



National Institution for Quality & Reliability

Chennai Branch

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Nov - Dec 2015

National President Speaks...

Fellow Members of NIQR,

It gives me immense pleasure in writing to you at the end of yet another year of milestones for NIQR. As a Country we have made good progress during 2015. Our GDP growth has reached the highest among all Countries. Our Economy is slowly turning around. We as a country shall aspire to become a favorite investment hub of the Globe and NIQR has been contributing to a very great extent to this National Cause.



Year 2015 turned out to be an eventful year for NIQR. Brainstorming was done to take NIQR to the next orbit. Many ideas were generated and driven forward & we can see good progress.

Some of the major milestones achieved are given below:

NIQR has become Nodal Agency for the ZED (Zero Effect Zero Defect) program driven by the Government of India through QCI (Quality Council of India). An MOU has been signed and we will be spreading this program vigorously to all the industrial sectors henceforth in South.

In our endeavor to spread the wings to all parts of the country, we conducted a Seminar on "Measurement Excellence - Key Driver to Success" with MSI. This program was a grand success and this has made NIQR visible in the NCR (National Capital Region) region & paved way for starting the new branch in the NCR region.

Apart from the above milestones, we have successfully conducted regular lectures and on dot release of Newsletters by the Chennai Branch. Many Branches have also become much more active, especially the Bangalore Branch. I'm sure we will strive to utilize the platform built (ZED) to enlarge the activities of NIQR in spreading the Quality Culture. We should also take big steps in spreading the Quality knowledge & awareness among student community. Our next biggest milestone to be achieved is Biannual Quality Convention in June 2016. I request fellow NIQRians to contribute through their creative ideas to make the convention a grand success.

Challenges bring out the best among the people. During Chennai floods, we were able to see how people got united and rose to the occasion to lend a helping hand to the needy. Now, Chennai has become even stronger. Wishing the very best in the wonderful year ahead, I'd like to take this opportunity to wish my all my fellow members and their families a very Happy and Prosperous New Year, 2016.

R SIVANESAN

National President

Q - ZINE

From Chairman...

Wish you all a very Happy and Prosperous New Year 2016

The year 2015 was very eventful to all of us and many mile stones were achieved during the course of the year. I wish to mention one important achievement during the year 2015, the enrolment of new members, which was one of the highest in recent years. This would not have been possible without the support of the existing members who worked hard for this feat.



We have served our members well throughout the year organising evening lecture programs regularly and bringing out the Bimonthly Newsletters in time. I personally assure all our members that the tempo will be maintained in the coming year and services to member fraternity will reach new heights.

The Biannual Convention is planned to be organised in 2016 and I request all our members to provide all necessary support to make the convention a grand success.

With kind regards,
S. RAJASEKARAN

From Secretary...

I started the last issue with these words "Expectations and faith complement each other in majority of times; hope we get bountiful rains in the NE Monsoon so that next year will be smooth." The rains were more than expectations; in fact, it was devastating; let us have faith in the same Mother Nature to mitigate the sufferings of all the affected people.



The floods have brought out the best of humanity in Chennai; the media have highlighted extensively how different types of people, NGOs, Army, Navy, Air force & Govt. agencies have helped the affected people after the calamity proving to the Chennaites that 'Humanity was the only Religion'. NIQR wishes all the affected people a speedy return to normalcy.

Due to the rains, some of our activities were affected and we hope to catch up in the New Year. Let us take this opportunity to congratulate Trivandrum Branch for bringing out their Newsletter.

Wishing all of you and your family members a **HAPPY AND PROSPEROUS NEW YEAR 2016.**

With kind regards,
C V GOWRI SANKAR



NIQR welcomes the 81 new Individual Annual Members who joined from Delhi Region during December 2015

Chennai Branch Activities

Evening Lecture on 31st Oct 2015 by Mr. Kavinkumar

The Evening Lecture for the month of October was organised on 31st Oct 2015 at NIQR Conference Hall, Nungambakkam.

Mr. Kavinkumar, Director of Engineering Project Management Consultancy and Research Pvt. Ltd was the speaker and the topic was "Construction Project Management". Mr. S. Rajasekaran, NIQR Chennai Branch Chairman presided over the session and Mr. Kavinkumar made a self introduction.

Mr. Kavinkumar started his lecture with the question whether Project management is an art or science.

Even though it resembles an art, Mr. Kavin explained how it is made a science by today's demands. He elaborated on the features of Project Management from 'resources to end results'. He explained how the sequence of activities is bonded by time. He dwelt at length the various factors of Project Management in Construction viz a viz Manufacturing especially Auto Components. He beautifully explained how Time, Staff or labour, Money, Material, Plant or Machinery & Space have to be analysed both as resources and constraints during the various stages of a project. Risk factor or unknown factor, according to him, demands a healthy space in Construction Project Management. Various phases of the project from Initiating, Planning, Executing, Controlling and Closing were explained thoroughly with a case study of construction of a caustic soda manufacturing plant. He rounded off explaining how much the construction time has shrunk from years to months in the last decade due to high demand and the role of Lean Construction.



Mr. Kavinkumar an M Tech from IIT Madras held multiple project leadership positions in Larsen & Toubro and under his leadership multiple large civil infrastructure projects across India were completed, besides several consultancy projects and advisory services to India's top construction companies. Mr. Kavin is the Director of EPMCR, an IIT Madras-incubated company that specializes in construction methods, management and related services. He is on board the management team of IIDCO PROJECTS INDIA LIMITED.



