% of the employees gave this factor the "6" rating.

With the use of a radar graph (Fig. 4) there was shown the average value of each of the production process factors (ULEWICZ R., MAZUR M., KNOP K. 2012).

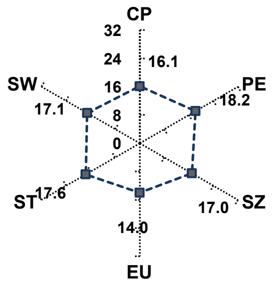

Fig. 4. Radar graph of the average of factors evaluation of E3 area

Based on this graph, a series of importance of the production process factors was constructed (Fig. 5).

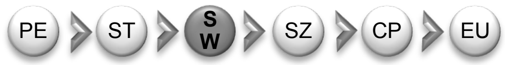

Fig. 5. Characteristic series of importance of production process factors

We can notice that the factor *the use of visual control (SW)* occupied the third place in the series of importance of the production process factors.

4. Conclusions

The aim of this study was to evaluate the importance of the production process factors, in particular *the use of visual control (SW)* factor, in the company of the automotive industry. The main tool for this evaluation was an innovative BOST survey - Toyota's management principles in questions.

Basing on the findings of E3 area of BOST we can say that in the analysed company:

- the use of visual control is the main factor in the production process, it is a very important element which completes and intensifies other elements of the production system, it leads to a specific action and in the analysed company this usually means a problem-solving process,
- *the use of visual control (SW)* factor occupied the third place in the series of importance of the production process factors,
- the most important factor of the production process, according to the employees, was the *interruption of production when it detects a problem of quality* (PE), and the least important factor was *granting the power of attorney* (EU),
- a characteristic of the production process importance series can be presented by dependency: PE>ST>SW>SZ>CP>EU.

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USING THE SHEWHART CONTROL CHARTS BY PROCESS CONTROL

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Resume

This article deals with the statistics pursing the process capability of turning in screws production in RIBE Slovakia, k.s. In technical practice, an important group of statistic methods is formed by analyzing qualification of measures, production equipment and qualification of process. By the term "process qualification" we mean the ability of the process to observe required technical parameters by required value and tolerance limits. Findings of the process capability can be isolated in the estimate process capability (before starting the production) and permanent process capability. Also, we have finished the quest for the process capability where the indexes C_p and C_{pk} are bigger than the determined value of 1.33 points.

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1. Introduction

In technical practice, an important group of statistic methods is formed by analyzing qualification of measures, production equipment and qualification of process. Out of the statistic methods mentioned above the most frequently used is examination of process qualification. By the term "process qualification" we mean the ability of the process to observe required technical parameters by required value and tolerance limits. Findings of the process capability can be isolated in the estimate process capability (before starting the production) and permanent process capability. The main distinction is in time span, in quantity of obtained values and in the form of obtaining them. This information presents facts for the customer about the expected fulfilment of his requirements.

We can say that the process is capable if C_p and C_{pk} are bigger than 1.33.

The input data comprises:

– definitive conditions of series production,
– convenient and able measuring equipment of high accuracy,
– able production facilities,
– statistically encompassed process through the quality control charts,
– test on assumed division,
– technical and other specification correctly expressing the customer's request.

2. Material and methodology of experiments

2.1. Description of the process:

Operating step:

Turning according to the production order WZ 12 860 B RIBE ISR – axial screw

Mark: *slot width*

Rating value: $1.62^{+0.08}$ *mm*

Lower Specification limit (LSL): *1.62 mm*

Upper Specification limit (USL): *1.70 mm*

Check centre:

Mitutoyo profile projector with precision of 0.001 mm.

Production device:

turning machine TRAUB TB 30

Volume of subgroup: *N = 250 screws*

Measure of subgroup: *n = 5 screws*

Interval of taking: *every 30 minutes*

Number of subgroups: *k = 50*

The criteria for competence valuation are indexes C_p and C_{pk}. By looking at the product specification we consider the screw´s slot width of 1.62 $^{+0.08}$ mm as a critical sign. We measure the slot width with a profile projector with precision of 0.001 mm and with capability of a measuring device. We suppose a normal division of the process and appreciate the suitability of application partitions through the medium of likelihood networks. By regulation of the turning process we shall use a regulating schema control chart for the average and span $(\bar{X}, R)$. In the turning process we use turning machine TRAUB TB 30 as a production machine.

2.2. Calculation of specification limits

Average range in subgroups

$$\bar{X}_i = \frac{1}{n}\sum_{j=1}^{n} X_{ij} \tag{1}$$

i = 1, 2 ....k and j = 1, 2 ...n,

X_{ij}– measured value in i- subgroups

j – serial number of measured value in i-th subgroups

k – number of subgroups

n – file size

Span in subgroups

$$R_j = MAX(X_{ij}) - MIN(X_{ij}) \tag{2}$$

i = 1, 2 ... k and j = 1, 2 ...n

MAX (X_{ij}) and MIN(X_{ij}) is maximum and minimum value in i-th subgroup.

Process average **:**

$$\bar{\bar{X}} = \frac{1}{k}\sum_{i=1}^{k} \bar{X}_i \tag{3}$$

$\bar{X}_i$ - average of j-th subgroup

Span average :

$$\bar{R} = \frac{1}{k}\sum_{i=1}^{k} R_i \tag{4}$$

R_i, X_i are spans and averages in *i*-th subgroups (*i*=1, 2, ..., *k*). $\bar{R}$ and $\bar{\bar{X}}$ in quality control charts are central lines (*CL*).

