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A STUDY OF LEAN SIGMA IN MANUFACTURING FUNCTION OF AN AUTO ANCILLARY

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BONAFIDE CERTIFICATE

Certified that this project report titled **"A STUDY OF LEAN SIGMA IN MANUFACTURING FUNCTION OF AN AUTO ANCILLARY"** is the bonafide work of **Mr.T.G.KIRUBANANDH (68107202052)** who carried out the work under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

Business fundamentally exists to make money, either for shareholder or owners. Lean sigma is a combination of methodologies to provide an organization with greater speed, less variation and more bottom line impact than any other methodology.

Central to lean sigma is the faster rate of improvement in customer satisfaction, cost, quality, speed and invested capital.
The fusion of lean and six sigma is necessary because

1. Lean cannot bring a process under statistical control.
2. Six sigma alone cannot dramatically improve process speed or reduce invested capital.
3. Variation is the enemy of all business; lean sixsigma removes more variation than any other process.

Lean sigma is described as “doing quality quickly” in a simple sentence. Lean sigma works out not by speeding up the workers or the machines, but by reducing the unneeded wait time between value-added steps. Many companies are finding that there is tremendous value creation opportunity in attending the process like Sales and Marketing, Product development, Finance/Administration and Human Resources, simply because they have been overlooked in the past.

The project work will cover the methods followed in an auto ancillary-manufacturing function and the results / benefits obtained by implementing the lean sigma.

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CHAPTER-I

INTRODUCTION

1.1 Background

The role of continuous improvement within organizations has changed and matured throughout history. From the first improvements made through the invention of machines that speed up production to using empirical or statistical methods to analyze processes, industries and organizations have pursued improved operating methods. Certain industries, such as manufacturing, healthcare and pharmaceuticals, focus the majority of their continuous improvement efforts on maximizing the quality of their products and services. For others, continuous improvement is viewed as a mechanism for driving down cost. In addition to cutting costs and improving quality. successful continuous improvement initiatives ultimately change the culture of an organization. The culture change focuses on the motivation and desire of the organization's members to continually improve business processes and policies. This fundamental change in operating and managing processes requires the stimulus of a structured method or program of continuous improvement.

Lean Six Sigma is a combination of two popular continuous improvement methodologies: Lean and Six Sigma. Lean and Six Sigma focus typically on improving the production and transactional processes of all organization. Although each Uses different methodologies and principles to effect the improvement, both have complementary effects. Each of these methodologies has been individually popularized by successful implementations at companies such as Toyota, General Electric. and Raytheon. Many companies are now recognizing the powerful synergy that is produced when these two methodologies are combined and have successfully implemented Lean or Six Sigma. However. these implementations were not without some difficulty. The experiences of the first implementations of Lean and Six Sigma methodologies are unique based on leadership and culture. Subsequent implementations of Lean and Six Sigma have benefited from the literature and experiences produced by these pioneering companies.

1.2 Problem Statement

commonly viewed as a daunting undertaking. Many organizations fail to properly structure or support continuous improvement initiatives which ultimately doom them to failure. The private own experience deploying and implementing Total Quality Management in the mid-nineties is an example of the difficulties in implementing, continuous improvement initiatives across a large organization. This research seeks to identify which key issues must be addressed to successfully manage or eliminate the barriers and challenges of implementing continuous improvement initiatives.

1.3 The company – Pricol Ltd.,

- Established in 1974 as "Premier Instruments Coimbatore Limited" to manufacture Automotive products.
- Established Plant II at Gurgaon, Haryana State, near New Delhi in 1988.
- Eatablished Plant III and IV at Coimbatore, in 1999.
- Established Plant V at Pirangnt, Pune, in 2005.
- Has dedicated dealers / representatives in countries like USA, UK, Germany, Turkey and other places abroad, for better service to customers.
- Products include Dashboard Instruments, Flexible cables, Switches, Sensors, Auto & Taxi Fare Meters, Oil Pumps (2 wheelers), Idle speed control valves, Chain tensioners, etc., predominantly for automotive industries.
- Export products for OEMs and market needs of North America, U.K, Australia, Turkey, Brazil, China and other European countries.
- Leading Customers are OEMs in India include Bajaj Auto Ltd, Hero Honda Motors Ltd, Maruti Udyog Ltd., Tata Motors Ltd., TVS motor company Ltd., etc.,

2003-2004	-	3800
2004-2005	-	4500
2005-2006	-	4800
2006-2007	-	5700
2007-2008	-	6000
2008-2009	-	6400
2009-2010	-	6900(Estimated)

- Employee Strength – 4800 (approx)
- Employed external consultants from M/s.Satyam Computers to implement lean sigma in our operations at Plant III.

1.4 Research Objective

The primary objective of this research is to obtain the benefits to private sector companies succeed at implementing the popular continuous improvement methodology Lean Six Sigma. This research assumes that implementation success is contingent on the ability of the company's leadership to overcome the barriers and challenges of Lean Six Sigma implementation. By identifying the barriers and challenges and comparing the methods or strategies employed to overcome them. This research with recommend effective strategies to enable Lean Six Sigma implementation success. At a general level, this research with expand the body of knowledge of implementation strategies and sustaining quality management programs. Through the investigation of companies that have implemented an emerging quality program, this research will provide valuable information useful for companies or organizations deliberating such implementation decisions.

1.5 Scope and Limitations of the Research

This scope of this research is limited to the deployment and implementation phase of the Lean Six Sigma methodology in private sector companies. Although the data for the research is gathered from the private sector, the barriers and challenges encountered are believed. The research specifically focuses on defining the operational model, the management decisions made to overcome the deployment

CHAPTER-II
REVIEW OF LITERATURE

2.1 Chapter Overview

The private sector uses Lean and Six Sigma to cut cost and improve the quality of their products and services. The complementary nature of Lean and Six Sigma principles has led the private sector to merge the two into a single process- and quality- improvement method. The current focus of the literature is centered on why these two should be integrated. Little research has been done developing, critiquing or comparing actually deployed and implemented Lean Six Sigma efforts. This chapter forms the foundation of the research effort by reviewing literature on Lean and Six Sigma respectively. The chapter then reviews the literature on the integrated Lean Six Sigma methodology.