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NIQR Student Chapter in Dr. M G R Educational & Research Institute University

NIQR Chennai Branch started yet another Student Chapter in Dr. M G R Educational & Research Institute University, Maduravoyal, Chennai. Dr. V Swaminathan, National Vice President - NIQR, was the Chief Guest for the inaugural function organised by the Department of Mechanical Engineering at the University Auditorium at 10.00AM on 29th October 2015.

Dr. M Ganesan, Chair Person & HOD - Mechanical Engg welcomed the gathering which included many dignitaries from NIQR, 250 students and 50 staff members. Dr. L Ramesh, Addl. Dean (E&T) addressed the gathering and commended NIQR for the services it was offering through Student Chapters. Dr. V Cyril Raj, Dean - Engineering & Technology in his Presidential address, asked the students to make use of the opportunity provided by NIQR to increase their knowledge. Dr. P Ramesh, Head - Materials Lab, Lucas-TVS Ltd & Co-opted Member, NIQR HQ was appointed Mentor for the Student Chapter and he assured the students that he is easily reachable for organising any programs. Mr. S. Rajasekaran, Chairman of NIQR Chennai Branch spoke about NIQR and its activities especially in the area of industry-institution interaction. Then Mr. G. Rangarajan, National Secretary of NIQR presented the vision, mission and goals of NIQR.



Individual Membership Certificates were presented to 25 student coordinators by the dignitaries. The Chief Guest, Dr. V Swaminathan while addressing the students advised the students to make use of opportunities created by NIQR to enhance their knowledge and be in industry ready stage when they leave the institution. Mr. K N Krishnamurthy, Former National President - NIQR gave a lecture on Global Scenario of Quality illustrated with lot of present day customer demands and how organisations satisfy them. Mrs. R Suganthini Rekha, Asst. Prof. - Mechanical Engg & Organizing Secretary of the Student Chapter proposed the Vote of Thanks.

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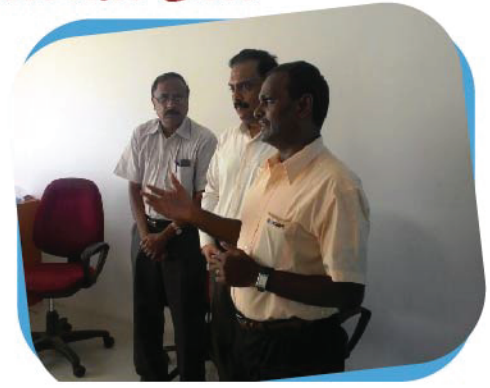
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Training Programs in Irungattukkottai Industrial Belt

NIQR Chennai Branch organised a training program on Advanced Product Quality & Planning at the premises of SIMA in Irungattukkottai. 13 middle level managers from member organisations of SIMA attended the training. Mr. C Sundaravadivelu, Treasurer of NIQR Chennai Branch was the faculty.

Mr. S Rajasekaran, Chairman of NIQR Chennai Branch inaugurated the program and explained to the participants the benefits the industrial belt will get by this joint arrangement. Mr. C Sundaravadivelu started the training with a detailed APQP process flow covering Preparation, Plan, Design & Development of Product and Process, Validation, Feedback, Assessment and Corrective Action. He covered all the core tools and explained in detail Control Plan and PPAP. The feedback of the participants was good.



Quality Month Celebrations

KRAMSKI Stamping and Molding India Pvt. Ltd., an injection molding & precision stamped parts manufacturer, located at Vellore celebrated October as Quality Month. They invited NIQR to partake in their QM celebrations on 31st Oct 2015 in their premises. Dr. V Swaminathan, NIQR National Vice President and Mr. V Venkatesh, NIQR Chennai Branch Vice Chairman graced the occasion.

Mr. V Venkatesh gave a lecture on Supply Chain Management describing how SCM is essential to meet the end customer requirements.

Dr. V Swaminathan detailed the Vision & Mission of NIQR and its activities for the benefit of around 80 organisations who are vendors to Kramski. He also gave an outline about the NIQR National Convention to be held in 2016.



Dwaraka Engineerings, one of the leading manufacturers of Precision Machined Elevator Parts and Assemblies in Chennai, India, celebrated December as Quality Month. The theme of the month was "QUALITY STARTS WITH ME". Mr. S Rajasekaran, Chairman of NIQR Chennai Branch was the Chief Guest for the celebrations on 6th November 2015. He visited the shop floor including the TQM corner and interacted with the associates. He addressed the employees and shared with them many of Quality concepts like COQ, FORM, FIT, and FUNCTION.



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Wheels India Limited celebrated November as Quality Month. They had month long celebrations with many competitions and seminars. Mr. C V Gowri Sankar, Secretary, NIQR Chennai Branch was the jury for their QC Competition and Poka Yoke Competition. In the valedictory function on 24th Nov 2015, Mr. C V Gowri Sankar spoke about the importance of value system in an organisation & gave the audience an account of requirements for going for a Poka Yoke and the novelties in designing it.



Members in News

Mr. S Rajasekaran elected as SIMA President

Mr. S. Rajasekaran, Chairman, NIQR Chennai Chapter and Managing Director, Infant Engineers Pvt. Ltd was elected as President of SIPCOT Irungattukottai Manufacturers Association on 4th Nov 2015. SIMA has over 70 Medium and Small Scale Industries which are mainly Tier I & Tier II suppliers. Incidentally, from August 2015, NIQR had tied up with SIMA to conduct training programs in Irungattukottai for member organisations of SIMA.