Calculation of specification limits:

$$UCL_R = D_4 \cdot \bar{R} \tag{5}$$

$$LCL_R = D_3 \cdot \bar{R} \tag{6}$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \cdot \bar{R} \tag{7}$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \cdot \bar{R} \tag{8}$$

D_4, D_3 and A_2 are constants depending on the volume of subgroups *n,* in our case n = 5: D_3 = 0.000, D_4 = 2.114, A_2 = 0.577.

Qualification of turning process

$$C_p = \frac{USL - LSL}{6 \cdot \hat{\sigma}} = \frac{T}{6 \cdot \hat{\sigma}} \tag{9}$$

$$C_{PK} = \frac{USL - \bar{\bar{X}}}{3 \cdot \hat{\sigma}} \tag{10}$$

$$C_{PK} = \frac{\bar{\bar{X}} - LSL}{3 \cdot \hat{\sigma}} \tag{11}$$

USL – Upper Specification limit

LSL – Lower Specification limit

3. Results

In the turning process of the RIBE screw we obtained values for 50 subgroups. The characteristics $\overline{X}$ and R were applied in quality control charts. Then we added regulation bounds and central lines to quality control charts .

For quality control chart $(\overline{X}, R)$ these are the actual regulation bounds:

UCL_X = 1.6758 mm

UCL_R = 0.04525 mm

LCL_X = 1.6448 mm

The process was mastered correctly, no regulating limit was overloaded and no trend or violation of the middle period was shown. The process is a mastered situation and no systematic influences impact on it. The general average is $\bar{x}$ = 1.66016 mm, the average span R = 0.054 mm. After qualification attestation the process can be treated as qualitatively qualified, indicators of qualification C_p and C_{pk} are higher than 1.33.

$\mathbf{C_p = 1.45}$ $\mathbf{C_{pk} = 1.44}$

Consequently, we have figured our values to quality control chart (Fig. 1), where on the top is a control chart for $\overline{X}$ and below - for *R*.

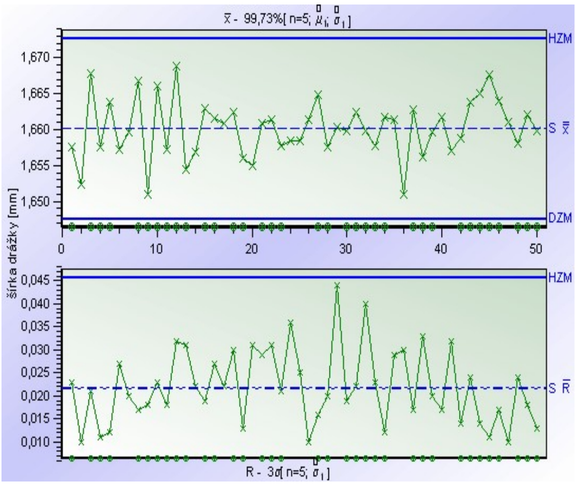

Fig. 1. Quality control chart

4. Summary

The capability of the turning process in RIBE Slovakia showed that the process provides the products which satisfy demanded quality criteria. The values of a potential process capability and a real process are respectively C_p = 1.45 C_{pk} = 1.41. These values are higher than the rate 1.33 and the process is able to provide products in compliance with tolerance zones.

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FATIGUE TESTING STRUCTURAL STEEL AS A FACTOR OF SAFETY OF TECHNICAL FACILITIES MAINTENANCE

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Resume
Guarantee of quality and safety exploitation of machines and equipment is a significant factor in the design and manufacture of these components. This paper presents an analysis of fatigue test results of samples in the bending load on the rotation in the range from 10^4 to 10^7 ,the number of cycles of applied load, with a frequency of 40 Hz. Whöler curve shows the results of the fatigue properties of steel S355J2 which is used in the construction of vehicles. There was also carried out a fractographic analysis.

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1. Introduction

The *Concept of fatigue* can be defined as a process of structural changes of the material and its features, which is induced by vibration or cyclic weight bearing. Material fatigue is a process of continuous accumulation of damage formed in a sufficiently long time. This process is caused by variables of mechanical stress which cause the nucleation and spreading (propagation) of cracks, revealed in the end as destruction of the material (WYRZYKOWSKI J.W., et al. 1999).

The information about the fatigue strength of the material becomes essential for solving the general problem of improving the reliability and durability of modern machines and constructions. The dynamic development of technology makes it necessary to carry out research aimed at increasing the length of exploitation cycle and reliability of modern technical objects (VĚCHET, et al. 2001). The analysis of causes for damage to machine components and constructions shows that most of over 80% of all cases are due to the fatigue cracking. Manufacturers are interested in optimizing operational costs and the increase of production. Therefore, manufacturers pay attention to getting the greatest durability of produced objects. This is obtained by looking for new construction solutions of their products and by the application of appropriate materials (materials with appropriate properties).

2. Results of the fatigue tests

The main characteristics of fatigue are obtained after the formation of the fatigue curve, which is a graphical representation of the relationship between the level of stress σ (or strain ε) and the fatigue life N in tests performed in the same conditions (number of cycles, type of samples).