2.2 Lean

Lean is commonly understood in manufacturing to be the elimination of waste from a process in order to increase process speed and improve quality. Lean production methodology was derived from the Toyota Production System (TPS) created by Taiichi Ohno. who is widely understood to be the father of the Lean methodology. Ohno (1988) further emphasized the link between improved business results with removing waste by stating that "The most important objective of the Toyota system has been to increase production efficiency by consistently and thoroughly eliminating, waste." The reduction on the order-to-cash cycle is an important goal of production and supply chain management (Ohno ,1988; Lambert. 2004) "A streamlined process reduces the order-to- cash cycle which frees up capital. and reduces the delivery lead-time which allows for reduced inventory levels" (Lambert, 2004).

Lean production was brought to the United States by James P. Womack, Daniel T. Jones, and Daniel Roos with their 1990's best seller called *The Machine That Changed the World:* The Story of Lean Production. Womack and Jones introduced the idea of "Lean thinking" which caused significant changes to how to lean production (Womack, Jones. and Roos. 1990).The popularity and success of Lean in production environments has led to the consideration of Lean for the rest of the supply chain. Once applied solely in the manufacturing environment, the term Lean is now applied to theories, activities, and methods focusing on the elimination of waste to speed up and improve processes in any environment. This expanded application of Lean methodology is commonly termed as the "Lean Enterprise." The Lean Enterprise is based on several constructs.

2.3 Lean Principles and Goals

The literature offers several similar descriptions of *Lean* goals and principles. All center on improving processes. A process is defined by *Lean* pioneer James P. Womack as "A series of actions that must be conducted properly in the proper sequence at the proper time to create value for a customer" (Womack, 2004). The following are two examples *of Lean* goals and principles. The first is McAdam's description *of Lean* principles.

1. Specify what does and does not create value from the customer's perspective and not from the perspective of individual firms, functions and departments
2. Identily all the steps necessary to design, order and produce the product across the whole value stream to highlight non value adding waste
3. Make those actions that create value flow Without interruption, detours, backflows, waiting or scrap
4. Only make what is pulled by the customer
5. Strive for perfection by continually removing successive layers of waste, as they are uncovered.

McAdam, 2003

The Lean Enterprise Memory Jogger lists *Lean* goals as 1) improving quality, 2)eliminating waste, 3) reducing lead time, and 4) reducing total cost of a process(Maclnnes 2002). The goal of improving quality is to align the process with process steps, excessive movement of people or materials, and non-value added activities. The focus on the customer drives the determination of what is value or non-value added to a product (Womack and Jones. 1996; George, 2002). The goal of reducing lead times is shortening the time it takes to complete the tasks within a process (Womack and Jones.1996: George. 2002; Ohno, 1988). These reductions enable the process to become more responsive and flexible to customers or other processes. Reduction of total cost is the expected result of reaching the preceding goals. Total cost consists of both direct and indirect costs of the products or services of the company.

These principles and goals originated from the original *Lean* principles set forth by Womack and Jones in "Lean Thinking" (1996). Womack and Jones's *Lean* principles are: 1) specify value, 2) identify the value stream, 3) smooth process flow, 4) production based on pull, and 5) perfection through elimination *of muda* or waste (Womack and Jones, 1996).

2.4 Waste

The literature offers either seven (Womack and Jones. 1996: Maclnnes, 2002; George, 2002; Ohno, 1998) or eight forms of waste (McAdam, 2003). These eight wastes identified in Table 2.4.1 are uncovered through the determination of what the customer values. To uncover the waste and find the value, a lean initiative uses value stream mapping.

Table 2.4.1 Forms of Waste

Waste	Definition
Over Processing	Adding value to a process / product the customer would not pay for
Transportation	Moving raw materials, product or information unnecessarily
Motion	The unnessary movement by people
Inventory	Work-in-process(WIP) that is not directly related to a customer requirement
Wait time	The time that WIP is not directly related to a customer requirement
Defects	Flaws in the WIP, final products or services that do not meet the

Overproduction	Products and services that are in excess to current customer requirement
Unused Human resources	Having excess workforce for the process

Womack and Jones,1996;George,2002;Ohno,1998;McAdam,2003;Maclnnes,2002

2.5 Value -Stream mapping

The Lean Aerospace Initiative at MIT describes the objective of value-stream mapping as "an important lean practice to eliminate waste and make the value-adding steps 'flow' in meeting customer requirements (Merman et. al. 2002). The value stream is further described by Womack and .tones in *Lean Thinking:*

> "A value stream map identifies every action required to design, order, and make a specific product. The actions are sorted into three categories: (1) those that actually create value as perceived by the customer; (2) those which create no value but are currently required by the product development, order filling, or production systems; and (3) those actions which don't create value as perceived by the customer and can he eliminated immediately" (Womack and Jones. 1996).

The "value-stream" or "Value-Chain" mapping is a visual representation of all the steps, tasks, or activities in a process and documents their sequence from start to finish (George, 2002). This mapping is done to identify the current state of the process and use it to determine the steps that are *value* and *non-value added.* A value-added step is one that directly impacts the customer's perception of the product's value. One might ask: "If this step was deleted would the customer complain?" (George. 2005). If yes, then the step is value-added; if no. then the step is non-value added. A non-value added step is one that does not add value to the product according to the customer. Although value-stream mapping is the primary measurement tool of Lean and contributes to the improvement of process speed, other tools are needed to implement the knowledge gained through value-stream mapping,. George (2002) states that "to improve the speed of the process...Pull

2.6 Pull Systems

Pull systems require thinking of production flow in the reverse direction: later processes pull on earlier processes to pick only the right part in the quantity needed, and exactly when needed (Murman et al. 2002). In production environments, a pull system is a method of managing work-in-process (WIP). WIP describes materials that are in the process of becoming finished products. As raw materials enter the process, the time the remain in the process is calculated. This time is described as the end Products lead time. If WIP exceeds the capacity of any individual process step, the lead times of completed products increases. If raw materials continue to he released into the process then lead times continue to increase. A pull system only releases raw materials or WIP once the preceding process step completes the WIP it is currently working on. This method of WIP management is also called a kanban which is the Japanese word for card. "The kanban system is said to have been inspired by the supermarket system—instead of using a system of estimated replenishment, the store restocks only what has been sold. Thereby reducing defective inventories" (Shingo, 1989).

