International Journal for Quality Research 9(3) 481–494
ISSN 1800-6450

Artemy Varshapetian[1]
Elena Semenova

ASPECTS OF INTEGRATION MANAGEMENT METHODS

Article info:
Received 11.05.2015
Accepted 23.07.2015

UDC – 332.05

Abstract: *For manufacturing companies to succeed in today's unstable economic environment, it is necessary to restructure the main components of its activities: designing innovative product, production using modern reconfigurable manufacturing systems, a business model that takes into account the global strategy and management methods using modern management models and tools.*
The first three components are discussed in numerous publications, for example,(Koren, 2010) and is therefore not considered in the article. A large number of publications devoted to the methods and tools of production management, for example (Halevi, 2007).

On the basis of what was said in the article discusses the possibility of the integration of only three methods have received in recent years, the most widely used, namely: Six Sigma method - SS (George et al., 2005) and supplements its-Design for six sigma –DFSS (Taguchi, 2003); Lean production transformed with the development to the "Lean management" and further to the "Lean thinking" – Lean (Hirano et al., 2006); Theory of Constraints, developed E.Goldratt – TOC (Dettmer, 2001).
The article investigates some aspects of this integration: applications in diverse fields, positive features, changes in management structure, etc.

Keywords: *quality, lifecycle quality, operation quality*

1. Introduction

Currently, there are a large number of vehicles (methods, techniques, tools) project management of various natures, ranging from production to social programs. Due to the fact, that in today's rapidly changing and stochastics world are increasingly used methods of situational control, some tools have lost their relevance and are not used. For example, if the situational management is hardly applicable Gantt chart, since the behavior of the system depends on the random situation, the appearance of which has been not scheduled in the diagram

The article discusses the use of management practices in relation to production problems. After analyzing a large number of publications devoted to the problems of management, all of the methods and tools of management can be divided into the following groups:

- Technological solutions that require the use of information technology,

[1] Corresponding author: Artemy Varshapetian
email: vagbnm@gmail.com

- Traditional methods of organization and management of production processes,
- New methods of management, taking into account the peculiarities of modern production.

Below we consider some of the most used methods that belong to the third group of conventional classification. These methods will include: - Six Sigma / Design for Six Sigma- SS/DFSS; Lean production -LEAN and Theory of Constraints- TOC. This choice is understandable, since in recent years increasingly used integrated version of these methods.

Recently released standard (ISO/IEC 13053, 2011), which is the first in a series of documents on quantitative methods in process improvement. The appearance of this standard should certainly play a positive role and benefit management practices.

2. A brief description of methods

2.1. Six Sigma and Design for Six Sigma

History of SS began in 1979 in Motorola (USA), after realizing the senior management of low quality products company. As a result, the company's management began work came to the paradoxical conclusion, that the production of high quality products cheaper than Medium.

Motorola while spending 5 to 10% of their income just to correct the low quality products. So Motorola launched its campaign for quality improvement. At the same time there was a work to reduce production time and costs on him. As a result, found an association between higher quality and lower costs, which led to the development of the concept SS (Table 1).

What is the difference between the previous approach and a new concept. Before emphasis on improving individual operations not related to each other processes. Motorola proposed SS program focuses on improving all the operations included in the process. This allows you to get a much faster and more effective results.

Table 1. A comparison of conventional mass production and SS

Denomination	The traditional approach	SS
Indicator	Failure rate	σ
Data	Discrete data	Discrete + continuous data
Target	Production requirements	Customer Satisfaction
Limit	Specified tolerances	Reducing the variation
Method	Experience + Skills	Experience + skills + statistics
Action	From start to finish	From back to front
Application	The production process	All stages of the life cycle

Introducing SS, the company has just over four years has saved $ 2.2 billion. In 1988, Motorola won a national award in the USA quality. Largely due to the application of the concept of Six Sigma company managed to regain the lead in the market of communication in the United States, displacing Japanese competitors.
In the development of the concept of Six Sigma famous cycle Shewhart - Deming transformed into a cycle MAIC: Measure ; Analyze; Improve; Control. In the mid-90s added Define- stage led to the emergence of a common sequence of steps DMAIC.

Further consideration of the development of ideas SS hardly appropriate in this article, since there are a large number of publications to which the reader is referred, for example (George *et al*., 2005; Zutshi and Sohal, 2005; Yang and El-Haik, 2009).

