INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE AND MANAGEMENT

CONTENTS

CALL FOR MANUSCRIPTS

We invite original research papers in the area of computer, finance, marketing, HRM, Banking, Insurance, and other allied subjects. The above mentioned tracks are only indicative, and not exhaustive. The journal expects unpublished and original quality research articles/papers only.

You may submit your articles/papers at the email addresses, info@ijrcm.org.in or infoijrcm@gmail.com.

GUIDELINES FOR SUBMISSION OF MANUSCRIPT

1. **COVERING LETTER FOR SUBMISSION:**

The Editor
IJRCM

Subject: **Submission of Manuscript**.

Dear Sir/Madam,

Please find my submission of manuscript for possible publication in your journal.

I hereby affirm that the contents of this manuscript are original. Furthermore It has neither been published elsewhere in any language fully or partly, nor is it under review for publication anywhere.

I affirm that the all author (s) have seen and agreed to the submitted version of the manuscript and their inclusion of name(s) as co-author(s).

Also, if our manuscript is accepted, I/We agree to comply with the formalities as given on the website of journal & you are free to publish our contribution to any of your two journals i.e. International Journal of Research in Commerce & Management or International Journal of Research in Computer Application & Management.

Name of Corresponding Author

Designation:

Affiliation:

Mailing address:

Mobile Number (s):

Landline Number (s):

E-mail Address (s):

2. **INTRODUCTION**: Manuscript must be in English prepared on a standard A4 size paper setting. It must be prepared on a double space and single column with 1” margin set for top, bottom, left and right. It should be typed in 12 point Calibri Font with page numbers at the bottom and centre of the every page.
3. **MANUSCRIPT TITLE**: The title of the paper should be in a 12 point Calibri Font. It should be bold typed, centered and fully capitalised.
4. **AUTHOR NAME(S) & AFFILIATIONS**: The author (s) full name, designation, affiliation (s), address, mobile/landline numbers, and email/alternate email address should be in 12-point Calibri Font. It must be centered underneath the title.
5. **ABSTRACT**: Abstract should be in fully italicized text, not exceeding 300 words. The abstract must be informative and explain background, aims, methods, results and conclusion.
6. **KEYWORDS**: Abstract must be followed by list of keywords, subject to the maximum of five. These should be arranged in alphabetic order separated by commas and full stop at the end.
7. **HEADINGS**: All the headings and sub-headings should be in a 10 point Calibri Font. These must be bold-faced, aligned left and fully capitalised. Leave a blank line before each heading.
8. **MAIN TEXT**: The main text should be in a 8 point Calibri Font, single spaced and justified.
9. **FIGURES &TABLES**: These must be simple, centered & numbered, and table titles must be above the tables. Sources of data should be mentioned below the table.

10. **REFERENCES**: The list of all references should be alphabetically arranged. The author (s) should mention only the actually utilised references in the preparation of manuscript and they are supposed to Harvard Style of Referencing. The author (s) should mention only the actually utilised references in the preparation of manuscript and they are supposed to follow the references as per following:

- All works cited in the text (including sources for tables and figures) should be listed alphabetically.
- Use (**ed.**) for one editor, and (**ed.s)** for multiple editors.
- When listing two or more works by one author, use --- (20xx), such as after Kohl (1997), use --- (2001), etc, in chronologically ascending order…
- Indicate (opening and closing) page numbers for articles in journals and for chapters in books.
- The title of books and journals should be in italics. Double quotation marks are used for titles of journal articles, book chapters, dissertations, reports, working papers, unpublished material, etc.
- For titles in a language other than English, provide an English translation in parentheses.
- Use endnotes rather than footnotes.
- The location of endnotes within the text should be indicated by superscript numbers.

PLEASE USE THE FOLLOWING FOR STYLE AND PUNCTUATION IN REFERENCES:

Books

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio," Ohio State University.

Contributions to books

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

Journal and other articles

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.
- Kiran Ravi, Kaur Manpreet (2008), Global Competitiveness and Total Factor Productivity in Indian Manufacturing, International Journal of Indian Culture and Business Management, Vol. 1, No.4 pp. 434-449.

Conference papers

- Chandel K.S. (2009): "Ethics in Commerce Education." Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

Unpublished dissertations and theses

- Kumar S. (2006): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University.

Online resources

- Always indicate the date that the source was accessed, as online resources are frequently updated or removed.

