POTENTIAL OF STRUCTURED PROBLEM SOLVING IN THE CONDITIONS OF METALLURGICAL INDUSTRY

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Abstract

All companies have to face a variety of everyday problems, regardless of the sector or particular focus of the organization. It also applies to enterprises in the metallurgical industry. Companies try to turn to the approaches of lean production in the hope of finding an easy and efficient solution of the issues occurring in manufacturing processes or other business areas. The effort to achieve reduction of wastes and cost savings often runs into a number of associated problems. The effectiveness of lean production methods used in practice depends on a wide range of factors, including the proper identification of the real problems, their description, detection of the current state, identification of potential and root causes, determination of the desired state and definition of ways to achieve it. Last but not least it depends on the choice of the right people, who will participate in the implementation of all these steps. Structured problem solving and application of lean production methods and tools should represent one of the basic skills of successful organization and its management. Mismanagement of these activities is often a source of unnecessary costs throughout the organization and can lead to fatal consequences, such as loss of a customer or customers. The article presents the potential of application of structured problem solving in enterprises engaged in steel production.

Keywords: Problem solving, lean approach, continual improvement

1. INTRODUCTION

The interest of enterprises to modernize the management systems, develop new products, restructure the processes and reduce the costs is permanent. This interest is also confirmed by annual listings of topics for master or doctoral theses in field of study such as mechanical technology or metallurgy.

In metallurgical secondary manufacturing, where the material is moulded by plastic deformation, it can concern metallurgical or mechanical engineering forming. In both cases, the enterprise engaged in the specific production needs appropriate tools, preparations or forms which must be produced, maintained and stored somewhere. A number of enterprises has therefore set up special departments or divisions, which are exclusively focused on these purposes - tool rooms, equipment rooms etc. For example the company Třinecké železárny a.s. and its subsidiary VÚHŽ a.s., which ranks among the modern enterprises producing machinery equipment for metallurgical plants and technological devices for secondary metallurgy.

The contribution presents the implementation of structured problem solving into the tool room department, the main tasks of which include the design of tools, templates, retractable technology and die casting moulds, the production of new tools, preparations and die casting moulds, the production of die casting moulds according to submitted documentation, repairs and maintenance of manufactured products.

2. METHODOLOGICAL BASE

A problem can be seen as an unsolved, debatable question which is to be solved; something which is difficult to solve. The basis of problem solving is a search for solutions, which are expected to provide us with satisfactory results with respect to the issue being solved, using appropriate methods and necessary available resources. Any problem can be grasped as a challenge. Successful problem solving will cause a positive change and improvement of its original state and condition. If we look at problems and their solutions from this

point of view, we will get into the area of improvement, where the generally recognized improvement methodologies can be used. If we look at each problem and its solution as something unique that must be resolved within a limited time and with the resources available, we can use project management methodology for the solution.

2.1. Basic methodology

Table 1 compares selected methodologies which can be used to solve problems in organizations [1, 2, 3, 4, 5]. The boundaries of particular approaches are not always strictly determined nor respected.

Table 1 Selected methodology

<table>
<tr><th>PDCA cycle</th><th>ISO 9004:2000
(nowadays invalid)</th><th>Six Sigma DMAIC</th><th>Global 8D</th><th>Project Management</th></tr>
<tr><td rowspan="3">Plan - establishment of the objectives of the system, its processes and needed resources</td><td>Identification of problem process (area) for improvement and reason for working on it</td><td>Define - definition a problem,
establishment of a team</td><td>Plan for solving the problem
Establishment of a team of people</td><td>Identification and development of opportunities</td></tr>
<tr><td>Description and evaluation of the current situation</td><td>Measure - establishment of current baselines as the basis for improvement</td><td>Description of the problem
Preliminary of protective measure</td><td rowspan="2">Feasibility evaluation, frameworks and specifications, starting points of the project
Choice of manager, establishment of a team of people
Development of project plans</td></tr>
<tr><td>Analysis - determination and verification of root causes</td><td>Analyze - identification, verification and selection of root causes</td><td>Determination and verification of root causes</td></tr>
<tr><td>Do - implementation of what was planned</td><td>Identification of possible solutions and implementation the best one</td><td rowspan="2">Improve - identification, testing and implementation of a solution of the problem
Comparison of the results with the initial conditions</td><td>Choice and verification of permanent corrections</td><td>Implementation - direct project work</td></tr>
<tr><td>Check - monitoring and measurement of processes and the resulting products and services according requirements, report of the results</td><td>Evaluation of effects</td><td>Implementation of permanent corrective actions</td><td>Controlling - control project work and all subject groups</td></tr>
<tr><td rowspan="2">Act -
taking actions to improve performance</td><td>Implementation and standardization of the new solution</td><td>Control - monitoring of the improvements, creating a control plan and standard procedures</td><td>Prevent recurrence of these and similar problems</td><td>Closing -closing of project phase or project, closure report</td></tr>
<tr><td>Evaluation of the effectiveness and efficiency of the process with the improvement action completed</td><td>Update documents, business process and training records, thank the team</td><td>Team recognition</td><td>Collecting of lessons learned</td></tr>
</table>