Design for Six Sigma -DFSS originated in the late 90s and jointly BMG (Breakthrow Management Group) and ASI (American Supplier Institute) starts to move in the same side of decision-making, as traditional SS . Pioneers in the creation of the method were Shin Taguchi (son of the famous author of the method of robust design Taguchi) and David Silverstein (Taguchi, 2003). Among the recent publications should be noted monograph (Yang and El-Haik, 2009), entirely devoted to the ideas of DFSS and methods for effectively implement them, in particular the axiomatic design and modernized ideas of TRIZ. In the book the authors (Antohina *et al.*, 2013), considered DFSS algorithm and examples of using this method in practice. DFSS helps to improve the design process, making it faster, cheaper and more effective. All this leads to the realization that DFSS becomes necessary, and subsequently required for use in various spheres of human activity. On Figure 1 formalized presentation on the role of SS and DFSS at different stages of the life cycle is given.

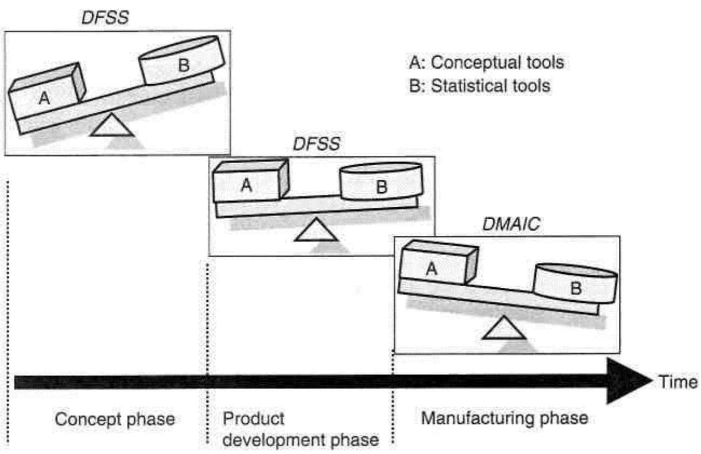

Figure 1. Typical life history of a complex product

Solving problems DFSS is to implement four consecutive stages techniques ICOV (Yang and El-Haik, 2009):

- I - Determine requirements (Identify),
- II - Creation of development (Characterize),
- III - Optimization of development (Optimize),
- IV - Verification of development (Verify).

The sequence of these steps and tools they used is shown in Figure 2.

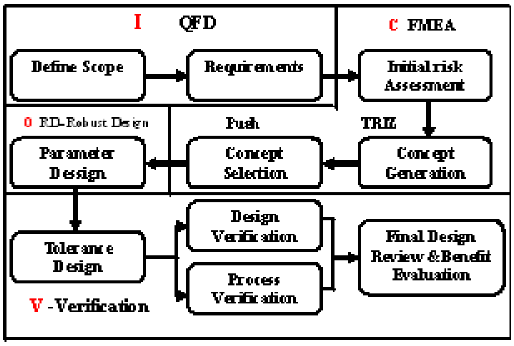

Figure 2. The sequence of steps ICOV

Comparison of methods of DMAIC and ICOV given in Table 2.

Table 2. DMAIC and ICOV comparations

DFSS- **ICOV**	SS - **DMAIC**
Used to develop or modify the process from scratch	Used to correct and improve existing processes
Stages / phases can vary considerably, depending on the company, consultant or training group	Stages / phases are clearly defined and widely accepted
A number of methods selected based on the needs of the enterprise or industry	A common methodology, with minor deviations or absence of abnormalities

Based on Figure 1 and Table 2, the following conclusions colud be drow:

- Traditional Six Sigma is easy to replicate from one company to another with little or no customization at the beginning;
- DFSS is different. There is much greater degree of customization required based on the specifics of the industry, the company, and the design itself;
- DFSS focuses on the phase of the study, design and development of new products and processes in accordance with the basic principles of Six Sigma, while SS focuses on the production phase. Figuratively speaking, the DFSS approach aims to "make a new process," while the DMAIC approach aims to "fix" the old process.

2.2. Lean management

TPS began in 1956 after visiting Soichiro Toyoda (grandson of the founder industrial empire Toyoda) and Taichi Ohno factories Ford in the United States. By the mid-60s the new production system was implemented at all factories and offices of Toyota, and by the mid-70s even from parts suppliers. The world began to realize that Toyota has the perfect weapon - an ideal method of workflow. But instead of storing it in the strictest confidence by competitors, the Japanese began to promote TPS, providing consulting services to everyone. Toyota's output to the US market aroused great interest among specialists. To study the phenomenon of Toyota, which came out in the US market in the 80s of the last century, inexorably pulling away more and more market share from the major manufacturers was developed some teams. In chapter one of them - the research group «International Motor Vehicle Program» stood D. Womack, (Womack *et al*., 1990). The concept of “Lean production- Lean" was first used in 1985 by a member of one of the research groups John Krafchik.