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5. 5S & Kaizen	10. World Class Manufacturing Practices

Head Quarters Activities

Annual Competition on Six Sigma Case Study Presentation

In its tireless journey towards spreading Quality across organizations in India, NIQR HQ had organised the first Competition on Six Sigma Case Study Presentation on 14th Nov 2015 in Hotel Westin Chennai, Velachery. Mr. G Rangarajan, National Secretary - NIQR, welcomed the participants and Mr. K N Krishnamurthy, Past National President - NIQR, inaugurated the competition and introduced the judges. Dr. A Sanjeeva Rao, Past National President - NIQR and Mr. R Mohanakrishnan, National Council Member - NIQR explained the rules of the competition. The teams were split into two groups and presented their case studies in two halls namely Evolve I & Evolve II. Mr. K N Krishnamurthy and Dr. D. Sampangi Raman from Indian Statistical Institute, Chennai were the jury panel members for Evolve I & Mr. Avik Mitra, Former President of QCI and Dr. A Sanjeeva Rao were the jury panel members for Evolve II. Off the 30 teams committed to participate, only 28 teams participated from 11 organizations for showcasing their case studies and the entire day was full of action. There were 10 delegates from 4 organizations.



The valedictory function was presided over by Mr. R Sivanesan, National President - NIQR. He wished all the teams to continue their good work done so far and stressed on the importance of six sigma in the problem solving at all levels. Mr. R Mohanakrishnan, compiled the results from the two streams and finalised the results. Mr. V Raghavan, Vice Chairman - NIQR Chennai Branch and Mr. I. Daniel Jeyaraj, Administrative Officer, NIQR coordinated the activities to make the Competition a Grand Success. Dr. V Swaminathan, NIQR National Vice President announced the results. The PEACOCK team from SRI JAYAJYOTHI & CO., LTD was adjudged the best team and presented with Platinum Award. 14 Teams were presented with Gold Awards and 13 teams with Silver Awards. Mr. C V Gowri Sankar, Secretary - NIQR Chennai Branch proposed the vote of thanks.

Feedback from Participants

Ms Subbulakshmi of SRI JAYAJYOTHI & CO., LTD: We have learnt lot of new things in a marvelous atmosphere. We have gained good knowledge through Cross learning. An Excellent opportunity.

Mr. Ramkumar of SESA STERLITE "It was very useful for practitioners of six sigma from the view point of cross learning as many industries participated; It was very informative"

Ms. Anila Thiagarajan of VISTEON Technology: "Internal talent made public; Weightage may be considered for masked confidential information."

Mr. Oswald Jones of SESA STERLITE: "Everybody gains from this; Comments from juries very useful; NIQR should conduct every year - we want it."

Feedback from Juries

Dr. Sampangi Raman: Level of presentation high; many have learnt new tools; don't spend too much time on statistics - use them as tools

Mr. Avik Mitra: Most important two things for six sigma are process knowledge and critical thinking; it was excitement for all young members of teams

Mr. K N Krishnamurthy: The presentations were of world class standards; the available limited time of 20 minutes has to be judiciously used

Dr. A Sanjeeva Rao: The level has gone up - DMAIC process clearly understood by all

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Seminar on "Measurement Excellence – Key Driver to Success"

Setting the Context of the Seminar:

In view of today's fast changing world of technology & changing customer requirements, our industry needs to adopt the processes with efficient and effective measurement systems to provide accurate, precise & real time feedback so as to enable outputs Right First Time ... Right every time. Through this approach, we can increase our operational efficiency and profits by eliminating the cost of poor quality and rework and achieve enhanced customer satisfaction amidst the present healthy competition, leading to a preferred choice of customers. Measurement excellence is extremely significant to measure it right, do it right.



Mr. P K Aggarwal

National Vice President - NIQR

The Strategic Initiative of NIQR to spread its wings:

To emphasize upon the above facts and to create this awareness in the northern part of our country, NIQR had organized a seminar titled "Measurement Excellence - Key driver to success" at Hotel Radisson Blu Plaza in New Delhi on 5th December 2015 in collaboration with Metrology Society of India which is a National forum, promoting awareness across the country, about various types of measurements viz. length, force, temperature, time etc. and to align our industry, labs and other organizations for traceability to national as well as international standards.

Response to the Seminar:

The Seminar got an overwhelming response and 84 delegates from the northern manufacturing giants like Maruti, Ashok Leyland, Hero Moto-Corp, their ancillary units, as well as some of the reputed laboratories participated in it.



The Organizing Committee:

The program was driven by the NIQR team consisting of Mr. P K Aggarwal, National Vice President, Mr. S Rajasekaran Chairman of our Chennai Branch, Mr. G Rangarajan, National Secretary, Mr. K Manikandan, National Joint Secretary and his team of volunteers. Dr. K P Chowdhary, Vice President, Metrology Society of India, New Delhi joined hands with the NIQR team.

The Seminar:

After the traditional lighting of the auspicious lamp, Mr. S Rajasekaran, Chairman of NIQR Chennai Branch started the proceedings. Dr. A Sengupta, President of MSI delivered the welcome address to the delegates. Mr. P K Aggarwal, NIQR National Vice President gave an overview and set the context of the Seminar. The Chief Guest Mr. R B Madhekar, former Dy. Director of Maruti Suzuki India inaugurated the seminar and emphasised the importance of metrology during his address.