As the basis for problem solving approaches can be considered the Deming PDCA cycle, which is often associated with the production system in the Toyota company known as the Toyota Production System (TPS) developed after World War II. The TPS lean manufacturing, the lean enterprise actually, uses a wide range of techniques, tools and methods for its operation. Fujio Cho, the president of the TMC says that the application of the Toyota production system in other than manufacturing plants is possible, but it requires a certain amount of creativity [1].

Jeffrey K. Liker [1] presents that understanding and commitment of top management are crucial for the creation and effective utilization of own learning lean organization using the concept of Toyota. If the leadership does not want to commit to a long-term vision of providing added value to customers, the development of employees and partners and in case the long-term continuity of corporate culture is not ensured, it is preferable to use familiar tools for short-term improvement processes.

Improvement in organizations is also a requirement of standard Quality management systems - Requirements. „The organization shall determine and select opportunities for improvement and implementation of any necessary actions to meet customer requirements and enhance his satisfaction.“[6] The improvement can include breakthrough change or continual improvement, innovation, reorganization, but also correction or corrective action. We use corrections or corrective actions for solving different problems in organization [8].

Choice of the methodology used depends especially on the type of production, business area, supply chain continuity and company management [9, 10]. However, it is preferable to use processed standards for solutions in all cases. Standards can be prepared in various forms, e.g. as rules, regulations, guidelines or procedures, or characteristics of activities or their results. The significance of standard, its creation and use increase with the eventuality of the formation, range and intensity of negative impacts, as well as with the number of possibilities of its use. From this point of view, the use of standard for problem solving in the steel plants in the Czech Republic seems appropriate and desirable. The standard in the form of a 3A report has already proved useful in the context of the TPS and its lean manufacturing.

2.2. Structured problem solving

Structured problem solving uses open communication and concentrates on finding an effective solution, knowledge and skills of the specialists in the team. It transfers the co-responsibility for both long-term and operative problem solving in production to them. Shopfloor management is a key element in this process and provides the necessary interconnection of individual steps during the process of solution. Standard Problem Solving Template can be reused for each process of problem solving, see **Figure 1**.