Lean initially used in industries with discrete manufacturing, especially in the automotive industry. Then the concept has been adapted to the conditions of the process of production. Later, the idea began to lean in the trade, services, utilities, health care, education, the armed forces and the public administration sector. The basic principles Lean formulated T.Ono and formed the basis of all the activities of enterprises Toyota (Ōno, 2007) All of the ideas and techniques TPS/ Lean are described in detail in numerous publications, such as (Ozeki, 2012; Hirano *et al*., 2006; Mann, 2005; George, 2002.).

The essence of lean manufacturing is a process that involves five steps:

1. To determine the value of a particular product.
2. Identify the value stream for this product.
3. To ensure the continuous flow of the value stream product.
4. Allow the user to pull the product.
5. Strive for excellence.

The value, in the view of the manufacturer, are influenced by various types of losses - muda in Japanese.

It identified seven types of losses:

- losses due to overproduction;
- loss of time due to expectations;
- losses in unnecessary transportation;
- losses due to the extra processing steps;
- losses due to excess inventory;
- losses due to unnecessary movements;
- losses due to the release of defective products.

Tayota experience shows that the process of improvement is endless: it is always possible to slightly reduce the time of production, the number of defective parts, production costs, etc.; and ever closer to what consumers really need. LIN ideas spread widely in the world and the companies that are adopting them at a profit and get real increase brand.

2.3. Theory of Constraints

Theory of Constraints, (TOC) a popular concept of management, developed in the 1980s, Eliyahu Goldrattю Name it received in 1984, when it was introduced by E. Goldratt. The basis of the theory is to find and manage key constraint system, which determines the success and efficiency of the whole system. In this case, it is postulated that making efforts over the management of a very small number of aspects of the system, an effect much greater than the result of simultaneous action on all or most of the problem areas of the system immediately. Constraint in TOC are the main factor which provides a starting point from which the system can grow and improve their performance. Figure 3 illustrates the root problem of TOC.

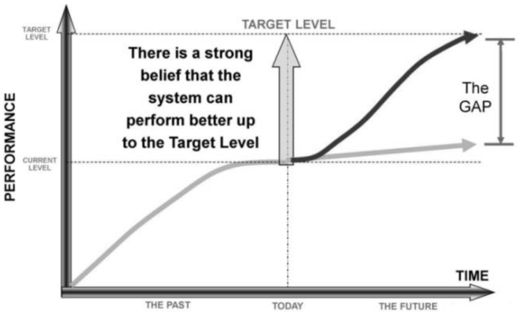

Figure 3. The root problem TOC

Consider the possible types of constraints (Cohen and Fedurko, 2012; Inman *et al*., 2009; Gupta and Boyd, 2008; Dettmer, 2001):

- ***Capacity Constraint*** - a resource which cannot provide timely capacity the systems demands for it;
- ***Market Constraint*** - the amount of customers orders is not sufficient to sustain the required growth of the system;
- ***Time Constraint*** - The response time of the system to the requirement of the market is too long to the extent that it jeopardizes the system's ability to meet its current commitment to its customers as well as the ability of winning new business;
- ***Behavioral constraints*** can’t be measured. It is evident when a comparison of cultures of different companies or nations;
- ***External constraints***. These include market factors (intense competition, capacity), the impact of the political situation on the purchasing power of the population, etc. Today the concept of ISO 9000 is aimed at the process of continuous improvement. Ideas TOC absolutely do not contradict this trend.

In the process of implementing TOC searches for answers to four questions, the first three - are traditional issues for many years used to analyze systems. TOC has added a fourth question and the direction of the responses to all four questions (Table 3).

Table 3. TOC question and the direction of the responses to all questions

Steps	Questions	Actions
Problem	WHAT to change?	*Pinpoint the core problem*
Solution	WHAT to change TO?	*Construct simple practical solutions*
Implementation	HOW to cause the change?	*Induce the proper people to make the change (to invent such solutions)*
POOGI	What creates the **P**rocess **O**f **O**n**G**oing **I**mprovement?	*Institute a process that facilitates continuous improvement SS+Lean+TOC*

Managers need a systematic approach to develop plans for the pursuit of a significant improvement of their systems. In doing so, they can help the ideas expressed by Cohen (Cohen and Fedurko, 2012) The most interesting seems to us a tool called the author "U-shape" and allows to solve all questions TOC. Illustration of this tool is given in Figure 4.