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The Topics & Speakers: Select experts and the captains of industry were the speakers in the seminar. They spoke on various interesting topics like:



Cost of Quality – Mr. Ranjan Vasishtha , MD, Quantum Jump Consultancy
An insight into the overall impact of not producing the part First Time Right

Digital Quality Management – Mr. Vikram Salunkhe, MD, Accurate Gauging & Instruments Pvt. Limited
Applications of Digital Technology for fast, efficient & effective Measurement System



Measurement excellence in Metallurgy – Mr. Amit Behl, Manager Quality Assurance , Hero MotoCorp Ltd.
Latest Systems for measurement for Force and other Metallurgical testing applications.

Advances in Metrology – Mr. Harrish Bajaj, Director, Mitutoyo South Asia Pvt Ltd.
An overview of the modern dimensional Metrology equipments available globally.



Contribution of Laboratories in promoting Measurement Excellence – Dr. K P Chaudhary, Chief Scientist & Head, NPL and Vice President MSI
Overview of current practices at National Physical Laboratory to help alignment of all the categories of measurements to international standards

Mr. A K Tomer, Executive Director, Maruti Suzuki India Limited, Chief Guest for the Valedictory Function commended NIQR and MSI for organising a wonderful seminar which is the need for manufacturing sector. Mr. S Rajasekaran, Chairman Chennai Branch - NIQR proposed the vote of thanks. NIQR extends its thanks to the following sponsors who had partnered with NIQR to make this seminar a grand success.



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Conclusion: Success of the seminar is evident from the unanimous voice of the delegates as well as other dignitaries present in the seminar, to create the northern chapter of NIQR. Almost all of them have applied for the NIQR membership. This is indeed going to be an important step towards spreading our wings across the country before going Global.

Case study

Presented by

Mr. S. Kumar - Jt. Secretary NIQR Chennai Branch: isokumar@yahoo.co.in
in association with **Mr. A Anbu Joel**: contactanbujoel@gmail.com
& **Mr. S Gokulraj**: gokulraj.sgr@gmail.com

Reduction of defects in Automotive Products manufacturing unit using DMAIC methodology

ABSTRACT—Simulation of the manufacturing processes being evolved had helped the industries for the past several years. But the Lean Six Sigma introduced another way of thinking in the processes improvement focusing on the profitability of the firm. This work is concentrated with one of the leading automotive component manufacturing company in South India. The main objective of this paper is to reduce the product defect with the application of Lean Six Sigma methodology. The paper follows the DMAIC methodology to investigate defects and its root causes and provide a solution to reduce and/or eliminate these defects. This paper also explores how a manufacturing process can use a systematic methodology to move towards world-class quality level.

Keywords—DMAIC, Six Sigma, LSS, Lean Six Sigma, Design Of Experiment

I. Introduction

The manufacturing industries worldwide have seen a revolution in the way they operate from the introduction of TPS. The manufacturing processes have become more customer oriented. Consumers have become more and more demanding, and the key to firm survival is the recognition of the importance of customer satisfaction. Consequently, companies have been forced to enhance the quality of both their

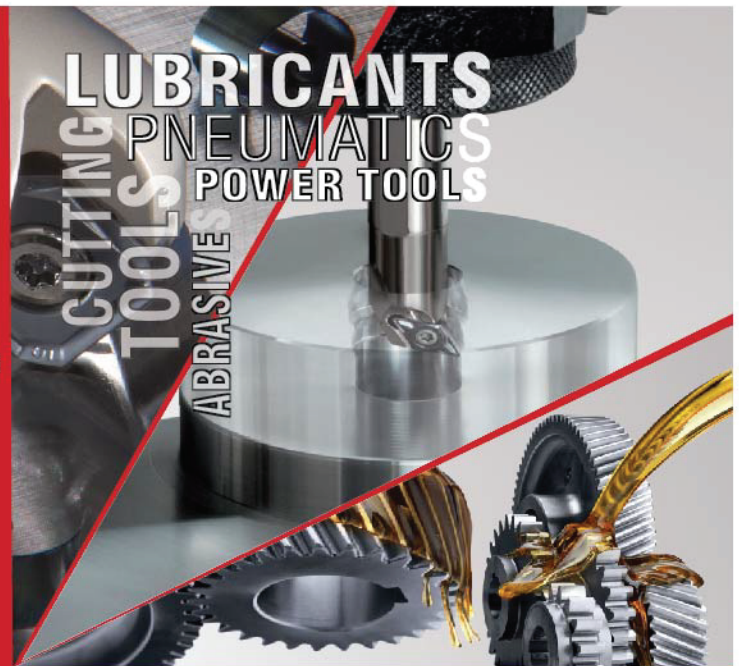
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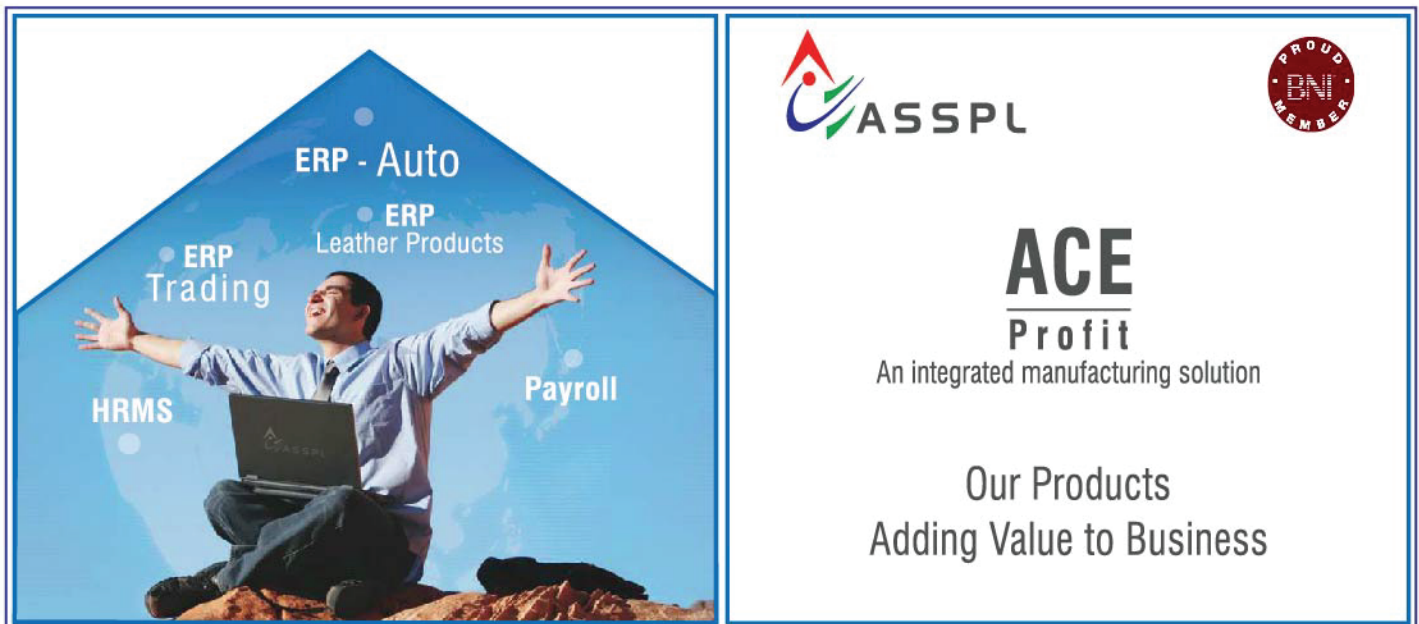
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processes and products. With the improvement in technology, the manufacturers are able to simulate the entire processes even before the implementation. But the Lean Six Sigma introduced the systematic way of thinking to improve the processes. Lean Six Sigma is the combination of concepts of Lean and Six Sigma. LSS is a customer focused continuous improvement strategy that minimizes defects and variation in the processes up to 3.4 defects per million opportunities by eliminating the 7 industrial wastes. Lean helps the company to eliminate the waste whereas the Six Sigma gives the systematic approach to reduce the defects thereby improving the profit.

