Use of Quality Management to Optimize Foundry Industry Processes

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Abstract: This work deals with the improvement of selected manufacturing processes in the finishing activities of the foundry and the solution to a specific problem involving the bottleneck in the blasting area. The aim of this article is to improve the selected blasting and handling processes. In the practical part, the current status of the finishing operation, by using process analysis, is determined and proposed herein is the approach to improve the process. In the project section, industrial methods were used, such as, workshops and brainstorming. By synthesis of the outputs from the analysis and workshops we have elaborated a catalog for the improvement of the blasting process in the following sections, including the handling process. This work includes a proposal for the technical adjustment of the blasting equipment, which leads to an increase in the efficiency of the entire production process.

Keywords: shot-blasting; efficiency; improving; performance; workshop; process; process analysis; DMAIC

1 Introduction

Quality Management and related improvements became the common part of management, with a strategic approach, for many small and large corporations. With regard to growing competition businesses are now in a situation where they must continuously search new ways of working efficiency, as well as, capital and technology development. Managers are systematically examining existing process behaviors, their experience is often reflected in proposals for changes and improvements that provide substantial advantages, client gratification, increased market share and improved economy inside the Corporation.

The aim of this work is to optimize the shot-blasting process within the foundry industry. The reality is that in many Czech and Slovak foundries there are many occasions to improve this process. Stockpiled parts between work operations and a high level of semi-finished components will illustrate the magnitude of any improvement. Detailed analysis of processes and the use of human resource, together with synergistic effects, can lead to the solution of specific problems, improved competitiveness and better economic results for the company.

After the analysis of the foundries existing processes, the shot-blasting sector was selected, with its necessary portion of manipulation, with castings. Developed and implemented was a project, separated, according to the DMAIC method, which aims to improve the shot-blasting and manipulation. To reach such a target, workshops and brainstorming tools were used, that lead to the needed changes in the production processes.

2 Literature Review

2.1 Quality Management

Valuable management is, above all, the effort for continuous improvement, resulting in more efficient processes and consequently, in lower costs and higher productivity. It is a broad topic, containing nearly all corporate processes. (Weske, Mathias 2007)

Total Quality Management (TQM), can be defined as a holistic management philosophy that strives for continuous improvement, in all functions of an organization, and it can be achieved only if the total quality concept is utilized, from the acquisition of resources, to the customer service and after the sale (Kaynak, 2003). Both manufacturing and service firms can successfully adopt TQM (Claver-Cortés et al., 2008). TQM-adopting firms obtain a competitive advantage over firms that do not adopt TQM. Firms that focus on continuous improvement, involve and motivate employees to achieve quality output and focus on satisfying customer needs, are more likely to outperform firms that do not have this focus (Joiner, 2007).

Many authors have suggested that TQM practices can have a positive impact on a firms operations, including customer satisfaction (Choi and Eboch, 1998), innovation (Hung et al., 2011; Prajogo and Sohal, 2004), manufacturing (Cua et al., 2001; Konecny and Thun, 2011), financial results (Hendricks and Singhal, 2001; York and Miree, 2004), operations (Yunis et al., 2013) and quality (Arumugam et al., 2008; Prajogo, 2005; Prajogo and Sohal, 2006a). Also, some studies have adopted a mix of firms outcomes, as organizational performance, in their investigations of TQM′s positive effects (e.g., Brah and Lim, 2006; Kannan and Tan, 2005; Kumar et al., 2009; Martínez-Costa et al., 2008; Pinho, 2008; Rahman and Bullock, 2005; Samson and Terziovski, 1999; Valmohammadi, 2011; Wang et al., 2012).

Nowadays, as competition increases and radical changes occur in the business world, there is a need to better understand the term “Quality” (Psomas & Jaca, 2016). Understanding clearly, this term, from a business perspective, is fundamental for companies to be successful and become profitability leaders in the new global economy (Antony, 2013). More specifically, top managers should understand and apply quality philosophies to achieve high performance levels, in products and processes and to face the challenges of global competition. A leading force in shaping and spreading quality management ideology and practices, in modern business management, is Total Quality Management (TQM). TQM has been recognized as providing a competitive advantage for an organization’s success, since the 1980s (Boateng-Okrah and Fening, 2012). The credibility of the TQM philosophy is no longer an issue and cannot be questioned, since it has been demonstrated in various countries around the world, that competitive advantages and performance benefits can be created and sustained, through the adoption of the TQM (Zairi, 2013). More specifically, the trend of TQM, is strong in Europe, Japan, USA, Australia and elsewhere (Lam et al., 2012; Brown, 2013).