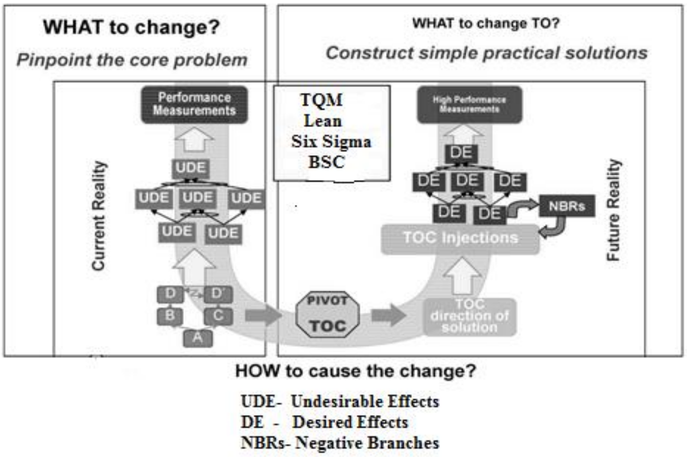

Figure 4. U-shape

A few words should be said about the concept of PIVOT (pivot-point of support, rod). PIVOT is a key element in understanding the structure and U-shape. PIVOT - a central point. He explains the essence of the new solution, which will be the basis for creating the desired reality. PIVOT serves as a bridge between the present and the future. The leading element of the existing reality is a wrong decision. In fact, the future will be another solution, more accurate for the organization. PIVOT is an answer to the question: "Why this time change will give the expected result?"

U-shape is developed for the implementation of decisions aimed at improving the performance of the TOC. U-shape has a universal character. It is suitable to solve the problems for the entire system, as well as for individual parts. It helps in the design, both the solutions, and the details of implementation. Since the U-shape technique is new, it is natural to correct to view it on the books of the author.

To implement the action TOC developed following 5 steps of the algorithm.

Step 1: Find the system's constraint. Which element of the system contains the weakest link? It has a physical or organizational nature?

Step 2. Loosen the impact of constraints on the system. Goldratt has in mind, it is necessary to maximize the use of bandwidth management, which is currently restricted system.

Step 3: Focus all efforts on limiting system. When the constraint is found (step 1) and decided that to do with it (step 2), set up the entire system so that the limiting element is working at maximum efficiency. Then analyzed the results of actions: a) whether the delay constraint is still the whole system? If not, proceed to step 5. If so, it means that the constraint still exists, go to step 4. It is necessary to monitor the behavior of limitation permanently, as it sets the rhythm of the whole system.

Step 4: Remove the constraint . If steps 2 and 3 is not enough to eliminate the constraint s, the need for more drastic measures. Only at this stage it is possible to realize the idea of large-scale changes to the existing system, such as reorganization, redistribution of powers, capital increase, etc. After improving the problematic parameter need to think about whether it is possible to improve the process more.

Step 5. Return to the first step, bearing in mind the inertia of thinking.

If in step 3 or 4 constraint is removed, go back to step 1 and start the cycle all over again.

Concluding this section, authors have compared considered methods, comparison results are presented in Table 4.

Table 4. Program comparation results

Program	Six Sigma	Lean	Theory of constraints
Theory	Reduce variation	Remove waste	Manage constraints
Application guidelines	Define Measure Analyze Improve Control	Identify value Identify value stream Flow Pull Perfection	Identify constraints Exploit constraints Subordinate processes Elevate constraints Repeat cycle
Focus	Promblem focused	Flow focused	System cjnstraints
Assump tions	A problem exists. Figures and numbers are valued System output improves if variation in all processes is reduced.	Waste removal will improve business performance. Many small improvements are better than systems analysis.	Emphasis on speed and volume. Uses existing systems. Process interdependence.
Primary effect	Uniform process output	Reduced flow time	Fast throughput
Secondary effects	Less waste. Fast throughput Fewer inventories Fluctuation—performance measures for managers. Improved quality	Less variation iniform output. Fewer inventories. New accounting system. Flow—performance measure for managers. Improved quality.	Less inventory/waste. Throughput cost accounting. Throughput—performance measurement system. Improved quality.
Criticism	System interaction not considered Processes improved independently	Statistical or system analysis not valued	Minimal worker input. Data analysis not valued.