II. Literature Review

The defects can be defined as any deviation in the CTQ (Critical to Quality) [1]. The combination tool Lean Six Sigma helps the industry to eliminate these deviations. Integrating LSS with other statistical tools could extend its effectiveness and sustain the improvements obtained as in the case of applying the quality plan tool [2]. For the purpose of the integration of these concepts the basics of both have to be studied. Lean manufacturing uses less of everything compared to mass production, half the human effort in the factory, half the manufacturing space, half the investment in tools, and half the engineering hours to develop a new product [3]. The purpose of implementing it is to increase productivity, reduce lead time and cost, and improve quality [4]. Lean concerned about the customer and the quick delivery of the product with the available use of the resources. So Lean concentrates on improving the efficiency of the worker, machine and facilities. There is an old saying about the lean manufacturing "Do more with less".

Six Sigma can be viewed as a metric, a mind-set, and a methodology [5]. Through implementation of Six Sigma, it was possible to determine the key factors, identify the optimum levels or tolerances and improvement opportunities [6]. It is a systematic methodology for continuous process of quality improvement and continuous process of achieving operational excellence [7]. According to the Six Sigma approach, for a stable process the distance from the 'process means' to the nearest tolerance limit should be at least six times the standard deviation σ of the process output [8]. The important key to success in Six Sigma is step by step approach using DMAIC



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methodology [9] Key business processes may be disjointed but using an improvement initiative such as the Lean Six Sigma ensures that a holistic approach is followed [10]. So the statistical approach for the problem is more helpful. BAE systems achieved substantial improvements in productivity, lead time, savings and reliability [11] with the help of the Lean Six Sigma. So LSS is selected to approach the problem.

III. Research Methodology

The DMAIC (Define-Measure-Analyse-Improve-Control) is the classic Six Sigma problem-solving process. This approach is to be applied to a problem with an existing, steady-state process or product or service offering. Variation from customer specification in either a product or process is the primary problem. Variation can take on many forms. DMAIC resolves issues of defects or failures, deviation from a target, excess cost or time, and deterioration. DMAIC identifies the key requirements, deliverables, tasks, and standard tools for a project team to utilize when tackling a problem. The DMAIC methodology uses a process-step structure. Steps generally are sequential.

TABLE I

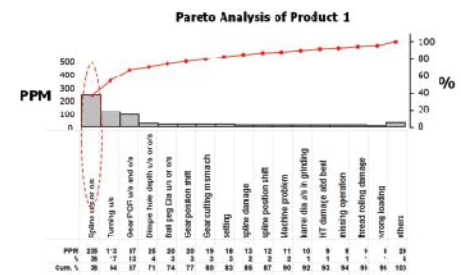
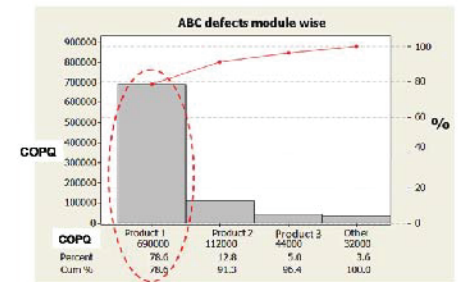
Dmaic Methodology: The above Table describes the methodology followed in the research work.