It is known that TQM is based on Process Management. (Řepa 2012). First introduced by Deming (1986), process management was quickly popularized as a central element of quality management. Since its original introduction, process management has evolved into more modern forms, including ISO 9000 and Six Sigma (Ciencala, 2011). Many organizations have adopted the practice of process management to improve quality and reduce costs. As the focus of process management practices turned to decreasing variation and increasing efficiency, its effects also affect a firm’s capacity for creativity.

Given the need for process management to be precise and consistent, it is frequently referred to as the reduction of epistemic uncertainty. Epistemic uncertainty is scientific ambiguity in a process (e.g., Six Sigma) model that can be reduced by obtaining relevant data to better understand the nature of the process itself (Kim, 2017). The DMAIC improvement cycle is the core tool used to drive Six Sigma projects. However, DMAIC is not exclusive to Six Sigma and can be used as the framework for other improvement applications (Gail, Erwin 2008).

Enterprises, nowadays, have complex information systems, that support decision making processes, at all management levels. Some information is stored in the companies’ computer systems, some is written e.g. in the form of processes’ description documents, and some of it is stored in the heads of the experienced staff (Svozilová, 2011). That is why enterprises search for a convenient and effective way to describe the rules that can support the decision making process. Today’s recommended solution is the use of business rules. Such approach has been successfully applied in customer relationship management, marketing, the mortgage industry, insurance services, e-government, telecommunications, engineering, transportation and manufacturing. Possessing a well-designed business rule management system can bring a competitive advantage not only for huge, globally operating enterprises, but also for small and medium manufactures (Boyer & Mili, 2011).

The topic of Quality management system in Foundry industry is pursued by scientists in Poland as well. The size and complexity of decision problems in production systems and their impact on the economic results of companies make it necessary to develop new methods of solving these problems. One of the latest methods of decision support is business rules management. This approach can be used for the quantitative and qualitative decision, among them to production management. Their study has shown that the concept of business rules BR can play at most a supporting role in manufacturing management, but alone cannot form a complete solution for **production management in foundries**. (Stawowy, Duda, & Wrona, 2016)

2.2 Foundry Processes Specifics

Foundry industry is using complicated, partial, often very different processes, with its own scientific background. Foundry is subject supplying casts mainly to the automotive, machinery and construction businesses to be processed further. It means, that it is the sector of secondary production, different from metallurgical, primary sector. Machinery castings are semi-products for machinery works, as well as forgings, pressed or molded parts. Metallurgical parts are tools for another sector of metallurgy, such as molds, slag pans, cylinders etc. The trend of casting use by industry still remains, but the share of their weight in final products is decreasing. Casts as semi-products for further processing are encountering competition. When they are not formed precisely, they are replaced with accurate forgings, ceramics, plastics and metallurgical powders. Since in this situation, it is important to optimize foundry processing, not only as a products sector but, as the one of processes themselves. (Chrást, 2006)

Actual threats for foundries are increasing prices in energy areas and other primary inputs. Another weak point is very high costs of materials. They are metallurgical batches, material for molds mix, and as the important material the abrasives, needed for foundry processes. To secure the future progress and increase foundries ability to compete, it is necessary to identify all kinds of wasting such as pointless operator trips, waiting time, needless manipulation and material losses. It seems rational, that foundry processes are researched by specialized experts and improving methods of industry engineering are applied. (Keřkovský, 2009)

2.3 Basic Characteristics of Foundry Processes

Production of foundry plants include two basic areas, foundry and polishing. Entering the processes are iron ingots and alloy additives. Great care is used to assure the input material quality. They are precisely dosed in each batch.

The material is melted in the foundry furnace and the sample is monitored prior to pouring the melted alloy into the mold. Mold mix is silica sand and furan resins.

Melted metal is poured into closed molds. After the castings are cooled, they are placed on a vibrating grate and the molds are then broken. In this way, partial sand cleaning is performed, the sand is transported to the recovery process. After the cast is cleaned, the material is heat-treated according to its type.