Website

- Kelkar V. (2009): Towards a New Natural Gas Policy, Economic and Political Weekly, Viewed on 31 January 2011 http://epw.in/epw/user/viewabstract.jsp

SIX SIGMA APPROACH FOR QUALITY AND PERFORMANCE EXCELLENCE IN PLASTIC INJECTION MOLDING INDUSTRY - A CASE STUDY AND REVIEW

P. K. BHARTI
HEAD OF THE DEPARTMENT
DEPARTMENT OF MECHANICAL ENGINEERING
INTEGRAL UNIVERSITY
LUCKNOW – 226 026

M. I. KHAN
PROFESSOR
DEPARTMENT OF MECHANICAL ENGINEERING
INTEGRAL UNIVERSITY
LUCKNOW – 226 026

HARVINDER SINGH
DIRECTOR
BUNDELKHAND INSTITUTE OF ENGINEERING & TECHNOLOGY
(CONSTITUENT COLLEGE OF GAUTAM BUDDHA TECHNICAL UNIVERSITY)
JHANSI – 284 001 (U.P.)

ABSTRACT

Injection molding has been a challenging process for many manufacturers and researchers to produce products meeting requirements at the lowest cost. Its complexity and the enormous amount of process parameter manipulation during real time production create a very intense effort to maintain the process under control. What is more, complexity and parameter manipulation may cause serious quality problems and high manufacturing costs.

Determining optimal process parameter settings critically influences productivity, quality, and cost of production in the plastic injection molding (PIM) industry. Previously, production engineers used either trial-and-error method or Taguchi's parameter design method to determine optimal process parameter settings for PIM. However, these methods are unsuitable in present PIM because the increasing complexity of product design and the requirement of multi-response quality characteristics.

Six Sigma is the most fervent managerial methodology not only in manufacturing area but also in the services industry. Many investigations have indicated that Six Sigma can increase organization's competitive capability and enhance the quality of products or services by conducting the projects. Since this program focus on data-driven analysis and rigorous methodology to improve quality, and seem to be gaining significant popularity in industrial settings. This article focuses on the benefits of Six Sigma in injection molding industries, Obstacles in its implementation and future of six sigma programs.

This study also aims to review the effect of six sigma tools in a plastic injection molding industries along with a case study to improve the quality of nylon-6 bush (KAMANI BUSH) produced by plastic injection molding process. The production equipment employed in this study is a precision injection machine, model: PPU7690TV40G, over all dimensions 856×1500×2480 mm manufactured by the Targor Corporation This study has two advantages. First is to choose the best tools that fit that type of industry. Second is to encourage similar companies to apply the same methodology. The case studies by researchers showed a significant improvement in the rejection rate using the structured DMAIC methodology.

KEYWORDS

Continuous Quality Improvement (CQI), Design for six sigma (DFSS).DMAIC , Parameter design, Plastic injection molding (PIM),

INTRODUCTION

One of the main goals in injection molding is the improvement of quality of molded parts besides the reduction of cycle time, and lower production cost. Solving problems related to quality has a direct effect on the expected profit for injection molding companies. As in many manufacturing processes, meeting required specifications means keeping quality characteristics under control. Quality characteristics in injection molding are classified as mechanical properties, dimensions or measurable characteristics, and attributes. In general, some of the main causes of quality problems are material related defects i.e., black specks and splay, process related problems such as filling related defects i.e., flash and short shots, packing and cooling related defects i.e., sink marks and voids, and post mold related defects i.e., warpage, dimensional changes, and weight.

Factors that affect the quality of a molded part can be classified into four categories: part design, mold design, machine performance and processing conditions. The part and mold design are assumed as established and fixed. During production, quality characteristics may deviate due to drifting or shifting of processing conditions caused by machine wear, environmental change or operator fatigue.

Faced with global competition in injection molding industry, using the trial-and-error approach to determine the process parameters for injection molding is no longer good enough. Quite a few researchers have attempted various approaches in the determination of process parameters for injection molding in order to reduce the time to market and obtain consistent quality of molded parts.

Manufacturing firms have long used structured methods to reduce process variability and standardize outcomes. Beginning with the introduction of statistical methods for measurin2g and analyzing quality in the late 1930s, Shewhart, Deming, Juran, Feigenbaum, Taguchi, and Ishikawa, among others, helped to formalize a discipline focused on quality. They advocated reducing outcome variation through control of processes, which they argued would increase customer satisfaction, and which would in turn result in increased profitability and enhanced product quality. Quality tools such as statistical process control evolved to help analyze behavior and variability of processes and to explore the relationships between inspections, defects, and operating costs.