A. Define Phase In the define phase, the objectives of the project are defined clearly. This project is selected in the Assembly line of a major customer ABC. The rejection data of the assembled product of ABC is taken for four months (Aug - Nov 2014) and also the COPQ for the same is analysed. The Product 1 is one of the components of the Assembled Product which has the major rejection of 2706 PPM and very high COPQ of Rs.690,000. Therefore the Product1 is selected for the project. The main goal of this research work is to reduce the defects in the module of the ABC.

Project Charter, CTQ flow down and Process mapping are the important tools used in this phase. Project Charter is used to document the project business case and benefits of the project. High level process mapping is done to study the project. SIPOC (Supplier Input Process Output Customer) diagram is done to study the station and product flow to clearly define the process. In the project the machining of the pproduct1 is considered since it has more defect.

B. Measure Phase The main objective of Measure phase is to measure the process performance and setting target to the Voice

Define Phase	Select the project
	Define the problem
Measure Phase	Establish performance parameters
	Validate Measurement System for Ys
	Data collection plan
Analyse Phase	Establish process baseline
	Define performance goals
	Identify variation Sources
Improve Phase	Explore potential causes
	Establish variable Relationship
	Design operating limits
Control Phase	Validate Measurement Systems
	Verify Process improvement
	Improve Process Control



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of the Customer (VOC). The current process is evaluated against the target and the gap between the current and the target is found for further analysis of the project team. A Pareto analysis is done for prioritising the list of defects in the product¹. From Fig2, the Pareto analysis clearly explains that Spline undersize or oversize causes the maximum rejection in the module that is 235 defects (36%). Then the MSA for the spline hobbing gauges has to be done. The purpose of Measurement System Analysis (MSA) is to determine the amount of variation in a measurement system and to allocate the variation to the categories, Repeatability and Reproducibility. Repeatability is also known as equipment variation. The tool used in MSA is Gage R&R. The Attribute gauges are used in the Spline hobbing. The following Fig.3. shows the analysis of Gage R&R by Fleiss' kappa Statistics method.

After analysing the Measurement System, the current measuring System is compared with the Automotive Industry Action Groups (AIAG) standard for the acceptance and rejection of the Measurement System. The following Table III gives the comparison of the current Measurement System against the AIAG standard. By the result of Measurement System Analysis, the current Measuring System can be considered for further analysis.

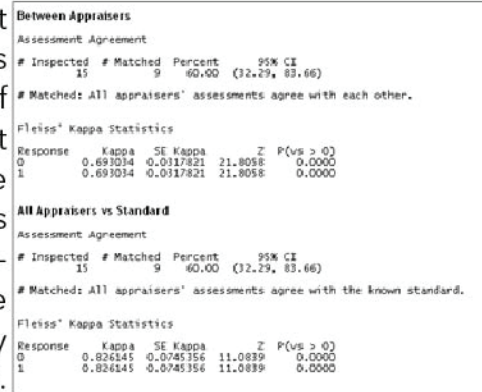
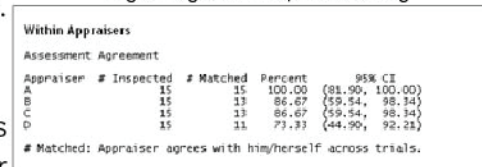


Fig 3. Gage R&R of Spline Hobbing

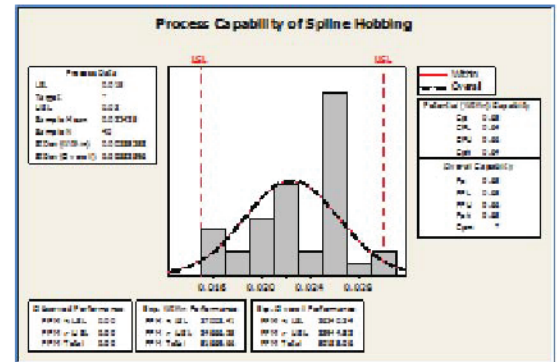


**Table III
Comparison Table**

AIAG guidance for gage R&R				
	Accept	Consider	Reject	Current System
Attribute Gage R&R	<20%	20-30%	>30%	1%

Once the team ascertains that the measurement is capable, then a data collection plan is prepared.

Process Capability is the ability of the process to deliver as per customer requirement consistently. Based on the data collection plan, the Process Capability analysis is done for Spline Hobbing process. In this analysis, 100 samples of continuous production of Spline Hobbing process is collected and the capability analysis is made. Fig. 4 shows the Process Capability for Spline Hobbing. By analysing the process capability of the Spline Hobbing process, it is observed that the process performance is 0.64 and the sigma level is 2.84 based on the expected overall performance. Therefore this process has to be improved. The current sigma level for the overall product 1 is calculated by using a formula, $DPMO = (D / U * O) * 10,00,000$ Where, DPMO : Defects Per Million Opportunity D- Defect : Any occurrence of an opportunity in a process or product that does not meet the Performance standard or CTQ. U- Unit : Anything that is produced or processed - a good, service or information. O- Opportunity: Anything that provides a chance of not meeting a performance standard or CTQ.