2.7 Six Sigma

Six Sigma is a continuous improvement methodology that focuses on the reduction of variation. Sigma represents the standard deviation, a unit of measurement that designates the distribution or spread about the mean of a process (Six Sigma Academy, 2002). Six Sigma as a business initiative was first espoused by the Motorola Corporation in the early 1990s (Breyfogle. 1999). Six Sigma's roots can be traced back to the 1920s through the contributions of many mathematicians, statisticians, and quality specialists. These efforts cumulated in the analysis tools contained in Statistical Process Control (SPC) and were combined with analysis methods defined and refined by Six Sigma pioneers Dr. Mikel Harry and the Motorola company's Bill Smith (Upton and Cox, 2002; Harry and Schroeder, 2000). Six Sigma is defined as a statistic, a philosophy, and a methodology. As a statistic in the quality paradigm, it is 3.4 defects per 1million opportunities and is related to the cost of quality (Harry and Schroeder. 2000). The philosophy of Six Sigma is the use of data quality variation. The Six Sigma methodology is a five-phase, disciplined approach to continuous improvement. The five- phases are Define. Measure, Analyze, Improve, and Control. These phases are referred to as DMAIC.

DMAIC

During the *Define* phase. projects are organized, improvement goals are set, and the overall value of the project is determined. Project teams and project sponsors use qualitative tools such as fish-bone and affinity diagrams to determine what resources are involved and to design a problem solving process. During the *Measure* phase the process is mapped and relevant data are collected. Process maps are first done at a high level and then continually refined as more quantitative data are collected. Graphical analysis of variation and root causes, such as time-series plots or run charts and Pareto charts, respectively, are also constructed to further enrich the available data. The time-series plots or run charts show the data in the order they occurred and valid show how the process changes over time. Pareto charts are a type of bar chart that categorizes the data to highlight the impact of a certain effect. The *Analyze* phase is then used to apply statistical tools to the collected data to determine process capability and sources of variation. The in-depth knowledge gained from using the Six Sigma tools helps the team specifically identify the problems or defects that are contributing to quality variation of the product. This analysis lays the foundation for improving the process. The *Improve* phase uses the knowledge gained from the *Measure* and *Analyze* phases to alternate possible solutions. These solutions are then prioritized, piloted, and then implemented. The project then moves into the *Control* phase. During this phase the improved process is validated and handed over to the process owner. The process owner is provided a set of metrics or other measures they can use to ensure the implemented solution continues to perform as expected. Periodic validations should then be conducted by the project leader to ensure consistent process performance (George, 2005). The structure of DMAIC encourages creative thinking within boundaries such as keeping the basic process. product or service (George. 2005). This structure ensures that the project team remains focused on the current problems and provides the leadership with a reliable, consistent result.

2.8 Lean Six Sigma

"In a system that combines the two philosophies, Lean creates the standard and Six Sigma investigates and resolves any variation from the standard" (Breyfogle. 2001). A leading Lean Six Sigma advocate, Michael George from the George Group, states that the purpose of Lean Six Sigma is two goals. First. "to transform the CEO's overall business strategy from vision to reality by the execution of appropriate projects," and second. "to create new operational capabilities that will expand the CEO's range of strategy choices going forward" (George, 2002). Alternatively, Lean Six Sigma has been defined as "a defined approach that synthesizes the use of established tools and methods" (Shere. 2003). The tools and methods of the Lean Six Sigma practitioner encompass the tool sets of both Lean production and Six Sigma. Dr..liju Antony (2003), a researcher of Lean and Six Sigma at the Caledonian Business School of Glasgow Caledonian University, concludes that "...the disciplined and systematic methodology of Six Sigma combined with the speed and agility of Lean (methodology) will produce greater solutions in the search for business and operations excellence."

CHAPTER-III

METHODS

Project Selection

The project – Implementation of 'Lean sigma in 4 stroke oil pump line' was selected, to address 'Total supply chain' (customer order to product delivery) with 'Units of measurement' (also known as 'Lean Metrics') as

RTY - Rolled Throulput Yield = Y1 x Y2 x .....Yn where
Y1,Y2.....are yield at each process

OEE - Overall Equipment Effectiveness = Availability x Usability x Performance Efficiency x Quality Rate

BTS - Built to Schedule = Volume x Mix x Sequence

DTD - Dock-to-Dock Time = Total Units of Control part / End of line rate

The selection was based on the 'value streams' that showed the most promise for growth and which is quickly followed by projects that will most likely yield the greatest benefits in those value steams.

Project Team Formation

The champion, Master Black Belt, Sponsor and Black belt have jointly formed the team consisting members from other relevant disciplines like Production, Materials (purchase), Mfg. Engg., Quality Engg. Etc.

Lean Metrics

Base data for RTY, OEE, BTS and DTD are collected form the history of past 5 months along with the current status and the targets for the lean metrics have been finalized.

Project Master Plan

The individual tasks in the DMAIC methodology of six sigma (Define, Measure, Analyze, Improve and Control) are listed sequentially and the time plan (start and end dated) is finalized for each task and phase of six sigma to review upon

Value Stream Mapping (VSM)

This is a tool used to visually map the material and information flow of a product or process for the entire operation starting from the receipt of raw material, through all manufacturing process steps, and off the loading dock as finished products, with a goal to identify and eliminate the waste in the process.

Activities derived from VSM are categorized as task, kazen and six sigma projects based on the effort required for making improvements and nature of the improvement (Quality, Productivity) required and responsibility for those project had been fixed with adequate target dates.