After this production procedures, castings are cleaned from sand completely, inspected, repaired and prepared for shipment. This part of foundry production is polishing. There the castings are shot-blasted, removing the remains of the sand, using blasting machines.

Casts are then separated from the inlet system and overflows. According to the type of cast, either burning with a carbon electrode or chop saw is used in this step.

After that, the cast is surface ground/milled and a capillary test is performed, indicating the compactness. When defects in compactness are detected, the critical point is ground and repaired by welding, ground again. If there are no other compactness defects indicated, casts are shot-blasted further.

Shot-blasting is unifying the surface structure and reinforcing it, as well. Final inspection then follows and the cast is washed or finish-blasted, according to the customers preference.

It is important to mention that the shot-blasting is often not, in the sphere of interest, by the management. It is a very dusty cleaning process, involving mechanically propelled abrasive particles, that are blasted toward the product. In the case of the Foundry, it is the propelling of steel or stainless steel balls using high velocity streaming machines toward a partially clean cast and thus, cleaning sand, controlling color and final surface unifications. The operation is accomplished using a special shot-blasting machine with blasting wheels and inside a closed chamber.

During the shot-blasting machine operation, there is no need for operator attendance and they can perform other activities. The machine, during operation, is working in a suction regime, but dust particles leak into the production area, spilling abrasives from the machine.

In past, this work was performed by less-qualified workers, with a minimum knowledge of processes, leading to high costs, low levels of production and a general lack of machine maintenance knowledge. (S+C Alfanametal s.r.o., 2016)

3 Research Methodology

The first part of this work is description of the method, formulating basic terms and development of a theoretical solution, for consequent analytical and project layout engaging the blasting process. The flow of one casting piece in polishing work, using process analysis was, therefore detailed. Then, the worker steps are analyzed, using an empirical method of industrial engineering, workday snapshot. To specify external and internal activities the SMED analysis was employed. The peak of the worker movement around the place of work, is highlighted by the Spaghetti Diagram. The 5S Mini-audit, functioned as a tool to discover the status of the shot-blasting procedure to be improved. Synthesizing the above analysis led to the data for developing improvement of foundry processes. Here the workshop method was used, where brainstorming is applied, the output, being the catalog of measures. Based on this catalog, the elaborate timetable of the shot-blasting process optimization using the DMAIC method, is prepared.

DMAIC, a cycle to improve, is a universally useable method, of its gradual development, an integral part of the Six Sigma method. It is used for any type of improvement, for example for quality of services, processes, applications and data. The individual phase of a complete cycle helps to achieve the real improvement. It is the perfected PDCA cycle. (Marques, Alexandre de Albuquerque & Matth, 2017)

Phases of the DMAIC cycle are:

D (Define)	Goals are defined, the object is described and goals of improvement services, processes, applications, data, etc.
M (Measure)	Measuring the initial conditions according to the principle “What I cannot measure, I cannot manage”
A (Analyze)	Analysis of established facts, reasons for imperfection
I (Improve)	Key phase of the complete cycle, where the improvement is realized, based on analyzed and measured facts.
C (Control)	Improved point is necessary to apply, manage and keep alive.

4 Solving the Problem

4.1 Definition of Addressed Problem

As previously explained, that the castings cleaning procedure is an important operation in the foundry and is where the weak point is found. The workplace is part of the polishing unit and it contains two pendant sandblasting machines. One of them is used for cleaning iron-based products and the other is for stainless steel alloys, used by petrochemical industry. The actual situation often happens, when the semi-finished products are piled-up on two shot-blasting machine buffers. This works goal is to find the reasons of this situation and to propose possible solutions.

4.2 Process Analysis, Analysis of One Piece of Material Flow and Daily Snapshot

One piece of the material flow, through the polishing unit was recorded. As a sample, the cast of a U-shape was chosen, a typical product from the stainless steel class castings. Single stages were observed and recorded on the prepared blank document. The purpose of the analysis is to name each step of the given piece of material flow.

The daily snapshot was then composed after one day of observations in plant and recorded one shift period.