During the 1980s quality control evolved into "named" initiatives or programs, such as Total Quality Management (TQM), Zero Defects, Quality Circles, Continuous Quality Improvement (CQI), Continuous Process Improvement, and many others. While each is perhaps technically different from the others, most involved identifying defects as they occurred through inspection and quality control and changing processes to sustain the improvements. It has been suggested that naming these quality initiatives contributed to their being perceived as short-term "fads," and the decline in their popularity and use . For many years, industries focused on quality improvement initiatives such as TQM and CQI. However, these programs lost momentum and popularity due to their lack of data driven analysis, and many managers became disillusioned with the prospects of quality improvement.

The most recent quality philosophy to be adopted by businesses around the world is known as "Six Sigma". This article focuses on the benefits of Six Sigma in manufacturing industries, Obstacles in its implementation and future of six sigma programs. Since this program focus on data-driven analysis and rigorous methodology to improve quality, and seem to be gaining significant popularity in industrial settings. This study also aims to review the effect of six sigma tools in a plastic injection molding industries along with a case study to improve the quality of nylon-6 bush (KAMANI BUSH) produced by plastic injection molding process. The production equipment employed in this study is a precision injection machine, model: PPU7690TV40G, over all dimensions 856×1500×2480 mm manufactured by the Targor Corporation.

THE SIX SIGMA QUALITY PHILOSPHY

Six Sigma is a process improvement methodology that uses data and statistical analysis to identify and manage process variations to reduce or eliminate "defects" in a company's operational performance. Developed by Bill Smith at Motorola Corporation in 1986[7] .Six Sigma can be applied to any work process by adapting the following goals: improve customer satisfaction, increase profitability, and increase productivity[16].

Six Sigma uses data and statistical analysis to improve processes by focusing on input variables. The methodology identifies sources of variability in the work process that result in "defects," defined as anything outside of customer specifications. Six Sigma traditionally sets the improvement goal of 3.4 defects per million opportunities. Once these sources have been identified, they are modified to reduce the defects.

Six Sigma has two key methodologies, each consisting of five phases: DMAIC (define measure, analyze, improve, control) and DMADV (define, measure, analyze, design, verify) [8]. The first methodology is used for existing processes, while the second is used to design new processes.

Six Sigma was originally used in manufacturing corporations, but has branched out in such diverse areas as the banking, health care, military, and telecommunications industries. One of the earliest corporations to use the methodology was General Electric, which reported benefits of more than $300 million during its first year of application [9]. Other major companies that have reportedly used Six Sigma include Ford, Caterpillar, Microsoft, 3M, and Siemens.

The focus on achieving six sigma quality is commonly referred to as design for six sigma (DFSS). The two goals in designing for quality are: (1). striving to maintain performance within acceptable limits, consistently (reliability), and (2). Striving to reduce performance variation and thus increase robustness. Reliability is defined as the probability of satisfying constraints; conversely, the probability of failure, probability of not satisfying constraints, is often measured [4].

IMPLEMENTATION

Most of the literature concerning Six Sigma focuses on successfully implementing Six Sigma practices into one's organization. Implementation comes in one of two models: tool-based and projected-based [6].

Tool based implementation focuses on "the mechanics of tool execution, as opposed to when and how a tool should be implemented and integrated with other tools."

Project-based implementation involves tools being "taught and then applied to projects that are defined before [training] sessions begins." [5].

The Six Sigma methodology is conducted by a team of people in five roles. The team is led by the quality leader/manager, who is responsible for representing the customer's needs. Master Black Belts are responsible for specific areas or functions of a business, such as human resources, and work closely with the Process Owners, who are individuals responsible for a specific process. Black Belts lead the quality projects and work full time with the company until they are complete. They also train the Green Belts, who are company employees trained in Six Sigma. [9]

DMAIC IN SIX SIGMA

DMAIC or Define-Measure-Analyze-Improve-Control, principle is used to execute six sigma projects in an organization.

DEFINE PHASE AND TOOL

Define (D) is the first step of the Six Sigma methodology where leaders are expected to select projects, set initial goals or targets, and develop a project charter or statement of work (SOW). Costs of poor quality associated with the new or existing process being analyzed are estimated. Improvement targets are set often in terms of sigma and cost [3]. Leader¬ship selects the appropriate team mem¬bers. The team then determines more precisely the criteria that are critical to the customer. Run charts, interviews, or surveys, for example, are utilized to obtain leads and useable figures. A high-level process map of the existing process is to be developed with start and end-points clearly illustrated. Strategic deliverables are a process map, a working project charter, a team roster, and the costs of poor quality. A progress report to leadership normally concludes each step [3].

MEASURE PHASE AND TOOL

Measure is the second step of the Six Sigma methodology and is denoted by the capital letter M. The goals of Measure appear to activate only in the mode of data management, which includes both collection and organization of the data for the purpose of observation. However, the modes of identification and solution generation may be triggered on a small scale as well.