	Baseline Performance	Targeted Performance
PPM (or DPMO):	460	100
Sigma Level:	4.8	5.2
COPQ:	Rs. 117500/ Year	Rs. 25000 / year
Relevant Metric:	Quality, cost &time	Quality, cost & Time

Number of Units, U = 510000 Number of opportunities, O = 1
 Number of defects (rejection), D = 235
 Defects Per Million Opportunities, $DPMO = (D / U * O) * 1000000$
 $= (235 / 510000 * 1) * 1000000 = 460$ Sigma Level = 4.8

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Therefore the current sigma level of the product 1 production process is 4.8. Once the baseline sigma level is evaluated, then it is necessary to fix a target level. The following Table IV gives the Baseline performance and the Targeted performance.

C. Analyse Phase

During this phase the data are processed to determine the root cause and discover the opportunity for the improvement. Through the analysis, the field of many Xs are narrow to the vital few Xs using the data collected.

Cause & Effect (C&E) Table is one of the established cause and effect analysis techniques that can be applied to identify unfavourable safety-related outcome and the design of protective measures. The cause and effect table helps in analysing the process which is operating to the Standard operating procedure. If there is any deviation from the standard operating procedure it is necessary to bring the process to the standard operating procedure and further analysis should be done. The factors like speed, feed and hydraulic pressure are considered for the Design of Experiments (DOE).

D. Improve Phase

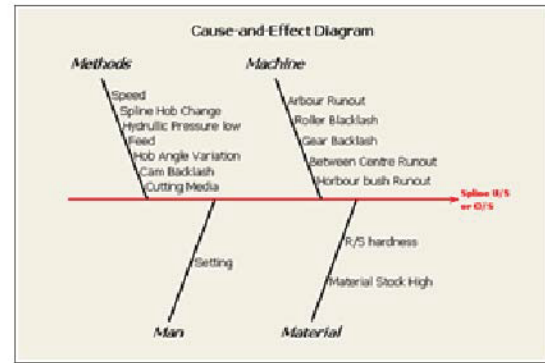
In the Improve Phase, the Design Of Experiment is conducted for the machining parameter to find its optimum operating level. The following table VII shows the Response values for each Run. Then the analysis is made by SN ratio for each run; from the ANOVA table VIII it is clear that only the Grinding Wheel Grit Size is a significant factor. The Optimum parameter selection is done by the help of above Main Effect plot. Speed - 180 rpm, Feed - 0.63mm, Hydraulic Pressure - 35 psi. These parameters are recommended for the confirmation experiments.

TABLE VII

Response Values For The Experiments: A confirmation experiment is the final step of the Design of Experiment. A confirmation experiment is performed by conducting a test using a specific combination of the factors and levels. The purpose of the confirmation experiment is to validate the conclusion drawn from the above analysed data. The Fig.9 shows the process capability for the confirmation experiment. From the Fig. 9, it is clear that, the optimum parameters have improved the performance of the Spline hobbing Process.

E. Control Phase

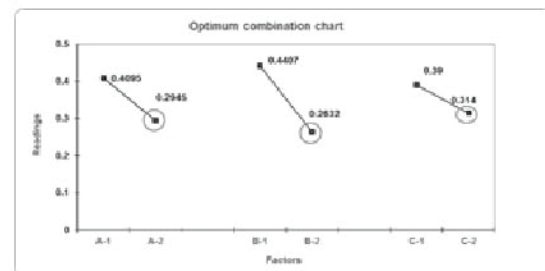
Control refers to the process by which standards are consistently met. The objective of the Control Phase is to determine whether the expected improvements actually occur. Without control of an improved



Sl No	Cause	Is Root Cause	Yes, what is the Effect?	How for the Effect?	Is it checked & fixed?	What is the action?	Diff. in spec. to action	Reference
1	Speed	No	100 RPM	SDP	Technician	100 RPM	No	Consulter for DOE
2	Feed	No	0.2 mm/min	SDP	Technician	0.20 mm/min	No	Consulter for DOE
3	Hydraulic pressure low	Yes	30-35 MPa (psi)	SDP	Pressure tap	34 MPa (psi)	No	Consulter for DOE
4	W/c backlash high	Yes	200/120 0.004	QCPC	Manual Measure Tester	200/110	No	
5	Material stock high	Yes	20.07 (20.07 (1/16))	QCPC	Teem slip gauge	OK	No	
6	Cutting media	Yes	same old S40-C4	SDP	Label	OK	No	
7	100 runout	No	10-12 mm	Operating Manual	Magnetic base dial	0.01	Yes	Bring to the spec
8	Tap and threading center states	Yes	0.02	Operating Manual	Magnetic base dial	0.05	Yes	
9	Between centre runout	No	Free from damage	Operating Manual	Visual	OK	No	Bring to the spec
10	Spine hob change frequency	Yes	100 AC3	SDP	Wall counter	100 AC3	No	
11	Gear backlash	Yes	0.02 mm	SDP	Magnetic base dial	0.02	No	
12	Between center runout	Yes	0.04 mm	SDP	Magnetic base dial	0.04 mm	No	
13	After runout	Yes	0.02 mm	SDP	Magnetic base dial	0.02 mm	No	
14	100 material variation	Yes	40P/20D	SDP	Visual	40P/20D	No	
15	Hob angle variation (cut angle)	Yes	0.01°	SDP	Checked on component parts	0.01°	No	
16	R/S center damage	No	Free from damage	Operating Manual	Visual	OK	No	
17	100 lead condition repeatability	Yes	0.2	Operating Manual	Magnetic base dial	0.1	Yes	Bring to the spec