Six Sigma Projects

i) Improving In-coming quality of pressure Die Casting components supplied by vendors.

ii) Elimination of vibration marks in the "Pump Casing Plate" Milling process thus avoiding rework and rejection of the same. The productivity improvement to be 50% above the present level.

iii) Reduction in in-process rejection of "Control Shaft"

Tasks

i) Reducing lead time, Inventory and creating Multi point procurement at M/s. Hybrid Auto Cast, Chennai.

ii) Creating Super Market before reaming process (Pump Body) and creating kit system before assembly.

iii) Cell formation for machining 'Pump Body' – Reaming, OD turning, Spot facing and Tapping.

iv) Reducing Lead time, Inventory and creating multi point procurement at M/s Kala Auto Tex / M/s Libra Industries.

v) Set-up/change over time reduction in compacting process of "Rotors"

vi) Setting time reduction in Double Disc Grinding Machine for " Rotors"

vii) Reduction of Nick marks and damages in " Rotors "

viii) Line Balancing

ix) Semi automation of "face clearance checking" process

xi) Reducing lead time at Goods Inward Inspection.

Visual Management

Its is the use of controls that mill enable an individual to understand the status and immediately recognize the standard and any deviation from it.

"Must do's" for implementing lean Sigma

1. Pick the right projects
2. Pick the right people
3. Follow the method (DMAIC Reviews for teams working on issues that affect our work areas)
4. Clearly define roles and responsibilities
5. Communicate, Communicate, Communicate (to support lean Sigma Efforts either directly or indirectly
6. Support education and training.

Note on the project

There are several six sigma projects and tasks have been identified and completed towards implementation of lean sigma.

The report here covers only a sample in each of the above approaches – one each in six sigma project and task which are identical for all the six sigma projects and tasks taken up in the execution of lean sigma methodology.

CHAPTER-IV

. DATA ANALYSIS AND INTERPRETATION

4.1 PROJECT DETAILS

Project Description : Implementation of Lean Sigma in Piaggio 4S oilpumpline

Project Y : Elimination of waste through " Lean Sigma "

Products Addressed : M27340 / M27370 / M27380

Processes Addressed : Total supply chain (Customer order to product delivery)

Unit of Measurement: Rolled Throughput yield (RTY), Overall equipment Efficiency (OEE), Build to schedule (BTS) & DTD (Dock to dock Time (or) Lead time

Operational Definition:

1. RTY = Y1 * Y2 * Y3 * ....Yn (where y1, y2.... Are yield at each process)
2. OEE = Availability * Usability * performance efficiency * Quality rate
3. BTS = Volume * Mix * Sequence
4. DTD = Total units of control part / End of line rate

BSC Measure impacted: Impact on COQ, Productivity, Customer schedule adherence, Inventory management and Total cost impact on COQ

4.2 PROJECT TEAM DETAILS

BLACK Belt	:	N.P. Loganathan
Champion	:	V. Shankar
Sponsor	:	P.M. Saravanabhavan
Master Black Belt	:	VSRC Murthy/Bharathi Mugilan

Team Members:

1. K. Balasubramanian	:	CIT
2. R. Gobinath	:	P& S (P) – MODULE – 607
3. S. Sarathbabu	:	P& S (P) – MODULE – 607
4. K. Selvaraj	:	BD (EXPORTS)
5. G. Senthilkumar	:	MATLS (P)
6. R. Sathyakumar	:	MATLS (P)
7. R. Manoharan	:	ME
8. P. Prabhakaran	:	Costing
9. A.Annaselvam	:	SCMS
10. R. Chandramohan	:	PMD
11. R. Gunasekar	:	HTS
12. R. Rangaraj	:	STORES
13. L. Rajagopal	:	QE

4.1.1 METRICS - BASE DATA, CURRENT LEVEL & TARGET

letric	BASE DATA	CURRENT LEVEL (July-09)	TARGET
OEE (%)	62.18	90.56	90
RTY (%)	M27380-76.91	M27380-92.63	M27380>95
BTS (%)	100	100	100
DTD Days)	M27380-P.Body - 13.67 Days, M27320-P.C. Plate - 8.5 Days, M27320 C.Shaft - 55 Days, M27320 Drn & Drg Gear - 62 days, Total DTD For M27340, 70 & 80 - 135 days (From R.M. to product reaching at customer end)	M27380-P.Body - 3.16 Days, M27320-P.C. Plate - 4 Days, M27320 C.Shaft - 10 Days, M27320 Drn & Drg Gear - 33.0 days, Total DTD For M27340, 70 & 80 - 95 days (From R.M. to product reaching at customer end)	Target (Reduction %) P.BODY - 76.8 % PC Plate - 51.0 % C.Shaft - 81.8 % Drn & Drg Gear - 46.6 %

4.1.2 METRICS - BASE DATA, CURRENT LEVEL & TARGET

UOM	PRODUCT / LINE	BASE DATA	TARGET	DATA				
				MAR'09	APR'09	MAY'09	JUN'09	JUL'09
%	PIAGGIO ASSY LINE - OEE	62.18	90	66.8	74.06	84.77	85.95	90.56
%	M273 80 - RTY	76.91	> 95	88.17	90.28	91.98	90.45	92.23
%	PIAGGIO ASSY LINE - BTS	100	100	100	100	100	100	100
DAYS	PUMP BODY	13.67	80% REDUCTION					
	CONTROL SHAFT	55	80% REDUCTION					
	DRIVING & DRIVEN GEAR	62.17	50% REDUCTION					
	PUMP CASING PLATE	8.5	50% REDUCTION					

4.3 PROJECT MASTER PLAN

TASK NO.	TASK	No. of Days	Start Date	End Date	STATUS
Lean Sigma in Piaggio 4S Oil pump		**103 days**	**13-Jan-09**	**6-Jun-09**	
	Define Phase	**16 days**	**13-Jan-09**	**3-Feb-09**	
1	Project slection	1 day	13-Jan-09	13-Jan-09	
2	Identification of Team Members	1 day	13-Jan-09	13-Jan-09	
3	Phase 1 Training	3 days	23-Jan-09	25-Jan-09	
4	Project Kick -off Meeting	1 day	27-Jan-09	27-Jan-09	
5	Base Data Collection	3 days	30-Jan-09	1-Feb-09	
6	Current Sate Value Stream Mapping	5 days	30-Jan-09	3-Feb-09	
7	Review by core Team	1 day	3-Feb-09	3-Feb-09	
8	Steering Committee Review	1 day	1-Feb-09	1-Feb-09	
	Measure	**25 days**	**30-Jan-09**	**3-Mar-09**	
9	Data Collection	10 days	30-Jan-09	11-Feb-09	
10	Future State Value Stream Mapping	1 day	10-Feb-09	11-Feb-09	
11	Review by core Team	1 day	13-Feb-09	13-Feb-09	
12	Identify and kick-off Six Sigma Projects	2 days	10-Feb-09	13-Feb-09	
13	Phase 2 Training	2 days	8-Feb-09	9-Feb-09	
14	Identify Value Stream Tasks	4 days	14-Feb-09	17-Feb-09	
15	Review by core Team	1 day	20-Feb-09	20-Feb-09	
16	Identify and Revise the Value Stream Tasks	1 day	21-Feb-09	21-Feb-09	
17	Steering Committee Review	1 day	3-Mar-09	3-Mar-09	
	Analyse	**66 days**	**10-Feb-09**	**12-May-09**	
18	Standard work charts and Spaghetti chargs	2 days	22-Feb-09	23-Feb-09	
19	Identify Actions for Line Balancing	5 days	20-Feb-09	24-Feb-09	