FMEA, MSA and particularly Gage R&R are tools that serve largely in a verification capacity, which fall into the problem identification and data management stages.

ANALYZE PHASE AND TOOL

The third step, A, is analyze. Here teams identify several possible causes (X's) of variation or defects that are affecting the outputs (Y's) of the pro¬cess. One of the most frequently used tools in the analyze step is the cause and effect diagram.

A Six Sigma team explores pos¬sible causes that might originate from sources, such as people, machinery and equipment, environment, materials, and methods. Another highly effec¬tive technique to expose root cause is asking "why" to a possible cause at least five times [10]. Team member suggestions may need clarified before proceeding further, so each and every team member has a clear under¬standing of the cause being presented. The resulting list should be reduced to the most probable root causes. Causes can be validated using new or existing data and applicable statistical tools, such as scatter plots, hypothesis test¬ing, ANOVA, regression, or design of experiments (DOE). Experts warn not to assume causation or causal rela¬tionships unless there is clear proof. Furthermore, validating root causes can help teams avoid implementing ineffective improvements and wasting valuable resources. Root cause is the number one team deliver¬able coming out of the analyze step [3]

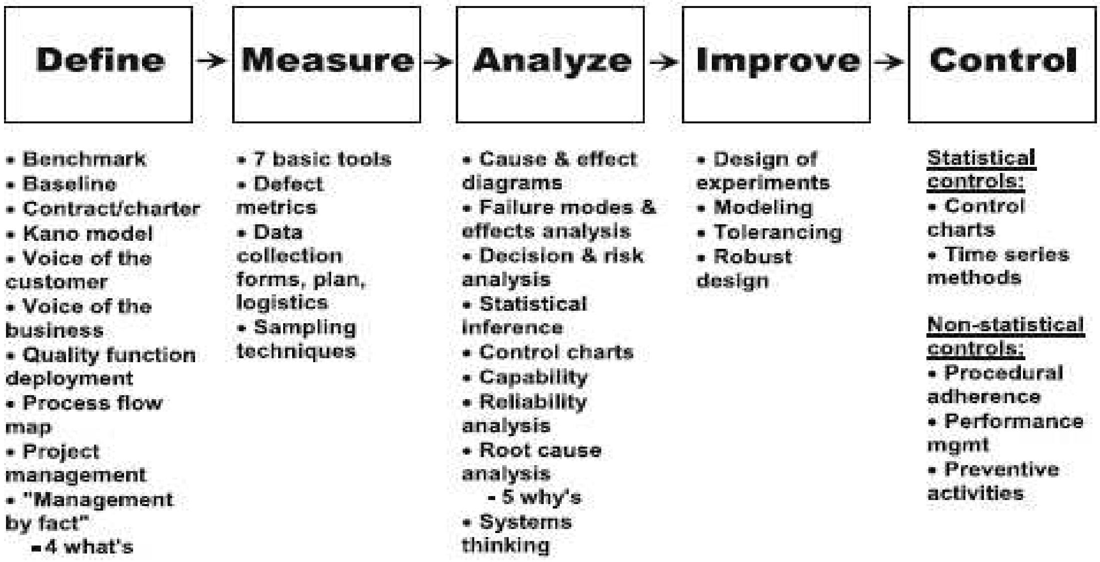
IMPROVE PHASE AND TOOL

The team then enters the improve (I) step. Here a team would brainstorm to come up with counter measures and lasting process improvements that ad¬dress validated root causes. The tool most preferred for this process is the affinity diagram, which is a brainstorm¬ing technique where a topic or issue is presented to a small team who then quickly list ideas or solutions [10]. The team should narrow the list to one or two potential improvements that are step deliverables for small- should be selected based on probability of success, time to execute, impact on resources, and cost. If newly gathered data in¬dicates the small-scale implementation is a legitimate success, teams should proceed to full-scale implementation [3].

CONTROL PHASE AND TOOL

The final step for at least the black belt and many of the team members is con¬trol, which is signified by the capital letter C. At this point devices should be put in place to give early signals when a process is heading out of con¬trol. Teams may develop poka-yokes or mistake proof devices that utilize light, sound, logic programming, or no-go design to help control a process [2]. The ultimate goal for this step is to reduce varia¬tion by controlling X's (i.e., the inputs) and monitoring the Y or Y's (i.e., the outputs) [10].

In brief Six Sigma improvement framework and tool kit can be shown as below (Siviy 2008)



SUCCESSFUL APPLICATION OF SIX SIGMA BY GIANTS

Identifies by company, the yearly revenues, the Six Sigma costs (investment) per year, where available, and the financial benefits (savings) [11].