Fatigue characteristics (dependence $\sigma = f(N)$) of steel have been determined at low testing frequency. Schematic presentation of the test device along with the course of bending moment and loading distribution on the section is provided in Figure 1 (MIKOVÁ K., et al., 2012, BOKŮVKA O., et.al., 2002). Stress ratio of the loading cycle in such tests is always R = -1.

To determine the fatigue strength of the material 12 specimens of S355J2 steel underwent a low cycle fatigue test. The results obtained in this way were the basis to build the S-N curve.

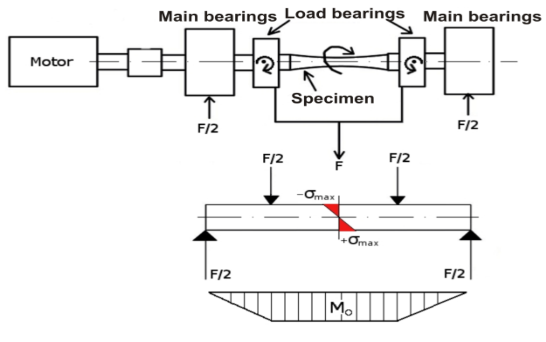

Fig. 1. Rotoflex - equipment testing bending strength in the rotation mode

The fatigue tests were performed with the use of the Rotoflex machine realizing load in bending in the rotation mode. During the load cycle the stress ratio was R = -1, with loading frequency 40 Hz and temperature 20°C ± 3°C. During the test the working part of the specimens was cooled by means of fans (ULEWICZ R. et.al. 2012).

The test results formed a dependency curve between the amplitude of applied load and the number of cycles to the specimen crack $\sigma_a = f(N_f)$ (Figure 2). The tested material shows a distinct fatigue limit of σ_C = 290 MPa for the loading cycles $10^6 < N < 10^7$.

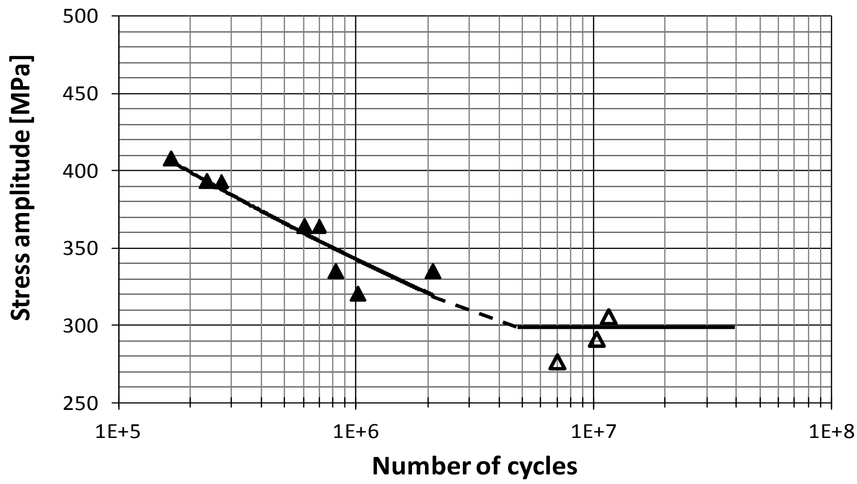

Fig. 2. Diagram of dependency between the load amplitude and the number of cycles of the tested steel

In order to learn about the nature of the fatigue process of the tested materials fractographic analysis for fatigue fractures has been performed (ZEMANDL M. 2006). The tests were performed with a scanning electron microscope (SEM) Tescan II.

The testing specimen of S355J2 steel was destroyed at cycles number being $N=2.7*10^5$ and imposed to load σ_a = 393 MPa. Figure 3 presenting the fracture surface of the specimen is characterised by the fact that it has two fatigue facture initiation places from which fatigue cracks spread.

One can clearly see the main crack and an extra one, a short crack. Fatigue cracks were initiated on the surface of the tested specimen (Figure 4). Fatigue fracture surface is presented in Figures 5 and 6.