20	Core Team Review	1 day	27-Feb-09	27-Feb-09	
21	VA/NVA Analysis	5 days	27-Feb-09	3-Mar-09	
22	Analyse Setup Changeover	5 days	6-Mar-09	10-Mar-09	
23	Analyse Demand and generate production plan	3 days	13-Mar-09	15-Mar-09	
24	Complete all the projects Kicked off	60 days	10-Feb-09	4-Feb-09	
25	Review by core Team	1 day	10-Mar-09	10-Mar-09	
26	Collection of all Action items and Revise Value Stream Tasks	2 days	5-Apr-09	6-Apr-09	
27	Review by core Team	1 day	7-Apr-09	7-Apr-09	
28	Steering Committee Review	1 day	12-May-09	12-May-09	
	Improve	**16 days**	**7-Apr-09**	**28-Apr-09**	
29	Implementation of cell layout	15 days	10-Apr-09	28-Apr-09	
30	Implement KANBAN	15 days	10-Apr-09	28-Apr-09	
31	Review by core Team	1 day	7-Apr-09	7-Apr-09	
32	Create level Pull	5 days	17-Apr-09	21-Apr-09	
33	Work Place organisation & 5S	2 days	10-Apr-09	11-Apr-09	
34	Review value stream Tasks	1 day	28-Apr-09	28-Apr-09	
35	Review by core Team	1 day	28-Apr-09	28-Apr-09	
	Control	**37 days**	**17-Apr-09**	**6-Jun-09**	
36	Create Standard Work	5 days	1-May-09	5-May-09	
37	Operator Training	3 days	8-May-09	10-May-09	
38	Review by core Team	1 day	15-May-06	15-May-09	
39	Create Andon Boards and Visual Management	30 days	17-Apr-09	26-May-09	
40	Create Inspection Standards / Control plans	2 days	29-May-09	30-May-09	
41	Core Team Review	1 day	31-May-09	31-May-09	
42	Project Closure and Management Presentation	4 days	1-Jun-09	6-Jun-09	

4.4 LEAN SIX SIGMA PROJECT STATUS

CONSOLIDATION OF ACTIVITIES FOR LEAN SIGMA PROJECT IN PIAGGIO 4S OIL PUMP ASSY							
Sl. No.	**Part name / Name**	**Activity derived from VSM**	**Task / 6-Sigma Project / KAIZEN**	**Responsibility**	**Saving In Mn**	**Target Date**	**Actual Completion date**
1	Pump Body & P.C. Plate	Die Casting blow holes & Porosity problem (Pump body & P.C. Plate)	6-Sigma Project	K.Balasubramaniam	0.286	15.5.2009	15.5.2009
2	P.C. Plate	Solving vibration mark & tapper problem in Double disc milling process	6-Sigma Project	M.Sureshkumar	0.2	31.7.2009	31.7.2009
3	Drive Gear & Driven Gear	Tip Clearance quality issue	6-Sigma Project	N.P. Loganathan	0.12	20.7.2009	20.7.2009
4	Control Shaft	Solving Nitriding growth & M6 Thread tight problem (Salt Deposition) in nitriding process	6-Sigma Project	V.RAVI	0.103	10.7.2009	10.7.2009
				Total	**0.709**		

Sl.. 3 is combined with TASK Sl no.10[illegible] (Nick & Dent mark issues)

4.6.1 Results on Improvements Made

IE CASTINGS PROJECT STATUS

l o	Part number / Name	Base level rej %	Rej % as on Mar-09	Action initiated	Rej % Apr-09	Rej % May-09	Rej % Jun-09	Rej % Jul-09
	M27380-Pump body	10.69	**4.50** (This 4.5% includes both M/s.Hybrid & M/s.Sreealloys supplies)	a. Process study at supplier end-completed b. Bulk melting and Holding furnace introduced c. Degasing practice implemented d. Shot blasting & Turning process established at supplier end e. MSA study conducted at casting stage & turning stage	5.28	4.01	4.90	3.90
	M27370-Pump body	26.72	13.16	a. Tool has been shifted from M/s.Sargam metals to M/s. Hybrid auto cast b. Sample lot produced thro Bulk melting & Holding furnace with degasing c. Shot blasting & turning process established (Sample lot approved) d. Bulk lot 200Nos will be processed on Apr-2009-completed on 25-Apr-09 e.MSA study to be conducted (Planned on 19-Apr-09)-completed on 25-Apr-09 f. Existing components are being received from M/s.Jothidayal inds	5.75	5.04	Nil schedule	5.00
	M27340-Pump body	22.13	9.73 (M/s.Jothidayal)	a. Turning process will be done by supplier at M/s.Balaji CNC as MPP from 15-Apr-09 - completed b. New tool already made.Sample lot expected on 22-Apr-09.Tool is under minor corrections.	2.73	New tool sample received.Minor dimensions to be corrected.(Nil schedule)	Nil schedule	5.37 (Old lot)
	M27320-P.C.Plate	6.63	3.68	a. M27350-Tool has been shjfted from M/s.Sargam metals to M/s.Hybrid	3.19	2.40	2.53	1.53
	M27350-P.C.Plate	6.50	2.60	b. Shot blasting process established at supplier end (Samples 100Nos accepted)	1.83	2.90	Nil schedule	1.50
			(M/s.Jothidayal & M/s.Hybrid)	c.Bulk supply will be 20-Apr-2009-Completed 2500Nos received & accepted d. MSA study conducted before trimming & shot blasting (Result:Not accepted) e. Re MSA study to be conducted after trimming & shot blasting (Planned on 19-Apr-2009)-completed on 26-Apr-2009				