COST AND SAVING BY A COMPANY [TABLE-1-SIX SIGMA 11]

YEAR	REVENUE ($B)	INVESTED ($B)	% REVENUE INVESTED	SAVINGS ($B)	% REVENUE SAVINGS
MOTOROLA					
1986-2001	356.9(E)	ND	-	16	4.5
ALLIED SIGNAL					
1998	15.1	ND	-	0.5	3.3
GE					

1996-1999	382.1	1.6	0.4	4.4	1.2
HONEYWELL					
1998-2000	72.3	ND	-	1.8	2.4
FORD					
2000-2002	43.9	ND	-	1	2.3
KEY: $B = $ BILLIONS, UNITED STATES (E) = ESTIMATED, YEARLY REVENUE 1986-1992 COULD NOT BE FOUND ND = NOT DISCLOSED NOTE: NUMBERS ARE ROUNDED TO THE NEAREST TENTH					

Wipro is the first Indian company to adopt Six Sigma. Today, Wipro has one of the most mature Six Sigma programs in the industry ensuring that 91% of the projects are completed on schedule, mush above the industry average of 55% [12].

The results of achieving Six Sigma are rapid and overwhelming at Wipro Its unique methodology provides Six Sigma knowledge and skills to the client, enabling the client to create ownership, generate results and sustain success. The maturity of Wipro's quality processes takes the benefits to another level, ensuring that the customers benefit from:

- 30-40% lower total cost of ownership
- 20-30% higher productivity
- On-time deliveries (93% projects completed on time)
- Lower field defect rates (67% lower than industry average). The performance enhancement enabled the client to have an improved product with the overriding Benefit that the end customer perception of the quality of the client's product is Improved [13].

CASE STUDY

The case study was conducted at a manufacturing facility specializing in plastic products. The particular plant is a part of the "parag group" of its parent company, which is made up of three divisions: filter, hygiene/medical, and plastics. This company's vision, which is to be innovative and quality-driven in its technically demanding applications, is determined by its guiding principles of continuous improvement, leadership, and commitment to anticipate and understand their customer's needs and expectations. Seventy percent of the plant's revenue comes from the plastic molded parts it produces for the automotive industry. The plant also produces inner carrier layers for rolls and carpet tiles, which makes up the other 30% of their revenue.

The DMAIC principle of six sigma was applied to improve the quality of nylon-6 bush (KAMANI BUSH) produced by plastic injection molding process. The production equipment employed in this study is a precision injection machine, model: PPU7690TV40G, over all dimensions 856×1500×2480 mm manufactured by the Targor Corporation.

Application of DMAIC principle at manufacturing facility is as described below

DEFINE

The first step in DMAIC procedures is to define the problems so that possible confusion in targets for improvement due to differences in cognition among project staff can be avoided. In this paper, the reasons for rejection and failure of nylon-6 bush were investigated by the management techniques like voice of customer and brain storming of production manager, quality engineer on the shop floor, as well as workers concerned with the production of above product. After voice of customer and brain storming we concluded that following three defects are playing important role in rejection and failure of bush.

1. Sink marks 2. Stress cracking 3.Bulging defect (over shrinkage)

After doing Pareto analysis we decided that bulging defect is responsible for 80% of the failures and rejection.

MEASURE

In the "measure" step, the process capability index is measured to illustrate the most efficient way to circumvent the problems defined in the previous steps(bulging defect in this case). For the nylon-6 bush molded in this study, the process capability index is measured based upon the measured data obtained from the bulging measurements. (For the bulging measurement we used a dial gauge attached with a v shaped anvil placed over a surface plate)

In general, the upper process capability index CPU is defined by the following equation.