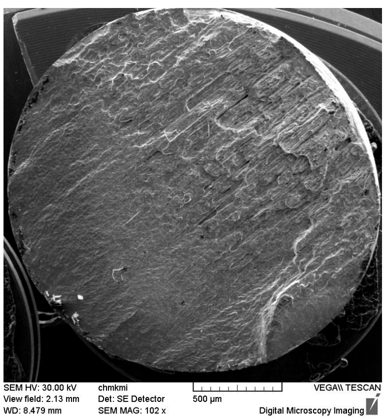

Fig. 3. Overview of the fracture surface

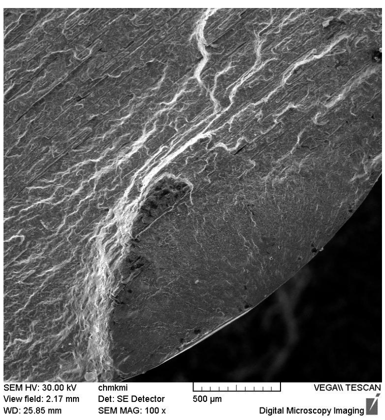

Fig. 4. The initiation place of fatigue fracture

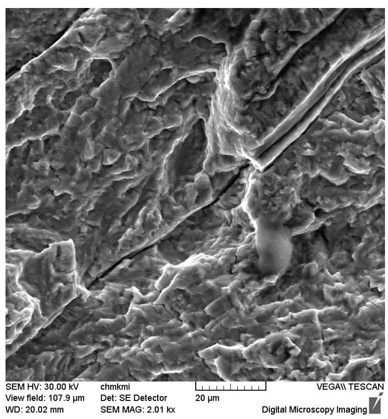

Fig. 5. Secondary cracks

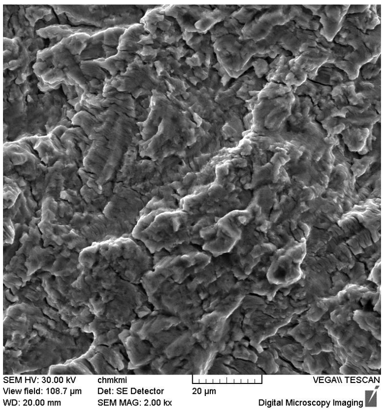

Fig. 6. Striations on the fatigue fracture surface

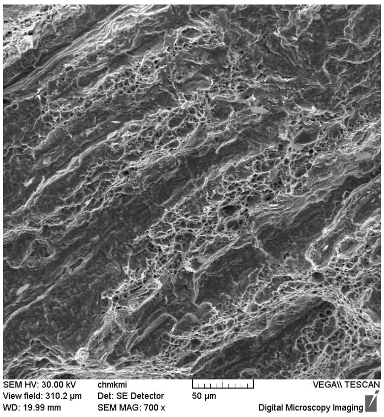

Fig. 7. Final overload fracture surface

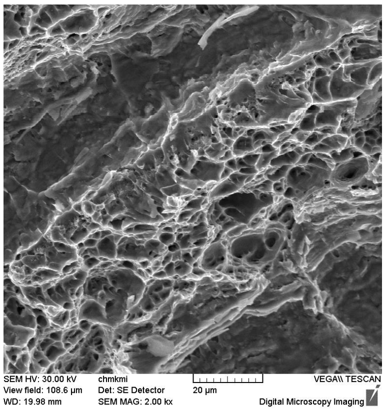

Fig. 8. Transcrystalline ductile fracture of ferrite with dimple morphology

The area has a nature of transcrystalline fatigue fracture with clear secondary cracks, arranged in accordance with rolling direction of the test material. In the area there are also characteristic striations (Fig. 6). The final overload fracture surface is characterised with a combination of transcrystalline ductile fracture with dimple morphology and transcrystalline quasicleavage fracture (Fig. 8). The area shows very clear combination of the fracture structure with the microstructure of the material (Fig. 7). Pearlite clearly arranged in lines is, after the rolling process, characterised with quasicleavage between which there is ferrite with plastic facture structure and clear dimples morphology.

3. Conclusions

The results of the fatigue tests of S355J2 steel are presented in this paper. The results show that S355J2 steel has a clear fatigue limit at the level of 290 MPa. Understanding the mechanism of formation fatigue cracks is an important element in safety assurance during the operation of the structure. To ensure safety of the material there was made a fractographic analysis.The fractographic analysis proved that the initiation of fatigue cracks was present on the surface of the test specimens, which was also influenced by their loading. This results from the fact that, while loading, bending in rotation is most intense on the surface of the tested specimen and when the distance from the surface to the specimen's centre increases, its value decreases. The characteristics of the ductile fracture of the fatigue area are closely related to the structure of the material. The results of the fractographic tests proved absence of factors that could have an impact on the decreased strength of the materials and the existing inclusions were not a direct cause of the initiated fatigue crack.

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BRIEF REVIEW OF GERMAN STANDARDS FOR QUALITY AUDITS IN AUTOMOTIVE PRODUCTION

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Resume

Quality management systems (QMS) in the automotive industry have several differences in comparison with other industrial factories. Each customer has his own specific requirements, the so-called CSRs (Customer Specific Requirements). Audits are one of the core-tools of quality management to make the PDCA cycle work. It is clear that compliance to ISO/TS 16949:2009 requirements is a condition for supplying the automotive industry. But there are some standards which co-exist together with the official ISO9001 Q-management systems standards and technical specification ISO/TS16949. What are those specific standards in the automotive industry and which standard should be used and why – those are the questions to be answered in this article.

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1. Introduction

In the times of economic dumping each vehicle maker does his best to effectively manage his internal and external processes. It finally leads to creation of their specific requirements for suppliers. It has become not enough to build the quality management system according to ISO 9001:2008, not even enough to meet the requirements of ISO TS 16 949:2009 which were created specially for the automotive production. It is important nowadays to meet the specific requirements of each customer (ŠURINOVÁ Y., 2011). Different customers create their specific requirement based on their special market strategy in order to satisfy customers needs better than other competitive organizations do. These special requirements are often based on the manuals of American quality management standards QS 9000 or German standards for quality management VDA. Globalization brings to the world of business the best improvement tools and methods which have been created in different countries and companies in the world (ŠURINOVÁ Y., 2011).

2. Description of the approach, work methodology, materials descriptions

There is no doubt that there are plenty of customer specific requirements in the automotive production. Even in the field of quality audits it would seem that some customers do not know what they want. In the automotive production ISO/TS 16949 certification is required, on the other hand, there are VDA standards which are required by German companies.

The hypothesis of the study is: VDA6 series should be treated as a customer specific requirement which can bring excellence to organizations.

The *related standards review and literature search* is the main tool used in this article. The core job was performed while reviewing the VDA6 series standards requirements and the ISO/TS16949:2009 requirements. To make conclusions, the information available in the article was verified in various Slovak automotive supplying organizations.