From one material flow record, it can be seen that, out of the total 10 operations performed on cast in polishing unit:

4 operations, totaling 100 minutes, were sandblasting

3 operations, totaling 185 minutes, in 4 workplaces, were grinding

The complete time for the operations on casting was 345 minutes, the total time of sandblasting is 100 minutes and is 29% of the complete time for all operations.

4.3 Shot-blasting Cost Measurement

The cost of the production process is a necessary consideration. Involved in the shotblasting process, are an operator of the blasting unit, the maintenance crew, machine operation and spare parts, energy, abrasive materials and waste treatment.

To compare and determine the correct steps, the total cost of the shot-blasting operation, during the time period, prior to 2018 changes, must be known. The volume of production in 2018 was 407 metric tons.

Each cost is presented, based on available SAP information system.

After the cost sandblasting analysis, the proportional indicator was calculated, “Cost of one-ton shotblasting during the given period of time”. This indicator will be used to compare with the following year. If the cost of one ton decreases in 2019, it corresponds to a savings. The total cost of such a savings can be calculated by multiplying the 1 ton saving figure and total production, during 2019.

An interesting figure from the cost analysis, is the share of abrasives costs and operator cost, on the total cost of the sandblasting operation, as seen on Fig. 1.

Table1
The cost of shotblasting process in 2018 (authors)

	Year	**2018**			
No.	**Item description**	**PCs**	**Cost/PCs (CZK/pc)**	**Total cost (CZK)**	**Shotblasting cost /1 ton CZK – 2018**
1	Operator-shot-blasting (hour.)	2.00	403200	806400	1981
2	Maintenance crew (hour) -	0.15	441600	66240	163
3	Machine operating parts (CZK)			240000	590
4	Spare parts (CZK)			115000	283
5	**Energy kW/h**	59.00	2,50	333645	820
6	**Abrasives (tons)**	13.50	96600	1304100	3204
7	**Waste (tons)**	15.00	0.60	9000	22
8	**Total cost**			**2874385**	**7062**
9	**Production in metric tons**	407.00			

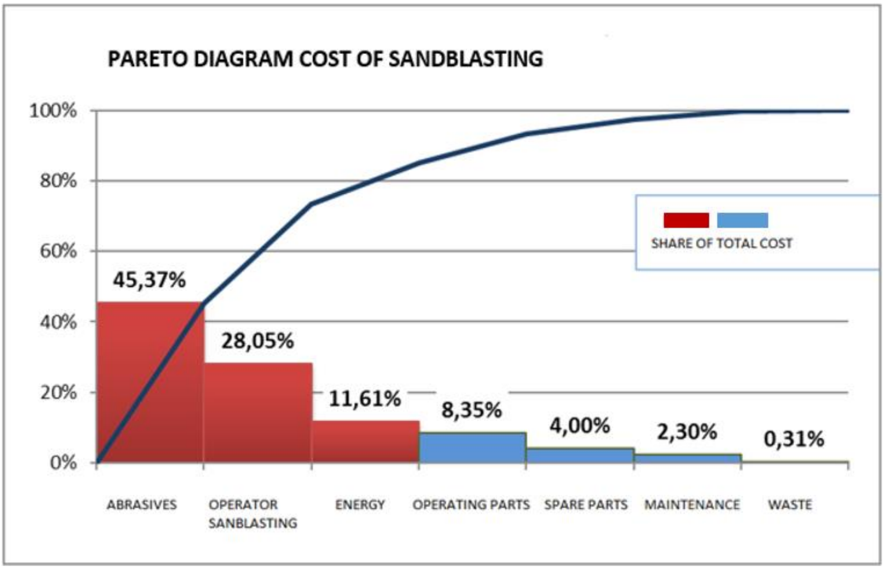

Figure 1
Pareto diagram, cost of sandblasting (authors)

4.4 Analysis of Measures Assessment

During the analysis, all processes in the polishing unit were assessed and then a more detailed breakdown of sandblasting operation of works on the Illingen C machine. This unit is becoming the weak point, of production procedure. As a result, the backlog of castings in front of the machine became the reality.

According to the research, using process analysis, it was confirmed, that the sandblasting process is essential for production and each casting must pass through it at least four times. Process analysis demonstrated, that the sandblasting operation is in comparison with the other polishing unit technology, under-proportioned.