3. Integration of the methods discussed above

3.1. Integration of SS / DFSS and LEAN

From the description given above it is clear that SS / DFSS provides answers to the question "How to organize activities?", and LEAN to the question "What should I do?" Each of the methods optimally solves only a certain range of tasks. And after many years of research conducted at MIT under the "Cars" it became clear that each method has drawbacks and only their integration provides a synergistic effect. Already in 2001, George Michael - President of the consulting firm for over 15 years engaged in the project for SS and LEAN, published his famous book (George, 2002).

LEAN + SS successfully combines the best achievements of Japanese and western schools of management, allows more efficient to reduce lead times and improve quality. Having passed approbation in enterprises both production and non-production areas, LEAN + SS gained versatility and became one of the most popular destinations in the quality management.

In SS success factors distinguish among the most significant - high degree of organization, which is expressed as follows:

- All activities are conducted within the framework of projects, each of which has a set of objectives, timelines, budget, responsibilities and powers, the requirements for risk identification, record keeping, etc..;
- requirements for the knowledge and skills of staff involved in the project are clearly defined and classified into categories ("black belt", "green belt", and so on.);
- progress of each project is regularly monitored by the established system of measurable indicators - "metrics".

LEAN has other success factors. There was first proclaimed by the idea of creating value, which includes the quality, cost and time to market. LEAN offers a fundamentally new approaches to the management culture and set of tools to lower the cost and accelerate (Montgomery, 2010). Table 5 shows a comparison of the capacity of both methods taking into account the basic controls and in the column SS+ LEAN result of their integration.

Table 5. SS+ and LEAN result of integration

Basic functions	SS	LEAN	SS+LEAN
Management Commitment	✓		✓
Allocation of resources	✓		✓
Responsibility, authority, training	✓		✓
Graduation specialists (BB,GB,EB)	✓		✓
Definition, selection, execution of projects	✓	✓	✓
Short-term projects to improve		✓	✓
Metrics and Monitoring	✓		✓
Using the principle of DMAIC	✓		✓
Statistical methods FMEA	✓		✓
Identification and elimination of waste		✓	✓

The table shows that the integrated system LEAN + SS has virtually no drawbacks. Combining methods of "lean management" and "Six Sigma" is necessary because:

- Lean can’t achieve statistical control of processes;
- Six Sigma alone can’t significantly reduce the rate of process or reduce the need for investment capital.

The combination of Lean and Six Sigma, if it is applied to high-value projects and maintains the proper infrastructure, can lead to surprising results, as is the most powerful available today engines of sustainable shareholder value creation.

According to a study MIT (Massachusetts Institute of Technology) for 40 companies using LIN +SS, listed below are typical improvement:

- operational improvements;
- reducing lead times by 70%;
- increasing productivity by 50%;
- WIP inventory reduction by 80%;
- improving the quality of 80%;
- reduction of the area occupied by 75%.

Improving the administrative system:

- reducing the number of errors in the processing of orders;
- optimization to help clients;
- reducing staffing requirements, the same number of workers to perform more work, etc.

Strategic advantages:

- Reduced lead time, reduction of various types of costs and improving quality permit to acquire a significant advantage over competitors;
- Principles of LEAN + SS applicability and effectiveness for all industries. They get results and on the shop floor and in the office and in the warehouse, because they optimize the organization of any work at all.

Several major factors affecting the success of the implementation of the LEAN +SS:

- the interest of management;
- allocation of resources;
- experience of successful projects.

3.2. Integration of SS / DFSS and LEAN

Despite the obvious advantages of the integration of LIN + SS / DFSS when there are different kinds of production constraints, then balanced on the principles of lean processes are not effective. Pay attention to this, and experts have begun to address the ideas of attraction theory of constraints, So in the book (Jacob *et al.*, 2010) the integration of TOC + SS + LEAN are considered and this combination called VELOCITY. True, this term is not found distribution, so the Internet under this definition understand anything, but not the integration of management practices. Brazilian specialist Reza M. Piratesh called this method iTLS (Reza and Kimberly, 2009). Because, to date, this option is integration methods have not received legal title will call it TLS.