3. VDA6 series review

Increasing requirements in the automotive production make organizations change and continuously improve the quality management system. The German automotive industry is recognized from all sides as having successfully followed a premium strategy – developing brands which stand for high performance and high quality and production values. The aim of VDA standards creation is reaching Automotive Excellence (VDA 6, 2006).

Comparing VDA 6 series and ISO 19011:2011 it is evident that VDA 6.x standards are more specific with their requirements. VDA 6 standards give us concrete formulas how to determine the audit range, how to quantify the analyzed system /process efficiency, what requirements should the auditor meet to perform a concrete audit.

It is also true that some of the VDA6 series standards indicate an evaluation system which sets the rules how to quantify the way the analyzed process or system meets the requirements. It is indisputably the case of quality quantification.

Different standards of the VDA6 series have each their own evaluation criteria. Questionnaires (for VDA 6.1 and VDA 6.3) or process signs (for VDA 6.7) may serve as an example of audit criteria. Each of these standards has also its own evaluation formulas, which help to quantify meeting the requirements of the VDA 6.2 process /system which was created for auditing services in automotive sites.

Further on, the most widely used standards VDA 6.1 and VDA 6.3 will be reviewed.

3.1. VDA 6.1 Quality management system audit

VDA 6.1 is the first standard of the VDA 6 series. According to Štetinová, this is a special standard which has added some special field-specific requirements for quality management systems audit and has some special features in comparison with ISO 9001. VDA6.1 provides a questionnaire for assessing a company's quality system (KLAUS J. ZINK, 1998).

Regarding contents, it substantially covers all elements of ISO 9001 and partly goes beyond them. Comparing ISO 9001 and VDA 6.1, there are some specific areas in VDA6.1 which are not covered in ISO 9001.

VDA 6.1 has been valid since 1998. Since April, 1st 1999 this standard has been used as obligatory for all German automobile producers. The aim of this standard is to make the automobile producers continuously improve their processes, prevent problems occurrence, eliminate critical factors in production systems and others. The standard was based on ISO 9001:1994 and was later revised in 2003 (ŠTETINOVÁ A., 2005). This standard has not been revised according to the ISO 9001:2008 due to the fact that registration to ISO/TS 16949 is now accepted instead of VDA 6.1.

Admittedly, this is the first tentative conclusion that VDA6.1 audits standard used to be widely implemented in automotive production, but in the light of this fresh research, we must conclude that it tends to be replaced by ISO/TS 16949 general specification for quality management in the automotive branch.

3.2. VDA 6.3 Process audit for mass production

VDA 6.3 is an excellent tool for process audits within the automotive industry acting as a guideline for performing audits. According to Cameron, 2011 it provides information on the significance and application scope of a process audit over the entire product realization cycle. It defines the audit process, the criteria for evaluation of the process audit results and the requirements of the processes. At the heart of the standard, each step in the process is modeled with six links and is governed by the Deming Loop – Plan Do Check Act. There are three grades that an organization can reach under VDA 6.3 – A, B & C. This means that an organization can pass the audit but still has the scope for further improvement (CAMERON, 2011).

It is clear that VDA 6.3 defines a process based audit standard for evaluating and improving controls of processes in a manufacturing organization. In order to continuously monitor and improve processes in organizations and to secure process reliability VDA 6.3 was designed. Together with VDA 6.1 and other VDA6 series standards it may be treated as a customer specific requirement of the European (German) automobile producers. The VDA 6.3 standard was designed in 1998 and was revised in 2010.

The standard was revised in order to follow changing environment in automotive production. Process risks and weaknesses as well as interactions between processes have to be followed. In other words, revised in 2010, the standard was comprehensively restructured to reflect the changes to ISO 9001:2008 and customer specific requirements in the automotive industry.

The revised VDA 6.3 supports process approach and thus is still widely used to perform audits of suppliers. This standard includes a questionnaire for each audit phase. It also contains an evaluation system which provides a formula how to evaluate standard requirements fulfillment. Besides, there is a supplier categorization matrix included in VDA 6.3.

The standard can be used by any organization, either for internal process audits or for evaluating potential or existing suppliers. Compliance to VDA 6.3 is mandated by some vehicle makers and encouraged by others. VDA 6.3 provides an opportunity to master some of the tools and approaches that have helped make this success possible. VDA 6.3 is particularly useful for a prime mover in any sector who wants to follow a premium strategy and wants to ensure that the supply chain is capable of supporting this approach to global competitiveness (CAMERON L., 2011).

4. Description of achieved results

We have made it absolutely clear that VDA6s series have some benefits in comparison with ISO/TS 16949. In fact VDA standards set some further requirements for automotive suppliers. However, VDA6.x can be treated as a customer specific requirement and must be applied if there is a customer´s special requirement.

Despite those arguments, the fact still remains that ISO/TS 16949:2009 is the only quality management standard for automotive production which is recognized and accepted by each vehicle maker all over the world. The VDA6.x standards are usually required by German organizations and are co-integrated with ISO/TS 16949 requirements.

5. Conclusions

The ISO/TS 16949 standard is a highly efficient standard, not a system of implementation of quality management and auditing, nevertheless there are some commonly known and used in practice standards which can help organizations perform the audits according to the verified and validated special formula (VDA6.x are the examples of such standards).