1) From one piece of material flow record, it can be seen that out of the total 10 operations performed on cast in polishing unit,

   Four operations totaling 100 minutes were sandblasting and

   Three operations totaling 185 minutes in 4 workplaces of grinding.

2) Shot-blasting is the most full-occupied workplace of the polishing unit.

3) Complete time of operations on casting is 345 minutes; the total time of sandblasting is 100 minutes; it is 29% of all operations' complete time.

Shot-blasting is taking 29% of the time of all operations; it is thus, needed to concentrate just on this process and propose methods for improvement.

Analysis of workday snapshot shows that:

1) The most repeated operation during the sandblasting process is the manual transfer of castings. By hand, the operator is moving 1644 kilograms of iron.
2) The waste of time was mainly observed as the waiting for the machine. This time total length was 67 minutes, which is 20.69% of all observed period.
3) Excess worker's activities were observed as well and other limiting points:
    a) Manipulation with heavy castings using bridge crane, this operation taking 53 minutes at the Illingen C workplace.
4) Palette with abrasives is not stored within the machine reach, the operator must twice per shift walk 10 meters with the 25 kg bag of material.

From the cost of sandblasting research, it is clear, that the higher cost is for abrasives, with the 45.37% of all cost, a second is a cost of blasting machine operator wages. The least important item is the energy, with the 11.61% share of total operation cost.

4.5 Brainstorming as a Tool to Optimize the Analyzed Shortcomings

During the two-day workshop, a regulated brainstorming method was used, where with the attendees host each participant can express their opinion about the addressed problems of foundry production. Others then host, were present the officials of casting enterprise, (president, production manager, maintenance manager, economist.), representatives of the abrasive material supplier (technologist) and designer from cooperating engineering corporation. The conclusions of the brainstorming are followed by a catalog of actions (see Table 2).

Table 2

Catalog of actions (authors)

Who?	What?	Why?	Deadline	Output-Plan	Form
Technician WALUE	Machine status and used mix expert appraisal	To shorten blasting time	50th week of 2018	Expert report	Binder A4 pages
Designer, industrial	Project of machine	Preventing abrasives	2nd. Week of	Drawing document	Drawing A3

engineer and production manager	modification –cabin doors	leakage	2019	for cabin doors	
Designer	Project of blasting wheel positioning	To shorten blasting time from 15 to 12 minutes	2nd week of 2019	Drawing document for block of blasting wheels units	Drawing A3
Industrial engineer and economist	Calculating the savings after design changes	Investment decision	2nd week of 2019	Calculated costs, savings and payback period	A4 – presented to the executive manager
Industrial engineer	To secure live test	Live test of modifications within other enterprise where they were implemented	50th week of 2018	Live test with modified machine	Technical report and observed blasting times
Industrial engineer	Selection of suitable suppliers according to the machine design changes	Selection of suitable technology supplier to implement it	7week of 2019	Offers processed	Printed tab. A4
Executive manager	Contract with the blasting machine changes supplier	Project implementation	7th week of 2019	Valid contract	Print A4
Production manager, industrial engineer, supplier	Implementation of changes, planning of machine temporary shutdown	Increasing the machine efficiency, waste and machine shutdowns elimination	11th week of 2019	Modified machine	Project realized
Production manager, industrial engineer, maint. mgr.	Standards for blasting workplace and maintenance	Setting of Standards	12th week of 2019	Standard for blasting workplace	Print A4 – laminated

Maintenance manager and industrial engineer	Operators training	Increase of knowledge and higher productivity	12th week of 2019	Operators training performed	List of attendees with signature

4.6 Proposals for Blasting Operation and Manipulation Improvement

To follow-up the conclusions of brainstorming those steps were implemented:

1) Technical report about the blasting machine. Then test of blasting with other technological design conditions was performed (another type of abrasive material, different type of blasting wheel). Based on resulting analysis it was discovered, that the casting can be blasted for 10 minutes, instead of the previous 15 minutes, after the technological changes of blasting operation. Changes were implemented.
2) Operators training about the blasting machine and blasting process details
3) New standards for blasting workplace and maintenance were developed

4.7 Comparing the Costs Prior to Optimization and After

In this chapter, the costs are compared with those of 2018 with the same production condition. Growing production volume is causing the time of investment return to shortening.