Exp. No / Run No	Factor and Levels			RESPONSE VALUES									
	1 (S) Speed	2 (F) Feed	3 (G) Hydraulic pressure	1	2	3	4	5	6	7	8	9	10
1	140	0.40	35	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
2	180	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
3	140	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
4	180	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
5	140	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
6	180	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
7	140	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
8	180	0.60	35	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

ANOVA TABLE							
Factor/Interaction (Source of variation)	Degrees of freedom	Sum of squares	Mean square	F-value	F-Ratio	Is it significant?	F-ratio to contribution
(S) Speed	1	0.045	0.045	33.094	4.001	Yes	14.80
(F) Feed	1	0.830	0.83025	78.840	4.001	Yes	35.89
(G) Hydraulic pressure	1	0.10	0.102245	12.703	4.001	Yes	5.64
(S)(F) Hydraulic pressure	1	0.119520	0.11952	14.404	4.001	Yes	6.20
(S)(F)(G)	1	0.030	0.030645	3.708	4.001	No	
Error	74	0.59	0.0080				
Total	79	1.738					62.33



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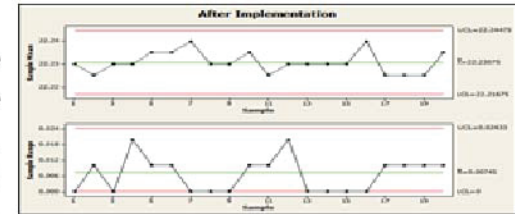
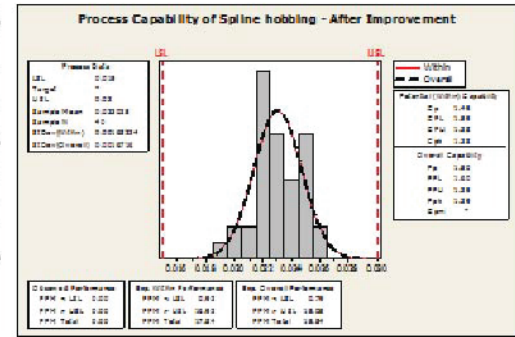
process, the process tends to revert to its old performance. Therefore, as part of the DMAIC process improvement methodology, control provisions must be made prior to the implementation of a new process. After optimising the parameters for Spline Hobbing, the process is monitored for producing to its mean value. The following Fig. 10 represents the control chart for the new process parameters. A control plan is developed and it is maintained for the sustenance of the Spline hobbing process.

IV Result And Discussion

By implementing the improved strategies in the improved phase, the defects are drastically reduced. The following table X compares the current result with baseline performance and targeted performance. Using this systematic approach, the sigma level improved from 4.81 to 5.15 which yielded the result of defect rate reduced from 460 PPM to 130 PPM.

V. Conclusion

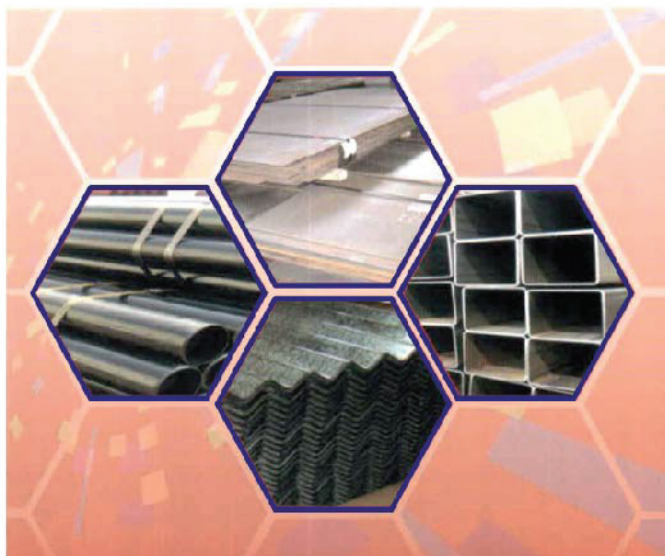
Six Sigma is an accurate systematic framework for quality improvement and business excellence. Improving the quality of the product and the process by reducing the cost of poor quality, the company's growth is increased. By establishing the well-structured Six Sigma DMAIC methodology we can improve the firm's overall growth and its Six Sigma DMAIC methodology is used to reduce the defects rate in the steering gear product. Initially past data were collected for the rejection quantity and measured for the current performance. Then the goal is clearly set for the current problem. A team is formed with different departments and the root causes were collected and validated for the process improvement. Finally DOE is done for the Spline Hobbing process to optimize the operating parameters to reduce the defect Spline Oversize / Undersize. Therefore the rejection is decreased from 460PPM to 130PPM which improves the sigma level from 4.81 to 5.15. Sustained improvements and cost savings are expected through well-established control plan.



Project Baseline:		Project Target:		Project Actual:	
DPMO	460	DPMO	100	DMO	130
Sigma Level	4.81	Sigma Level	5.22	Sigma Level	5.15
Metric	Quality, cost, Time	Metric	Quality, cost, Time	Metric	Quality, cost, Time

TABLE X RESULT

performance. In this project, Six Sigma DMAIC methodology is used to reduce the defects rate in the steering gear product. Initially past data were collected for the rejection quantity and measured for the current performance. Then the goal is clearly set for the current problem. A team is formed with different departments and the root causes were collected and validated for the process improvement. Finally DOE is done for the Spline Hobbing process to optimize the operating parameters to reduce the defect Spline Oversize / Undersize. Therefore the rejection is decreased from 460PPM to 130PPM which improves the sigma level from 4.81 to 5.15. Sustained improvements and cost savings are expected through well-established control plan.



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