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EFFECTIVENESS ASSESSMENT OF FUNCTIONING OF QUALITY ASSURANCE SYSTEM

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Resume
This paper presents the results of six-year studies that were conducted in an iron foundry. The research consisted in effectiveness assessment of the quality assurance system. Determinants of three groups of estimation criteria were characterized. In technological criterion the required values of dimensional tolerance, the value of required hardness, raggedness, the required values of coefficients of the scattering process and also acceptable fractions of the products were taken into consideration. The economic criteria included the assumed values of internal and external costs of product defects. The exploitation criteria comprised the required level of reliability or durability and the required value of products repairability. The obtained results point to too high costs of lacks in technological criteria. The undertakings were proposed in order to decrease them.

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1. Introduction

The quality assurance systems present the necessity and standard in a company, their analysis and effectiveness assessment have even greater meaning. Reparation activities conducted in the company will not bring positive changes and results if the quality system effectiveness assessment does not present correct estimation and diagnosis of the real quality system. The quality system effectiveness assessment is necessary for identification of the differences between the real quality system and the planned one (BORKOWSKI S. et al. 2007)

The assessment system of the quality system effectiveness consists of the following systems: assessment system, diagnostic system, quality service, finance service, analytical centre and operational results use system (ŠUJANOVÁ J. et al. 2005).

The system using assessment results initiates the assessment procedure, it formulates estimation problems for the diagnostic system. Elaboration of the estimation characteristics corresponding to the estimation problem presents the aim of the diagnostic system. The system using assessment results based on the conducted quality system effectiveness estimation precedes making a decision about implementing changes in the estimation system (LESTYÁNSZKA ŠKŮRKOVÁ K. et al. 2011) . The structure of the assessment system of the quality system effectiveness in a casting foundry is shown in Fig.1.

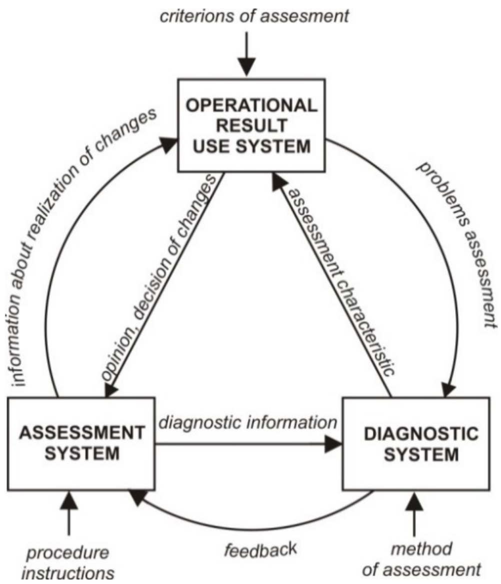

Fig. 1. Structure of the assessment system

In technological criterion the following features can be taken into consideration: the required measurement of tolerance value, the required hardness or roughness value, the required process scatter coefficient or process centring values, admissible parts of the products. In economic criterion: the assumed values of internal or external product fault costs. Operational criterion may include the required reliability or durability level and the required product maintainability value.

The examples of the estimation criteria of the quality assurance system efficiency in chosen stages of the realization of cast were introduced in Fig. 2.

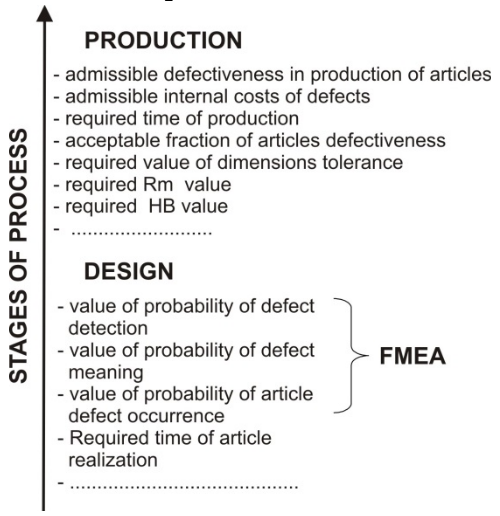

Fig. 2. Chosen estimation criterion for the estimation of the quality system efficiency

2. Assessment methods of systems

Among many other methods cost account and statistical methods seem to be particularly effective. Thanks to statistical methods the use of the estimation period is shortened and estimation results reliability is obtained. In the case of mass and numerous populations statistical methods are the only admissible effectiveness estimation methods. Quality system effectiveness estimation methods at the production stage are cost account, seven QC tools, investigated measurable characteristic trial methods (KONSTANCIAK M. et al. 2011). Effectiveness estimation methods can be used at particular stages of casting form production, beginning from marketing through the project, purchase and delivery production stage to the operation stage, where reliability investigation methods can be used In the investigations two criteria were used: economic criterion, costs of defects and incompatibilities of produced casting articles (serial and individual) and they were referred to assumed acceptable level. In the technological criterion using $\bar{x}$-R and $\bar{x}$-s cards (LESTYÁNSZKA ŠKŮRKOVÁ, K. 2012) three most essential features: meeting dimension tolerance, strength properties Rm and hardness HB were considered. In the selection of methods as well as prameters of estimation it is essential that estimation allows achievement of credible results.