Does this mean that implementing TLS should forget about the ideas of TQM (Total Quality Management) - and the concept of ISO 9000? Already in the 90s E. Goldratt in one of his articles criticized the approach of "either - or" and offered to move in the direction of "together". Many organizations have adopted this position and TOC added to an existing system TQM. TQM and TLS are promoting continuous improvement in the production flow. Several articles are convincing arguments about the consistency of the ideas of TQM and TOC (Jin *et al.*, 2009; Sproull, 2009; Srinivasan *et al.*, 2004). The most compelling arguments in favor of matching the concepts brought by Goldratt in one of his last articles (Goldratt, 2009). He has defined four basic concepts of flow control:

1. Improving flow (or - equivalently - reducing cycle time) - is the primary task of operational management.
2. This primary objective should be transformed into a practical mechanism to indicate the production, there is no need to produce (prevents overproduction).
3. Indicators of local effectiveness should be canceled.
4. Develop and implement a focusing process of balancing the flow.

In an interesting article (Ehie and Sheu, 2005) provides a detailed analysis of these concepts and concludes that the consistency of TOC and Lean Approximate TLS algorithm is as follows:

1. The work begins with the application of management principles TOC, described above. After defining the problem at the system level, the project team

analyzes the problem and puts tasks aimed at excluding or minimizing constraints. At this stage, must be determined and the possible loss types are proposed for improvement. At the same time, do the following;

2. Determine the value;
3. Determine value stream;
4. Take action to the value stream was continuous;
5. Allow pull value from the manufacturer. These steps are widely used tools of LEAN; The main purpose of these steps is to produce the desired amount of product at the right time and its delivery to the right place. To do this, create a new thread. At this stage, the input variables of the process should work consistently and repeatedly with minimal variability, in order to achieve the best results in waste minimization, cancellation of marriage and rework. This leads to the following process steps;
6. Strive for perfection;
7. Introduce flexibility. At these stages of excellence should be applied DMAIC or IDOV model. It allows employees to identify and isolate the source of the deviation of the process and systematically remove or minimize these deviations. After installing the optimal parameters of the process variables necessary to define the standard modes of operation and management mechanisms, taken from LEAN and SS/DFSS.
8. Develop procedures of verification and audit of process to investigate productivity for a long time. If any deviations are observed during audit process, they have to become a reason for creation of the correcting and preventive plans of action.

4. The practical results of the integration

It is clear that no methodological ideas and theoretical schemes can not be considered effective to check them in practice. Therefore, we give some examples of practical application of TLS.

First example. Company National Semicoductor (Selicon Value), which became in 2008 the Department of Texas Instrument Corporation faced a problem of increasing demand on the part of many consumers. At senior management level there is concern that each of the production departments of companies do not use the best approach, and the leaders sought to find a solution and to establish appropriate processes (Pirasteh and Calia, 2010). In order to respond to the dissatisfaction among its team leaders, the company hired consultants, who came to a unique conclusion: Combine the best components of TOC, lean and six sigma to form TLS.

The company consultants designed an experiment that would enable the business to establish TLS as its foremost approach to continuous improvement. Data were collected for more than two years during the trial, and the results were statistically analyzed for significance among the methodologies. The success of each approach was determined by its aggregate contribution to verifiable financial savings as a result of process improvement projects. These savings were validated by the organization’s plant controllers and senior management. The assignment of methodologies was as follows:

- 11 plants applied six sigma
- 4 plants applied lean
- 6 plants applied TLS

The 211 team leaders in these 21 plants had been trained in - and were using - one of the three methodologies. Over the more-than-two-year study, the plants completed 101 projects in all. These tasks were studied for accuracy in claimed improvements, savings, and approach.

While the results from all projects were documented, the plant personnel and the trainers were unaware of the ongoing comparative study, as the research was designed in a double-blind format to cut down on any potential biases.

The TLS process improvement methodology delivered considerably higher cost savings to the company. Specifically, its application resulted in a contribution of 89 percent of the total savings reported. Six sigma by itself came in a distant second with a 7 percent contribution to company savings; followed by a 4 percent from stand-alone lean applications (Figure 5). Accuracy of figures in article isn't discussed, entirely relying on a correctness of authors.

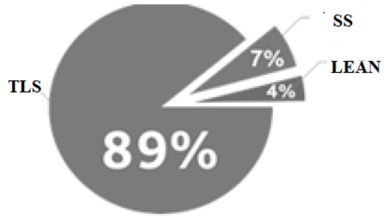

Figure 5. Importance of a contribution of each method

Second example. Sample analyzes the activities of the group of Brazilian companies (Pacheco *et al.*, 2014; Pacheco, 2014). One company that used the integrated approach is Votorantim, which is the 4th largest private Brazilian group and operates in several countries in various market segments, such as mining, metal industries, cement, paper, steel, and fruit juices.Consider the experience of TLS on the mining and metallurgical plants of this company. In the period from 2003 to 2005 conducted extensive research in which analyzed for assessing the efficacy of the enterprises use TLS, but on the part of enterprises used alone LEAN and SS. After the experiment the results were compared.