$$CPU = \frac{USL - X}{3\sigma}$$

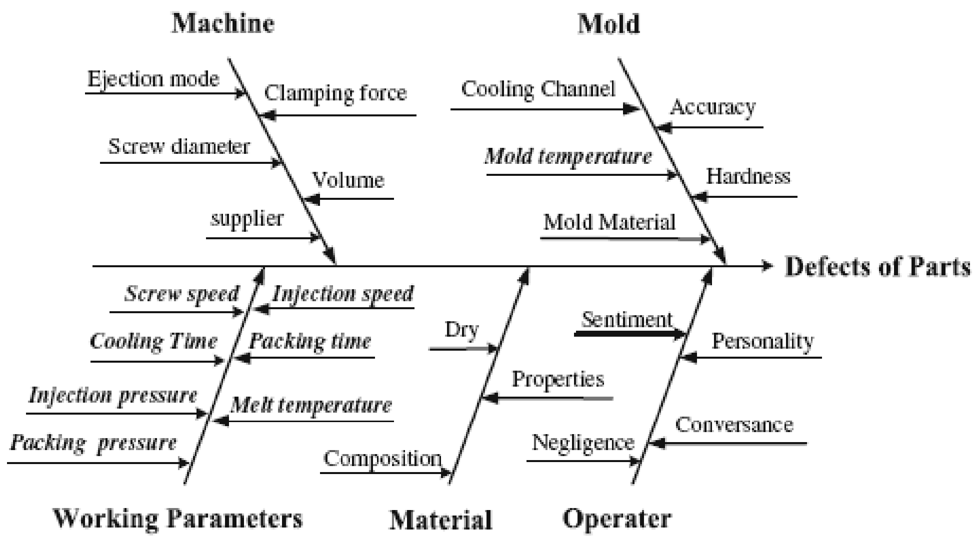
Where USL is the upper specification limit X is the mean of all measured values, and σ is the standard deviation.

Before implementation of six sigma project value of CPU calculated from random samples was 0.80.

ANALYZE

In the analysis step, the data collected from the process is analyzed in accordance with the CTQ (critical to quality) factors. The literature review suggests that to have better surface quality of molded part, it is important to correctly tune the settings of process parameters in injection molding plus precision machining of mold.

FIG. 1 CAUSE-AND-EFFECT DIAGRAM SHOWN IN FISHBONE SCHEMATICS FOR THE MOLDED LENSES. THERE ARE MANY FACTORS THAT INFLUENCE THE QUALITY OF THE MOLDED BUSH AND EIGHT FACTORS ARE SELECTED HERE AS SHOWN IN BOLD ITALIC TYPE



According to the literature and with the cause-and-effect diagram shown in Fig. 1, the most significant processing parameters selected were melt temperature, screw speed, injection speed, injection pressure, packing pressure, packing time, mold temperature, and cooling time.
Using Taguchi method L27 orthogonal experiment was performed setting above eight parameters at three levels. The results obtained from this orthogonal array were further analyzed with the help of ANOVA and regression analysis.
The optimum setting of these parameters obtained with the help of above analysis was implemented in next step.

IMPROVE
At this step, the approach in the analysis step is carefully conducted for generating results into the current process so that the effectiveness of improvement can be verified.
First, the bush are injection molded by using the optimal combination of process parameters(decided in analysis step) for an adequate number of samples. Bulging defect measurements are then conducted on 50 randomly sampled bushes. After process improvements, the upper process capability index CPU is increased from original 0.80 to 1.56. which implies a substantial improvement in quality characteristics of bushes.

CONTROL
The results must be clearly defined in the control plan in order to constantly monitor its process capabilities and retaining the fruitful improvements. The production equipment employed in this study is a precision injection machine, model: PPU7690TV40G, over all dimensions 856×1500×2480 mm manufactured by the Targor Corporation.

OTHER APPLICATIONS OF SIX SIGMA IN PLASTIC INJECTION MOLDING
Tarek Safwat, Aziz Ezzat (2008) presented an approach to implement six sigma technique to decrease the scrap rate in a plastic injection molding plant. Using a case study of NATPACK Co. a plastic packaging company in Al Obour City, Cairo, Egypt. A Six sigma DMAIC methodology was applied to structure the study and scope the project. DMAIC which stands for Define, Measure, Analyze, Improve, Control is widely used in many six sigma projects since the 1990s. The proper tools that are suitable for injection molding industry needs were investigated. The primary tools used in this work were SIPOC, MSA, FMEA, P-Control Charts, Hypothesis Testing. In this case study the average scrap rate for the “Before” study period with the average scrap rate of the “After” study period were compared.
This study created a decrease in the scrap rate from an average of 5.2% to 2.6%. Using the financial department of Natpack Company to calculate the hard savings in Egyptian Pounds, the result was 123000 L.E/Yr. This value equals to a cost saving of 3% of the total cost of goods sold. Knowing that Nat pack’s plastic injection molding department profit margin is 5%, then we are looking at a breakthrough in the company’s cost structure However, the team was faced with a lot of challenges. The culture change required to depend on statistical data analyses rather than experience and intuition was not easy.
This study aimed to investigate the effect of applying six sigma tools in a plastic injection molding department trying to decrease the scrap rate. This study has two advantages. First is to choose the best tools that fit that type of industry. Second is to encourage similar companies to apply the same methodology. Decreasing the plastic scrap will have a very positive effect on the society and environment. The case study showed a significant improvement in the scrap rate using the structured DMAIC methodology. This work would encourage all plastic injection molders to apply this methodology for decreasing the scrap, cost saving and consequently make more money. Hopefully, the companies use the extra generated profit in a socially responsible way.
Team members who participated in the study needed a lot of training on soft skills such as team work, communication skills, continuous improvement, Brain storming, cost of poor quality concept, etc. and hard skills such as sampling, data collection, Minitab software and the applied six sigma tools. It was not an easy task. [15]
W. C. Lo & K. M. Tsai & C. Y. Hsieh (2009) studied to improve the quality of injection-molded lenses with the implementation of DMAIC procedures based on the Six Sigma approach. At first, critical-to-quality factors (CTQ) were determined according to customer requirements for quality.
This study employed Taguchi design-of-experiment method (DOE) for screening pertinent process parameters in the injection process. After completing the DOE procedures, confirmation experiments were conducted with selected combinations of factors and levels. The experimental