Table 4
Costs prior to optimization (authors)

Costs of blasting operation in 2018

	Year	**2018**			
No.	**Cost description**	**No. of units**	**Price of 1 unit (CZK/unit)**	**Total cost CZK**	**Cost of blasting 1 ton in 2018**
1	Labor cost /1 hour (operator-blasting)	2.00	403200	806400	1981
2	Labor cost /1 hour(maintenance)	0.15	441600	66240	163
3	Operating parts (CZK)			240000	590
4	Spare parts (CZK)			115000	283
5	**Energy/kW/h**	59.00	2,50	333645	820
6	**Abrasives (tons)**	13.50	96600	1304100	3204
7	**Waste (tons)**	15.00	0.60	9000	22
8	**Total cost**			**2874385**	**7062**
9	**Output in tons**	407.00			

Table 5
Cost optimization (authors)

Costs of blasting operation in 2019

	Year	**2019**				
No.	**Cost description**	**No. of units**	**Price of 1 unit (CZK/unit)**	**Saving of blasting time 20%**	**Total cost (CZK)**	**Cost of blasting 1 ton in 2019**
1	Labor cost /1 hour (operator-blasting)	2.00	403200		806400	1981
2	Labor cost /1 hour(maintenance)	0.12	441600	13248	52992	130
3	Operating parts (CZK)		0	48000	192000	472
4	Spare parts (CZK)		0	23000	92000	226
5	**Energy/kW/h**	59.00	2,50	66729	266916	656
6	**Abrasives (tons)**	10.80	96600	260820	1043280	2563
7	**Waste (tons)**	10.40	0.60	1800	7200	18
8	**Total cost**				**2460788**	**6046**
9	**Output in tons**	407.00				

As can be seen in presented Tabs, the total expected savings will be achieved by the shorter time of blasting operations, it means the costs items, based on this process. They are items directly related to the wear by blasting operation. It is mainly wear of abrasive, operation parts, spare parts, energy, waste and time for maintenance.

One position not influenced will be the labor cost, blasting machine operator, the production must continue. When the production volume will increase, this position can bring the savings as well. Figure 2 demonstrates the results of savings:

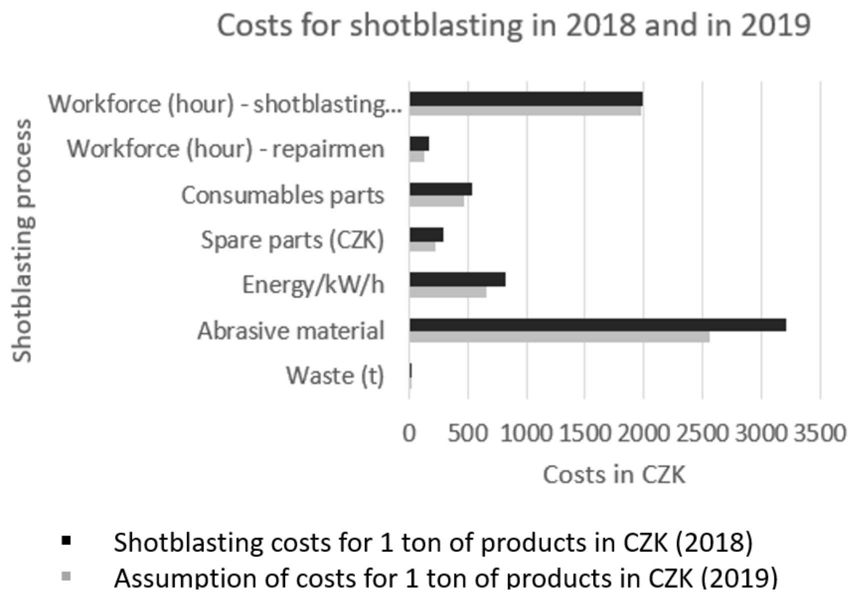

Figure 2
Cost prior to optimization and assumption of cost after (authors)

Total assumed saving when the production level will be the same is 413597 CZK. This figure after rounding - off means 1016 CZK saving on every ton produced.

4.8 Calculation of Project Payback Period

Assessing the project payback period requires to take into consideration all project expenses and calculate a rate of return.