For three years in the 21 plant was carried out 105 projects. Study would measure financial performance obtained when using each of these methods. Statistical analysis showed that the method of Lin and 6-Sigma have yielded significant results in financial organizations in which they were applied. The results from the use of these techniques individually were about the same, increase profits by 12-15%.

Five plants was integrated system TLS, it allowed successfully synchronize the production and use of existing production capacity to ensure the stability of the process. TLS method optimally agreed on the following methods:

- From TOC focusing on a few key elements that restrict the activities of the company as a whole,
- From LEAN: removing faults in the production by detecting so-called "hidden factories".
- From SS: reduce the possibility of unwanted variability of processes to ensure stability.

After a year of use TLS at all plants were obtained similar results. In all cases, the use of TLS, performance index were significantly increased for 3-4 months. Continued use of TLS in the next 3-4 months helped to stabilize production processes, along with the achievement of strategic targets in production that was previously thought impossible. New production figures were significantly superior to the previous, with no investment in additional capacity.

In this case study the TLS approach successfully synchronized production with the available capacity levels while providing process stability. This approach was smoothly implemented through involvement and participation of the organizations' people and their powerful commitment for success.

The case study is a summary of application of TLS in a number of Brazilian conglomerates includes mining plants, ore concentrating plants, and metallurgical production plants. In all cases studied, when the TLS was applied, within 3 to 4 months production throughputs significantly increased. Continuing with the implementation with additional 3 to 4 months the processes stabilized while achieving the desired strategic target production levels. This was previously perceived as impossible.

The new performance levels are significantly exceeding previous production thresholds without adding and investing in additional capacity. Consequences were simply generation of more revenues, more profits and higher ROI.

The repeatability of results achieved with iTLS implementations was consistent with expectations. The following were some of the results achieved through implementation of this approach in all plants:

- Production improved by 10% to meet 100% customer requirement, without any additional capital investments;
- Profits increased by additional 5%;
- Pay-back periods were only a few months at each plants and sometimes less as low as 28 days;
- Process stability improved exceeding the strategic target level expectations.

5. Conclusions

In article some aspects of integration of methods of SS/DFSS, LIN and TOS are considered. Synergetic application of integrated TOC, Lean and Six Sigma, TLS, provided a rapid and effective approach to improve capacity and productivity for many enterprises and organizations in which significantly improved the operations profitability and meeting 100% customer commitments.

Despite the world popularity, practical use of all considered methods demands a maturity of management, a certain level of preparation, experience. Introduction of popular methods and instruments of management at early stages of development of the organization is unpromising as as that "organization" finally wasn't created: there is no harmonous structure, the debugged control system, accurate distribution of duties and powers. At each new stage of development all organizations face a unique set of calls and difficulties.

In the course of activity of the organization it is possible to allocate natural consecutive stages: creation of the organization, infancy, stage of rapid growth, youth, blossoming, stabilization, aristocratism, bureaucratization and death. SS, LEAN, TOC, are directed on improvement of already existing system (management, production) therefore their application at initial stages of organizational development won't provide desirable results. Only at the stage "stabilization" when a certain system of processes, when there is an accurate distribution of functions, when system approach is adjusted settled, competent use of the mentioned methods and tools can increase productivity of activity of the company.

Therefore at making decision on what method to use, it is necessary to understand accurately the purpose of introduction and desirable result. Likely, thus the help of skilled consulting firm and only will be required after that it is possible to make the decision, based on that is more useful and more preferable for cjmpany, without forgetting thus obligatory following to the principles described above.

References:

Antohina, A., Varzhapetian, G., & Semenova, G. (2013). *Management of quality and productivity of projects*. Politekhnika.

Cohen, O., & Fedurko, E. (2012). *Theory of Constrainrs*. Tallinn: Strategic Solution.

Dettmer, W. (2001). *Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement*. Milwaukee, Wisconsin: ASQ Quality Press.

Ehie, I., & Sheu, C. (2005). Integrating six sigma and theory of constraints for continuous improvement: a case study. *Journal of Manufacturing Technology Management, 16*(5), 542-553. doi:10.1108/17410380510600518

George, M. (2002). *Lean Six Sigma*. New York: McGraw-Hill.