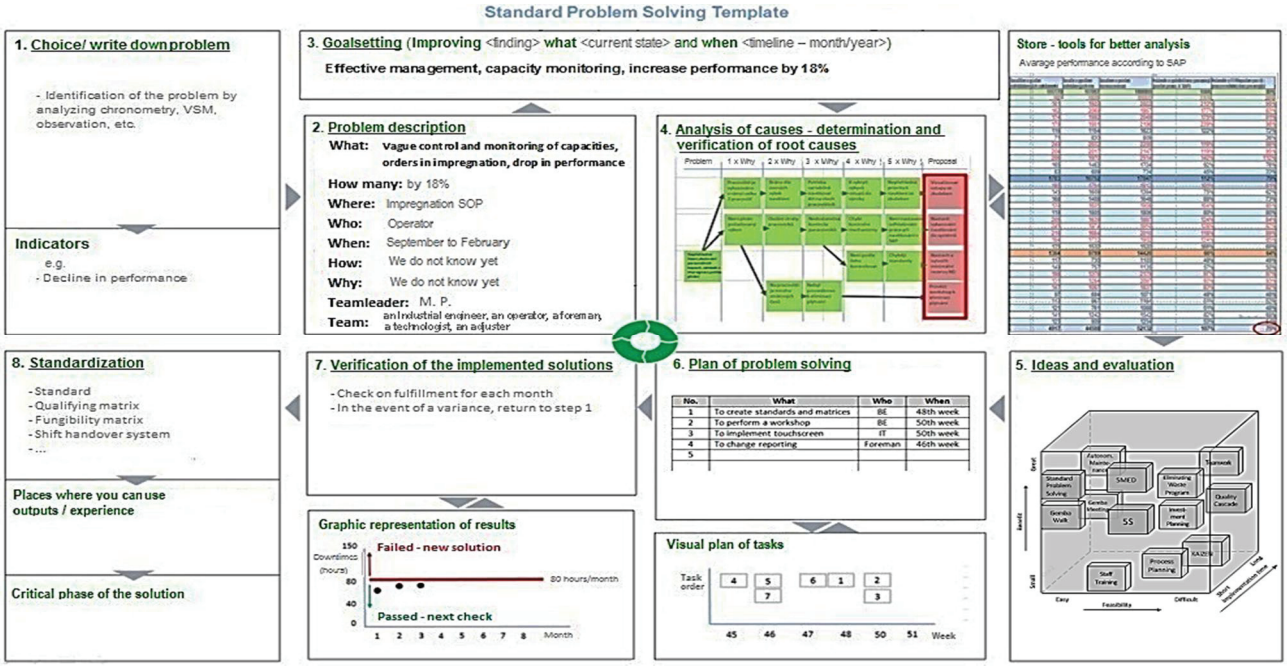

Figure 1 Standard Problem Solving Template

3. A CASE STUDY ON THE APPLICATION OF A STRUCTURED PROBLEM SOLVING

The contribution presents the use of visualized structured problem solving as a tool for elimination and problem solving on a practical example from a tool room. This Standard Problem Solving Template was used for the adjustment of tool used for the repair of stator lamination [7].

Structured, team problem solving can be summed up in a minimum of six basic points in **Figure 2**. All members of staff must get familiar with the methodology and rules of problem solving, e.g. at a briefing session. Practical examples can show them how to write down problems, where there are places with the forms, how to deal with recorded problems and where the feedback on the progress of the problem solving can be found.

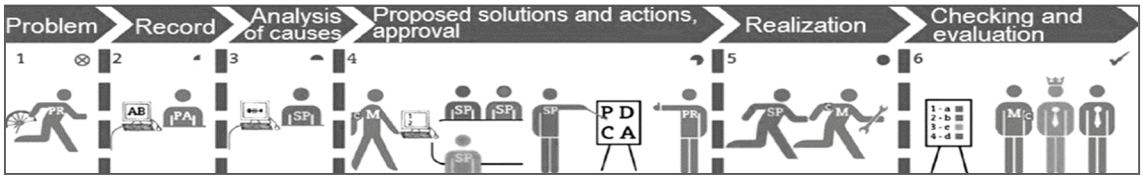

Figure 2 Six basic points of structured problem solving

1st point - Problem message reported by the employee

The employee reports the identified problem to the person in charge or writes it down to the form directly at the collection point (date and time when the problem occurred, detailed data such as order, account, or material number, description of the problem, legible signature of the problem reporter).

2nd point - Record of the problem into the database

The responsible employee enters the problem into the problem database and assigns it an ID number (production order, device type, problem type, priority). He determines the person responsible for the problem solving (e.g. by selecting from the catalogue where there are departments and persons suitable for problem solving in the particular area - specialists). He proposes the deadline till when the problem will be removed. The database is used for information transfer, request for a specialist, history of solved problems or detection of ineffectively solved, recurring problems. It is advisable to enter the complete documentation related to each problem there.

3rd point - Cause analysis

The employee responsible for the problem solving reads a problem assigned to him / her from the database, he / she provides it with available data, carries out an analysis using the four-phase method with the selection of the main causes and proposes measures to remove the problem. If he / she is not able to perform some of the tasks individually, they are carried out as part of a team meeting.

4th point - Proposed solution and measure, approval

Both presentation, defence of analyses and proposed solutions with measures for particular problems by responsible employees take place at a team meeting. During the presentation, remarks, comments and completion of the proposed solution are made within the team. Issues which could not be solved individually in advance are resolved within the teamwork. The problem-solving team carries out data collection, specification, analysis, root causes selection and proposes solutions and determines measures. In order to make the meetings effective, it is important to keep certain rules - the responsible staff is summoned by the discussion leader who opens the meeting, introduces the agenda and the sequence of particular problems. Responsible persons present individual problems and their solutions. The discussion is conducted by the discussion leader who enters data into the database and deals with other documentation. After the meeting, the discussion leader prints out the list of solved problems including the solution proposals and the assigned

implementation progress and displays the list in the workplaces. He / She writes down the feedback to the problem collection site. This is performed after each team meeting.

5th point - Realisation (implementation)

The implementation starts on the basis of approved proposals from the team meeting and it´s performed by an authorized employee. Partial implementation steps can be carried out by other departments. Coordinating and implementation control are provided by the discussion leader.