Table 6
Project payback period (authors)

No.	Item	Cost in CZK
1	Workshop – defining the actual status and problem, measuring actual status, teamwork to analyze problem	8000
2	Developing technical report about the machine status-technical solution, expenses by (7000 CZK, Kovobrasiv)	7000
3	Testing by another enterprise, verification of solution	3500
4	Proposal of machine design changes	28000
5	Supplier inquiry	2000
6	Supplier selection	1000
7	Contract	1000

8	Implementing machine changes + cost of external shot-blasting	342000 22000
9	Trial operation	10000
10	Operators training	1600
11	Developing machine workplace and maintenance standards	500
Total costs		**426600**

Cost of project: 426600 CZK/16100 EUR

Savings on each ton: 1016 CZK / 39 EUR / ton

Return on investment/payback period:

$$\frac{\boldsymbol{Number\ of\ produced\ tons} \times \boldsymbol{Savings\ on\ each\ ton}}{\boldsymbol{Cost\ of\ the\ project}}$$

The result of this calculation are, keeping the actual production of 407 tons, as in 2018, the resultant payback period is about 1 year. The condition for a 2 year payback, is then accomplished.

4.9 New Processes Status

Calculating the payback period, the process analysis was rewritten and the times for the shot-blasting procedure were considered.

Improving the shot-blasting process total time of all operations is 329 minutes. With Illingen C machine the improvements, bring the reduction of shot-blasting time from 100 minutes to 84 minutes.

5 Discussion

This project was initiated following the foundry's request to solve the problem with castings pile-up, in front of the shot-blasting machine, Method DMAIC was used, at the beginning with the conversation was discovering the problem status. We were introduced to the production processes and specific shot-blasting operation in great detail.

After defining the problems, the authors measured and analyzed the actual status. Analysis results were the basis for the project formation. The project was defined in cooperation with the Enterprise Management team. The main goal of project was established leading as the improvement shot-blasting operation and manipulation, and the overall customer satisfaction improvement with the blasting of castings, prior to the expedition. This customer request was a narrow point in the production process.

After the status analysis and discovery of the best solution, the workshop format and time was selected. Risks from implementation were minimized, by involving qualified team members. During the workshop, a brainstorming method was used to select the appropriate solution. Output developed as a Catalog of actions.

Using the Catalog of actions, the timetable was made more precise. The calculation of cost savings from the project realization and implementation started. Each action was described according to the timetable.

Then the new process was developed, taking into consideration, expected time of shot-blasting. The total time of all operations was cut from 345 minutes to 329 minutes.

Time of one cast shot-blasting, in the production process, is now 84 minutes instead of the original, 100 minutes. Time of shot-blasting operation was thus shortened, by 16 minutes, which is an improvement of 16%.

Payback time calculation of the project is based on a negative scenario, involving non-increased production and savings coming just from the shortest time of shot-blasting.

Total cost of project:	426600 CZK / 16100 EUR
Project payback time:	1 year, if the production if not increased
Machine temporary shutdown:	Maximum 4 weeks

Conclusions

This work traces the shot-blasting and manipulation processes, occurring today, in foundries. The performed analysis and subsequent brainstorming, confirmed that those processes are in the production are underestimated. To improve the situation, it was necessary to become familiar with each part of the shot-blasting machine, castings flow and operator working procedures.

The work led to the solution for a narrow point in the production cycle, by demonstrating the need for investment in machine modifications, thus, creating the possibilities for savings and alerts concerning the time needed for castings loading and unloading.

The main contribution to the problem is the discovery of special production processes, in the foundry industry, with the larger space for improvement. It was then possible to help improving foundries economy.

Another significant discovery is that it is very difficult to find experts on the shot-blasting processes. Without detailed knowledge of the usual output of the shot-blasting machine, it is not possible to develop the technical changes and shorten the blasting process. Another alternative of project solution was the investment in a second machine. This leads to the increase of Enterprise Capital, an increase of costs and lower fiscal efficiency.

This work can be used as an example, for the Foundry Industry, for how to improve the shot-blasting processes. A continuation of this work could be the further development of methods and emerging technologies for the improvement the blasting process in foundries. To realize this, it is necessary to further research the Czech and Slovak foundries. The given issue is applicable in various industries including, forging, machinery, automobile and the energy industry, where the shot-blasting process is used.

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