George, M., Rowlands, D., & Price, M. (2005). *Using DMAIC to improve speed, quality, and cost* (p. 282). New York City, USA: McGraw-Hill.

Goldratt, E. M. (2009). Standing on the shoulders of giants: production concepts versus production applications. The Hitachi Tool Engineering example. *Gestão e Produção, 16*(3), 333-343.

Gupta, M., & Boyd, L. (2008). Theory of constraints: a theory for operations management. *International Journal of Opperations & Production Management*, *28*(10), 991-1012. doi:10.1108/01443570810903122

Halevi, G. (2007). *Handbook of Production management methods*. Oxford, UK: Butterworth-Heinemann.

Hirano, H., Furuya, M., & Bodek, N. (2006). *JIT is flow*. Red Bluff, CA: QCI International.

Inman, R., Lair Sale, M., & Green, K. (2009). Analysis of the relationships among TOC use, TOC outcomes, and organizational performance. *International Journal of Opperations & Production Management*, *29*(4), 341-356. doi:10.1108/01443570910945819

ISO/IEC, (2011). *ISO 13053-1:2011 - Quantitative methods in process improvement -- Six Sigma -- Part 1: DMAIC methodology*. Geneva, Switzerland: ISO/IEC.

Jacob, D., Bergland, S., & Cox, J. (2010). *Velocity: Combining Lean, Six Sigma and the Theory of Constraints to Achieve Breakthrough Performance*. New York: Free Press.

Jin, K., Hyder, A-R., Elkassabgi, Y., Zhou, H. & Herrera, A. (2009). Integrating the theory of constraints and Six Sigma in manufacturing process improvement. *Proceedings of World Academy of Science, Engineering and Technology*, *37*, 550-554.

Koren, Y. (2010). *The global manufacturing revolution*. Hoboken, N.J.: Wiley.

Mann, D. (2005). *Creating a lean culture*. New York: Productivity Press.

Montgomery, D. (2010). A modern framework for achieving enterprise excellence. *Lean Six Sigma Journal*, *1*(1), 56-65. doi:10.1108/20401461011033167

Ōno, T. (2007). *Taiichi Ohno's workplace management*. Mukilteo, WA: Gemba Press.

Ozeki, K. (2012). How to improve Toyota Production System flow factory performance in 6 days by 60% increase. *TOCICO International Conference: 10th Annual Worldwide Gathering of TOC Professionals*. Chicago, Il.

Pacheco, D. (2014). Theory Of Constraints And Six Sigma: Convergences, Divergences And Research Agenda For Continuous Improvement. *Independent Journal Of Management & Production*, *5*(2). doi:10.14807/ijmp.v5i2.150

Pacheco, D., Lacerda, D., Corcini Neto, S., Jung, C., & Antunes Júnior, J. (2014). Balanceamento de fluxo ou balanceamento de capacidade? análises e proposições sistêmicas. *Gestão & Produção, 21*, 355-368. doi:10.1590/s0104-530x2014005000006

Pirasteh, M., & Calia, G. (2010). *Integration of Lean, Six Sigma & TOC Improves Performance*. Retrieved 8 April 2015, from http://www.industryweek.com/articles/integration_of_lean_six_sigma__toc_improves_performance_21537.aspx?showall=1

Reza, P., & Kimberly, F. (2009). Continuous Improvement Trio. *APICS Magazine*, *94*.

Sproull, R. (2009). *The ultimate improvement cycle*. Boca Raton: CRC Press.

Srinivasan, M., Jones, D., & Miller, A. (2004). *Applying Theory of Constraints Principles and Lean Thinking at the Marine Corps Maintenance Center (Defense Acquisition Review Journal)*. Ft. Belvoir: Defense Technical Information Center.

Taguchi, S. (2003). *Design for six sigma*. London, UK: Quality Press.

Womack, J., Jones, D., & Roos, D. (1990). *The machine that changed the world*. New York: Rawson Associates.

Yang, K., & El-Haik, B. (2009). *Design for six sigma*. New York: McGraw-Hill.

Zutshi, A., & Sohal, A. (2005). Integrated management system. *Journal Of Manufacturing Technology Management*, *16*(2), 211-232. doi:10.1108/17410380510576840

Artemy Varshapetian
State University of
Aerospace Instrumentation,
Russia
vagbnm@gmail.com

Elena Semenova
State University of
Aerospace Instrumentation,
Russia
egsemenova@mail.ru