4.6.2 INITIAL LEVEL DATA SHEET

ANNEXURE-A

no	Part name	Cost from shot blasting upto cleaning	Final inspection cost	Total cost / piece	Current rej %	Target %	Qty rejected	Qty rej / Annum	Rejected cost	Saving	% Improve ment
1	M27380-Pump body	6.35	0.52	6.87	10.69	4	8348Nos / 4months	25044	172052	106672	62%
2	M27370-Pump body	15.14	0.52	15.66	26.72	5	2016Nos / 2months	12096	189423	151539	80%
3	M27340-Pump body	6.45	0.52	6.97	22.13	5	603Nos / 3months	2412	16812	13113	78%
4	M27320-P.C.Plate	1.04	0.23	1.27	6.63	3	6178Nos / 4months	18534	23612	12987	55%
5	M27350-P.C.Plate	2.14	0.23	2.37	6.50	3	494Nos / 4months	1482	3518	1935	55%
										286246	
	Final inspn cost (Body)	126Nos/Hr	0.476Min/ piece	1.0941667	0.520744						
	Final inspn cost (Plate)	280Nos/hr	0.214Min/ piece		0.234116						

Estimated savings / Annum : Rs 0.286Mn

4.6.3 FINAL IMPROVEMENT DATA SHEET

art number	Total Qty/annum	Initial rej %	Rej qty / annum	Rej cost / unit	Total rej cost	Impmnt (Target)	Cost in Rs	Actual improvement	Actual savings in Rs	Current rej % level
7380010000- np body	234330	10.69	25049.88	6.87	172092.70	0.62	106697.45	0.64	110139.30	3.90
7370010000- np body	51756	23.26	12038.45	15.66	188522.10	0.8	150817.65	0.82	154588.09	5.00
7340010000- np body	10044	22.13	2222.74	6.97	15492.48	0.78	12084.13	0.87	13478.46	2.73
7320040000- .Plate	279621	6.63	18538.87	1.27	23618.52	0.55	12990.19	0.769	18162.64	1.53
7350040000- .Plate	22791	6.50	1481.42	2.37	3516.88	0.55	1934.24	0.77	2708.00	1.50

er annum : Rupees Two lakhs nintynine thousand seventy six only) **TARGET : 284524 ACHIEVED : 299076**

ving / annum : Rs 0.299Mn

4.7 Project Plan

Phase	Planned completion date	Actual completion date	R/Y/G status
Define	28-Feb-2009	24-Feb-2009	G
Measure	15-Mar-2009	24-Mar-2009	G
Analyse	15-Apr-2009	15-Apr-2009	G
Improve	15-May-2009	30-May-2009	
Control	31-May-2009	5-Jul-2009	

4.8 TASK NO: 4

Task Description : Cell formation: Reaming, OD turning, Spot facing and Tapping

Project 'Y' : Process cost in Rupees

Base Line : Rs. 1.98 / Component

Target : Rs. 1.42 / Component

Financial Benefits : Rs. 0.14 Millions

Other Benefits : Inventory reduction / Space savings

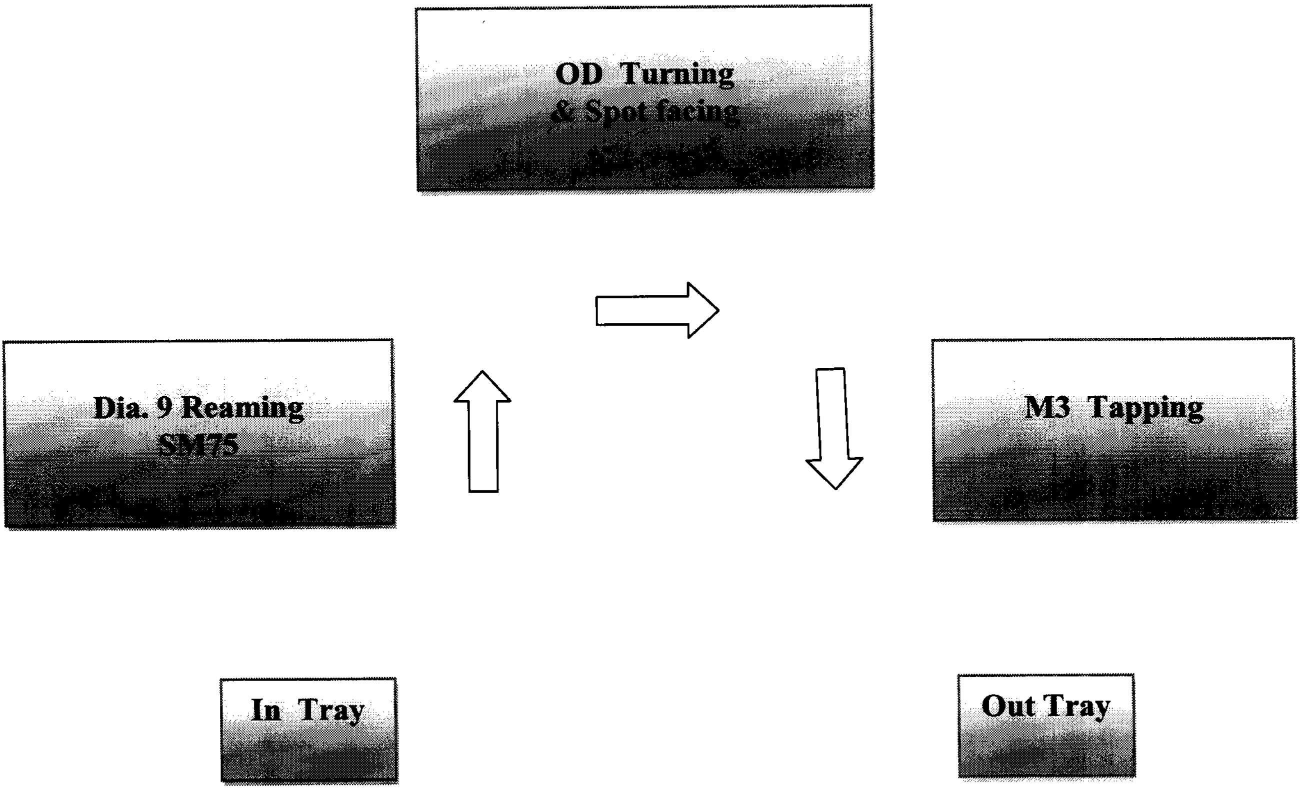
Team Details : Mr.Arokiadoss – Mfg.Engg
Mr.Srinivasan – MOD 607