6th point - Check and evaluation

In order to make the whole problem solving process viable, it is necessary to have a set control of how the problems are dealt with. It can proceed e.g. by going through a list of problems item after item by the representative of the company management, with the participation of the foreman and the head of the department. The results are presented in the form of proposed solutions and implemented measures. The task of the company management representative is the check of the problem solving process, the check of the measures undertaken, strategic support, and pressure to accelerate the implemented steps.

The functionality check of the performed measures is also carried out by individual members of the staff who have reported the problem or who are affected by the problem. The comments and evaluation are recorded into the list of problems at the collection site. Checks can also be performed online by viewing the database. The following step can be the standardization of the determined solution, on condition that it is successful and effective.

The suitability of using a structured problem solving has been verified on the basis of the problem solving of an unsatisfactory moulding dimension with coaxiality out of tolerance.

After setting the measures, the proposed solution based on root causes was assigned to the action plan, where the implementation deadline and the responsible persons were determined. The following **Table 2** summarizes the individual steps including the results of the implementation.

Table 2 Application of A3 Problem solving

A3 – Problem solving Subject matter: **Poor-quality laminations from the tool 1XX1xx-4-1**

1. Choice/ write down problem

Inconvenient dimensions of the moulding, see the protocol

Coaxiality out of tolerance, Outer diameter

The tool has pressed circa 2 million mouldings

The tool producer is

Name of the part:	Stator plate	Tool number:	T 243
Number of drawing:	5_x78_xxx00_40_00x	Number of material type:	1LE1xxx-1XX
Production order:	243	Number of measurement:	3
Operator's names:	Vybrany	Departments:	M160
Measuring device:	MS 422	Date:	16. 9. 2014 12:44

Name	Sign [Unit]	Value	Nominal size	Upper tolerance	Lower tolerance	Deviation	Evaluation
Inner diameter	D_i [mm]	180,064	180,000	0,063	0,000	0,064	0,001
Circularity - inner	C_i [mm]	0,039	0,000	0,050	0,000	0,039	****
Outer diameter	D_o [mm]	295,570	295,500	0,060	-0,020	0,070	0,010
Circularity – outer	C_o [mm]	0,137	0,000	0,050	0,000	0,137	0,087
Coaxiality	Co [mm]	0,221	0,000	0,150	0,000	0,221	0,071

2. Goal

To achieve the required dimensions of the stator laminations by adjusting the tool.

3. Analysis of causes

1. Possible position change of the side punches – wear of supporting surfaces.
2. The effect of the processed material.
3. Tool damage, deformation of individual parts
4. Damage of the viewfinder or poor adjustment of the viewfinder.

4. Proposed solution

To check the individual causes of possible mistakes in the tool
There is probably a mistake in the tool's step.

5. Action plan

1. Check and adjustment of the viewfinder – done – pressing 17.9.14 – unsatisfactory
2. Check of the lower tool part 18.9.14 ok, deviation to 0,01mm
3. Pressing 19.9.14 unsatisfactory moulding again
4. Check of the upper tool part – wiper damage detected (deformation), damage of the support line, viewfinder cases out of position
5. Test pressing after the tool was adjusted occurred 24.9.14 - coaxial dimensions satisfactory

Coaxiality	Co [mm]	0,059	0,000	0,150	0,000	0,059	****

6. Verification of effectiveness / Standardization

To increase attention during tool maintenance with regard to wiper damage. Viewfinder cases are not guided in the lower tool part. When pressing, the lamination can be moved away from the required position and this can cause subsequent errors in coaxiality of the mouldings.

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4. CONCLUSION

The achieved results demonstrate that the methods of lean manufacturing and structured problem solving can also be successfully implemented into support operations, e.g. tool rooms, i.e. those which do not have the character of serial or mass production. The functionality of this process has been proved.

The standardization of individual steps can also be applied for solving different, existing or potential problems in the organization.

The implementation in practice has shown that the management support is crucial for successful problem solving. Transfer of shopfloor meetings with the participation of management which is more closely connected with the production and its daily problems brings instant feedback, reaction to the development of determined indicators.

Using the Standard Problem Solving Template for the problem solving and its visualization have obviously brought positive results with an impact on the cost, time and efficiency of the production process.

The evaluation concludes that lean manufacturing, especially Structured Problem Solving, Gemba Walk and Gemba Meeting which were processed and implemented are viable and sustainable in time. Among the benefits, there is the employees´ belief that the introduction of lean manufacturing is possible and purposeful even in piece and professional production, such as tool room.

Structured problem solving together with other lean manufacturing tools and approaches can contribute to the improvement of effectiveness and quality both in the production and in providing of services and therefore to the competitiveness of the company.

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