3. Estimation of Quality System Effectiveness

On the basis of iron foundry data, the effectiveness of the quality system in relation to the costs of casts incompatibilities in the period of 6 years was evaluated. The cumulated costs of casts incompatibilities R(t) were adopted as an assesment characteristic and the anticipated permissible incompatibilities costs P(t) were adopted as an evaluation criterion. This analysis showed that up to the third year, the quality system of the iron foundry had been ineffective $R(t) - P(t) > 0$. Since then, the foundry has been implementing new procedures and new solutions in quality management. It has contributed to reaching the state where the anticipated incompatibilities costs turned out to be higher than the actual ones $R(t) - P(t) \leq 0$. Since the third year, the value of the adopted price characteristics of the effectiveness of the quality system has been contained in the effectiveness area. The effectiveness evaluation of the quality system is necessary and indispensable in order to improve companies and adjust them to a competitive struggle on the market. In the fifth year, big investments were made in the company. They were connected with extending the assortment from the produced casts to precision castings for the motor industry. New machines and technologies were purchased, which, in turn, had a big influence on the process of destabilization at the initial stage. The cumulated incompatibility costs, mainly internal, and external in a smaller degree (warranty repairs), definitely exceeded the anticipated incompatibility costs. The data used for the analysis has been shown in Table 1. The analysis has been presented graphically in Fig. 3.

Table 1. Iron foundry data

Coast% / Year	Delivery faults	Internal faults	Guarantied repairs	Faults cumulated costs	Faults planned costs
1	0.70	0.20	0.60	1.50	0.90
2	0.65	0.17	0.65	1.47	0.80
3	0.26	0.14	0.28	0.68	0.70
4	0.20	0.08	0.20	0.48	0.60
5	0.50	0.40	0.30	1.20	0.50
6	0.20	0.02	0.20	0.42	0.40

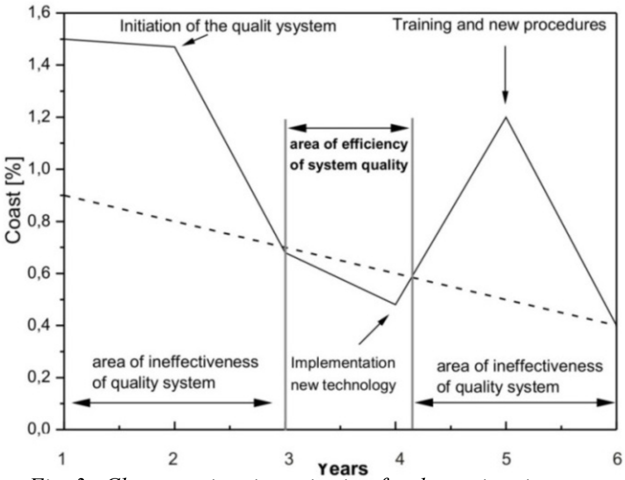

Fig. 3. Chosen estimation criterion for the estimation of the quality system efficiency

4. Conclusions

The aim of this article was to identify effects of implemented quality management system and assessment of its functioning in the foundry. The research problem is not new, visionary, but it is not fully tested, either. In 2000 there came into being standardized quality management systems that were developed by the International Organization for Standardization (ISO - International Standard Organization) which is a worldwide federation of national standards organizations. To this day, there have been introduced updates and new standards specifying a new standard constituting model to ensure the ability to meet quality requirements and increase customer satisfaction in business-to-client. Effective quality management system is one that provides tangible results of introduced changes while increasing the value of the organization. In the considered company, the most important obtained effects indicated by entrepreneurs are: improving the quality of offered castings, better work organization and effective management of the enterprise, as illustrated in Figure 4.

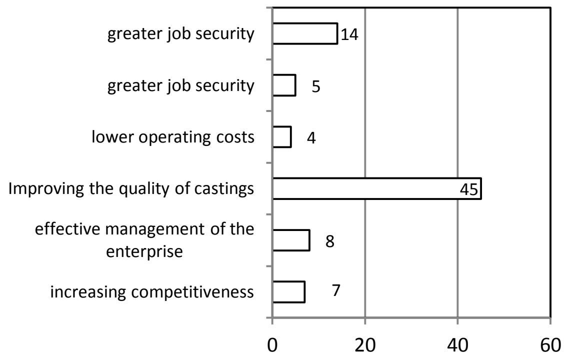

Fig. 4. The effects of the implementation of the quality management system

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ABSTRACTS:

S. Borkowski

The Toyotarity and BOST term was presented in the chapter. The BOST method allows to define relations between material resources and human resources and between human resources and human resources (TOYOTARITY). This term was also invented by the Author (and is legally protected). The idea of methodology is an outcome of 12 years of work.

O. Bokůvka, T. Liptáková, P. Palček, M. Chalupová, L. Trško

The quality of welded joint is an assumption of long-term reliability in operation. On the contrary, defective work of bad quality welded joint leads to fracture and crashes of plants. In this paper the authors state that experimentally obtained causes of rails and pipes fractures were the result of bad realization of welded joint. Pores, blowholes, slags, lack of fusion, non-plastic non-metallic particles, cracks, shrink holes were the defects observed in the welded joint area. These defects substantially decreased the load-bearing cross section and the final result was fracture. The railway and high-pressure gas lines out of operation are undesirable and accompanied by considerable financial losses.

J. Rosak-Szyrocka

The paper uses an innovative research methodology - BOST questionnaire. Based on the questionnaire, two Toyota's principles were evaluated. These were E2 and E2 areas. According to the results it is possible to state that the most important factors for workers are the following: customer's good (DK), followed by product innovativeness (IP), independence and accountability of employees (SP), formation of products stockpile (PZ), cooperation with partners (WK), technology development (RT) and corporate culture care (PR).