4.8.1 Estimated time after Body line cell formation

Sl no	Process Description	Machine	Std time in Secs		Station time Secs	Output / Hr.nos
			Man	Machine		
1	**Dia. 9 Reaming**					
	Unloading & Loading	SM75	4.42			
	Reaming			31.20	35.62	101
2	**OD Turning**					
	Unloading & Loading	SM57	4.42			
	Gauge checking		7.47			
	Turning			13.52		
3	**Spot facing**					
	Unloading & Loading	SM57	4.42			
	Spot facing			8.00		
4	**M3 Tapping**					
	Unloading & Loading	SM182	2.09			
	Indexing		2.12			
	Tapping			4.16		
	Storing & picking		2.09			
	Inspection		0.25			

No of Opr.
1

MODIFIED LAYOUT



4.8.2 COST WORK SHEET - BEFORE

PUMPS DIVISION COMPONENT COST WORKINGS - 2009

ustomer	: Piaggil	Raw Material Code		Bought out
roduct	: Oil Pump Assy 4S	Raw Material Description		
omponent C	: 22738001CL1P	Raw Material Cost pe	Rs.	
omponent D	: Body	Conversion per Kg	Nos.	
equirement / month in No	13807	Raw Material Cost / C	Rs.	

l no	V or I	Process Code	Process Description	Machine Used or Po.No. / Jo.No	Machine Hour Rate (A) Rs	Setting time (B) Hours	Batch Qty (C) Nos	Setting Cost D=(A*B/C) Rs	Production Qty per Hour (E) Nos	Process cost per piece F=(A/E) Rs	Process + Setting Cost (D+F) Rs	Cost upto previous process Rs	% Rejection	Cost After Existing Process Rs	Tool Cost Rs	Tool life Nos	Tool Amortn. Cost Rs
1	V	227380010	Die Casting + Matl	4500160596							9.27	0.00	0.00	9.27			
2	I		Shot Blasting	SC 019	180.25	0.00	2500	0.00	2500	0.07	0.07	9.27	0.00	9.34			
3	V	22738001T	Turning	5500053434							2.75	9.34	0.00	12.09			
4	I		Reaming	SM 058	72.41	0.50	2500	0.01	115	0.63	0.64	12.09	1.00	12.86	1000	150000	0.01
															250	10000	0.03
5	I		OD Turning & Spot Facing	SM 057 - M273	137.24	0.50	2500	0.03	135	1.02	1.04	12.86	0.50	13.98	4000	200000	0.02
	I			MD 005 - M273											1678	5000	0.33
															400	200000	0.00
6	I		Tapping (Twin Head)	SM 182	102.62	0.25	2500	0.01	275	0.37	0.38	13.98	0.50	14.43	644	5000	0.13
															3600	200000	0.02
															146	6000	0.02
7	I		HPW Cleaning	SC 033	201.25	0.00	2500	0.00	324	0.62	0.62	14.43	0.00	15.06			
						TOTAL								**15.06**			**0.56**

4.8.3 COST WORK SHEET - AFTER

PUMPS DIVISION COMPONENT COST WORKINGS - 2009

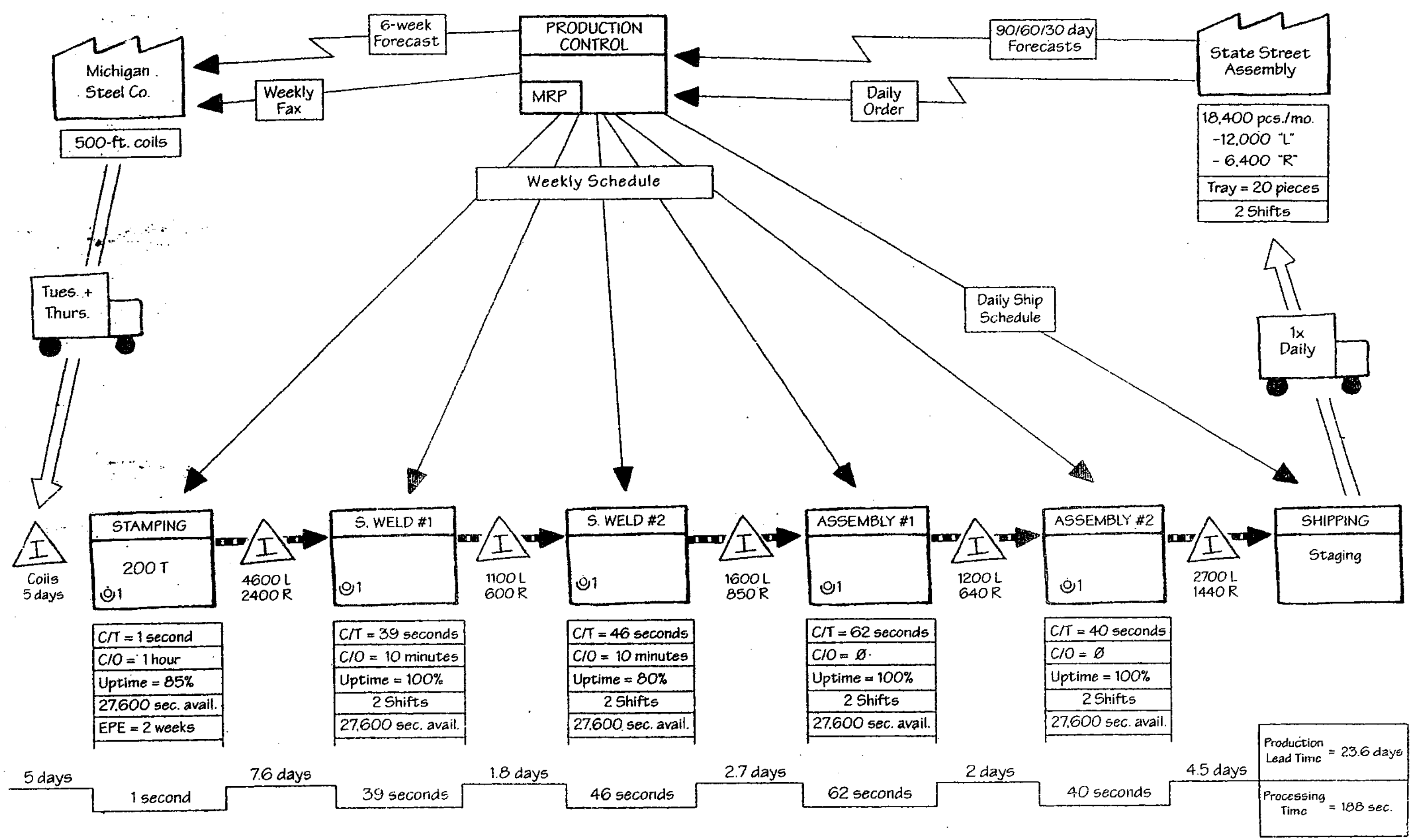
ner : Piaggil
t : Oil Pump Assy 4S
onent C : 22738001CL1P
onent D : Body
ement / month in Nos 13807