results show substantial improvement for the profile accuracy on molded lenses. As a further step, an optimal set of factors and levels were taken during the mass production processing conditions. In conclusion, the Six Sigma approach effectively improved the upper process capability index CPU from 0.57 to 1.75, i.e., 0.07 defects per million, without an upgrade of production equipment or an increase of production costs [16].

Before the implementation, the original process could only deliver 0.57, or equivalently 43,331 PPM. This approach not only significantly improved quality characteristics of the lenses but also achieved the targets of improvement. Furthermore, the Taguchi method adopted in the analysis step successfully identifies the optimal combinations of process parameters as well as the most significant factors affecting the surface qualities. In the meantime, the factors are evaluated via ANOVA of S/N ratio for various combinations of process parameters throughout the experiments. The final results suggest that among all the process parameters, the most significant factors affecting surface accuracy of products were packing pressure, melt temperature, injection pressure, and packing time. [6]

OBSTACLES IN SIX SIGMA PROGRAMS

Despite the immense popularity and the wide spread adoption of Six Sigma, there is a rising concern regarding the failures of Six Sigma programs.

Berg (2006) reported that their Six Sigma program was expensive and did not yield results. Concerned about Six Sigma's problems, Sutton (2006) described nine ways to get the best out of Six Sigma programs [10].

A national survey of healthcare companies revealed that 54% do not intend to embrace Six Sigma programs [10].

Angel and Pritchard reported that "nearly 60% of all corporate Six Sigma initiatives fail to yield the desired results…" In short, we lack an understanding of how and why so many Six Sigma programs fail. One explanation of many Six Sigma failures could be escalation of commitment.

Escalation of commitment refers to the propensity of decision-makers to become overcommitted to a course of action. In escalation situations, decision-makers first receive negative feedback on a previous course of action, and then they are faced with a dilemma, 'whether to persist with or withdraw from the previously chosen course of action'. This decision error is repeated many times during the course of action and several authors have studied this phenomenon [14].

Where Six Sigma does excel is in the setting of standards for measuring, analyzing, and reducing inefficiency. However, forcing every single business activity into this Six Sigma Model may not work. Such was the case with NBC, a business unit of General Electric. Not every activity or process should be squeezed into a quantifiable model when in fact; the real value proposition gets completely lost.

A good example of how Six Sigma can make you sick was Polaroid. Polaroid, a large manufacturer of cameras found out the hard way. Polaroid put enormous emphasis on quality, but failed to pay attention to a critical product substitute, digital cameras. As a result, Polaroid went bankrupt despite its outstanding quality. So make sure you balance Six Sigma against all those other factors in running your business; otherwise you will destroy value in the name of quality. This is perhaps the biggest risk with Six Sigma – getting blindsided by all those other things that impact your business [11].

FUTURE OF SIX SIGMA PROGRAMS

It seems everything within corporate America is getting six stigmatized. Though, Six Sigma is a well-defined methodology for improving quality, which in turn, leads to control over costs. However, like any major business initiative, Six Sigma can have its drawbacks.

Common problem with Six Sigma is playing games with the numbers. How you categorize and define defects is significant in how well you meet Six Sigma targets.

Like so many major initiatives, Six Sigma can receive less than enthusiastic response from workers. For example, Six Sigma can be somewhat divisive – a few people are chosen as Black Belts, a larger group is selected as Green Belts, and others are not included at all. In order for Six Sigma to be truly accepted, everyone should be given an opportunity to become a Green Belt and people who have demonstrated strong leadership on improvement issues should be considered for Black Belts. Don't exclude people on such a major enterprise-wide initiative as Six Sigma [12].