J. Selejdak

In the paper there were described the elements of the Toyota roof. Electroacoustic products were characterized. Immaterial resources of the company were analyzed. To do so, the BOST survey, whose questionnaires were filled in by employees of the chosen enterprise, was used. Particular attention was paid to the following factors: quality, costs, lead time, work safety and personnel morale.

P. Sygut

The aim of the study was to identify the problems and improve the production of cement in a ball mill in terms of technology and management associated with the use of known methods and techniques to improve quality. A detailed analysis helped to explain the process which affects the efficiency of grinding cement and which is the most common cause of disturbance and incompatibilities in the process of milling, how the production process is managed and controlled in order to obtain the required grain size, which is the main parameter influencing the quality of the manufactured product. To manage the change of the process there has been used a value stream map for analysis of the intermediate process of cement production, transport to the silos, bagging and selling. Based on the research some proposals of the process improvement have been designed that might have a chance of implementation and execution.

M. Krynke, K. Mielczarek

In this chapter there were presented the characteristics of the research object (cement mill) and the description of the enterprise products. There was introduced an analysis of the results obtained on the basis of the BOST questionnaire survey and there was made a statistical analysis concerning principle 4 of the Toyota. The structure of evaluation was determined and importance series were built.

Z. Kovačević, Z. Karastojković, V. Aleksić

Testing of materials properties is usually a discipline for the quality assurance during manufacturing processes. In condition monitoring, certification or upgrading of existing plants and in failure analysis similar benefits from non- destructive testing of materials properties can be achieved. Another benefit from the Non-Destructive Metallography (NDM) is that the test can be made on-site. NDM is a well established and proven tool to help determine the integrity of generator and hydro turbine components during their life-cycle in power plant environments. On-site metallography of components makes it possible to evaluate the microstructure of materials. It allows microstructural analysis of large components that are difficult to move or not permitted to be destructively tested, enabling rapid evaluation of the material. Here are monitored the microstructural changes and crack detection in St 35 connecting rod steel after approximately 15 years in service. The paper includes a short description of the replica method as a technique for microstructural examination of components by using non-destructive testing method.

S. Borkowski, K. Knop

This article presents a theoretical basis for one type of control in enterprises – visual control. It presents the meaning of visual control in the Toyota Production System and BOST researches as a tool of measure, among other things, the importance of visual control in production companies. The level of importance of visual control usage as one of the production process elements in the analysed company was indicated. The usage of visual control is a main factor in a production process of the analyzed company, the factor which provides continuous help to employees to check whether the process differs from the standard. The characteristic progression of production process elements was indicated and the SW factor (the use of visual control) took the third place, PE factor (interruption of production when it detects a problem of quality) turned out to be the most important one, while the least important was the EU factor (granting power of attorney down). The main tools for this evaluation : an innovative BOST survey - Toyota's management principles in questions, in particular, the Pareto-Lorenz diagram, radar graph and series of importance as graphical interpretation tools, were used to present the importance of each factor in relation to individual assessments.

K. Lestyánszka Škůrková

This article deals with the statistics pursing the process capability of turning in screws production in RIBE Slovakia, k.s. In technical practice, an important group of statistic methods is formed by analyzing qualification of measures, production equipment and qualification of process. By the term “process qualification“ we mean the ability of the process to observe required technical parameters by required value and tolerance limits. Findings of the process capability can be isolated in the estimate process capability (before starting the production) and permanent process capability. Also, we have finished the quest for the process capability where the indexes C_p and C_{pk} are bigger than the determined value of 1.33 points.

R. Ulewicz, M. Mazur

Guarantee of quality and safety exploitation of machines and equipment is a significant factor in the design and manufacture of these components. This paper presents an analysis of fatigue test results of samples in the bending load on the rotation in the range from 10^4 to 10^7 ,the number of cycles of applied load, with a frequency of 40 Hz. Whöler curve shows the results of the fatigue properties of steel S355J2 which is used in the construction of vehicles. There was also carried out a fractographic analysis.

Y. Šurinová, K. Lestyánszka Škůrková

Quality management systems (QMS) in the automotive industry have several differences in comparison with other industrial factories. Each customer has his own specific requirements, the so-called CSRs (Customer Specific Requirements). Audits are one of the core-tools of quality management to make the PDCA cycle work. It is clear that compliance to ISO/TS 16949:2009 requirements is a condition for supplying the automotive industry. But there are some standards which co-exist together with the official ISO9001 Q-management systems standards and technical specification ISO/TS16949. What are those specific standards in the automotive industry and which standard should be used and why – those are the questions to be answered in this article.

R. Ulewicz

This paper presents the results of six-year studies that were conducted in an iron foundry. The research consisted in effectiveness assessment of the quality assurance system. Determinants of three groups of estimation criteria were characterized. In technological criterion the required values of dimensional tolerance, the value of required hardness, raggedness, the required values of coefficients of the scattering process and also acceptable fractions of the products were taken into consideration. The economic criteria included the assumed values of internal and external costs of product defects. The exploitation criteria comprised the required level of reliability or durability and the required value of products repairability. The obtained results point to too high costs of lacks in technological criteria. The undertakings were proposed in order to decrease them.

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