CONCLUSION

The purpose of this paper has been to review the effect of six sigma tools in a plastic injection molding industries and better understand what Six Sigma is as described by a rapidly developing body of literature. Six Sigma is generally described as a metric, a mindset, and a methodology for strategic manage¬ment and process improvement. Six Sigma has numerous strengths and a near equal amount of weaknesses which implies that it is not perfect and should not be mistaken for a solution to all problems.

Because of the remarkable benefits the Six Sigma approach has demonstrated, the method has been employed for study of injection-molded nylon-6 bush so that quality improvement via systematic design can be demonstrated. Prior to application of the Six Sigma approach, compromise among various interacting process parameters are difficult for obtaining the desired quality characteristics. After the implementation of the proposed method, targets for improvement are clearly defined with the problems and causes being identified. The process parameters are then optimized for quality improvement so that the Six Sigma standard can be reached.

Six Sigma should not be mistaken as something that is suitable for all people and all organizations. However, Six Sigma has been around for over a decade and is still grow¬ing to the extent that more people and more organizations should probably be prepared.

The study tried to clarify some of Six Sigma's expanding influence on industry. Though, more research is required to determine the true extent of Six Sigma's success and influence on industry.

This study also reviewed the effect of six sigma tools in a plastic injection molding industries. This study has two advantages. First is to choose the best tools that fit that type of industry. Second is to encourage similar companies to apply the same methodology. The case studies by researchers showed a significant improvement in the rejection rate using the structured DMAIC methodology.

REFERENCES

1. Brey fogle, F.W. (1999) Implementing "six sigma": smarter solutions using statistical methods. John Wiley and Sons New York NY ,Page791-782.

2. Pande Peter and Larry Holpp (2001) What is Six Sigma? McGraw- Hill
3. Pande, Peter S., Robert P. Neuman, and Roland R. Cavanagh (2000) The Six Sigma Way: How GE, Motorola, and Other Top Companies Are Honing Their Performance, McGraw-Hill.
4. P.N. Koch, R.-J. Yang and L. Gu, (2004), Design for six sigma through robust optimization, Structural Multidiscipline Optimization, Vol. 26, Page 235–248.
5. DMAIC.jpg.http://www.sixsigmaqualtec.com/Transactional/dmaic.html
6. W. C. Lo & K. M. Tsai & C. Y. Hsieh(2009), Six Sigma approach to improve surface precision of optical lenses in the injection-molding process. International Journal of Advance Manufacturing Technology, Vol. 41, Page 885–896.
7. Motorola, "The Inventors of Six Sigma" (accessed March 2006), www.motorola.com/content.jsp
8. J.A. De Feo and W.W. Barnard, (2005). JURAN Institute's Six Sigma Breakthrough and Beyond—Quality Performance Breakthrough Methods (New Delhi, India: Tata mcgraw-Hill Publishing Company Limited,
9. Subodh K. Das and Margaret Hughes, Improving Aluminum Can Recycling Rates: A Six Sigma Study in Kentucky, JOM web site (www.tms.org/JOMPT)
10. Sean P. Goffnett, (2004), Understanding Six Sigma: Implications for Industry and Education, Journal of Industrial technology, Vol. 20
11. www.isixsigma.com
12. www.wipro.com
13. Manisha Sharma, Kapil Pandla, Case study On Six Sigma at Wipro Technologies: Thrust on Quality
14. Satya S. Chakravorty (2009), Six Sigma failures: An escalation model, Journal of Operations and Management Research,Vol. 21
15. Tarek Safwat, Aziz Ezzat (2008) Applying Six Sigma Techniques in Plastic Injection Molding Industry, IEEE conference proceeding, 978-1-4244-2630.
16. W. C. Lo & K. M. Tsai & C. Y. Hsieh (2009), Six Sigma approach to improve surface precision of optical lenses in the injection-molding process, International Journal of Advance Manufacturing Technology, vol.41 page 885–896.

REQUEST FOR FEEDBACK

Esteemed & Most Respected Reader,

At the very outset, International Journal of Research in Commerce and Management (IJRCM) appreciates your efforts in showing interest in our present issue under your kind perusal.

I would like to take this opportunity to request to your good self to supply your critical comments & suggestions about the material published in this issue as well as on the journal as a whole, on our E-mails i.e. **info@ijrcm.org.in** or **infoijrcm@gmail.com** for further improvements in the interest of research.

If your good-self have any queries please feel free to contact us on our E-mail **infoijrcm@gmail.com**.

Hoping an appropriate consideration.

With sincere regards

Thanking you profoundly

Academically yours

Sd/-

Co-ordinator