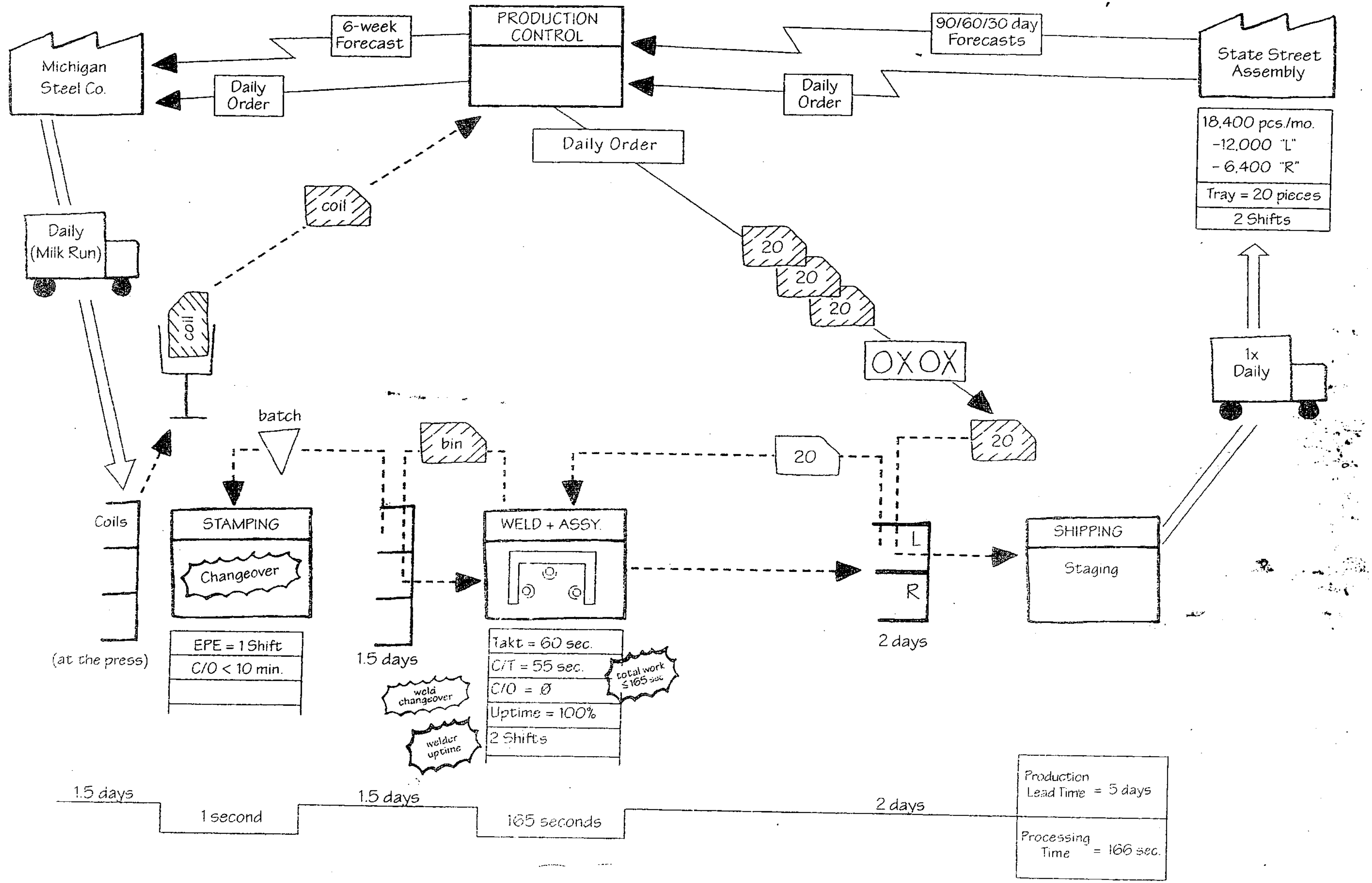
Raw Material Code Bought out
Raw Material Description
Raw Material Cost pe Rs.
Conversion per Kg Nos.
Raw Material Cost / C Rs.

V or I	Process Code	Process Description	Machine Used or Po.No. / Jo.No	Machine Hour Rate (A) Rs	Setting time (B) Hours	Batch Qty (C) Nos	Setting Cost D=(A*B/C) Rs	Production Qty per Hour (E) Nos	Process cost per piece F=(A/E) Rs	Process + Setting Cost (D+F) Rs	Cost upto previous process Rs	% Rejection	Cost After Existing Process Rs	Tool Cost Rs	Tool life Nos	Tool Amortn. Cost Rs
V	227380010	Die Casting + Matl	4500160596							9.27	0.00	0.00	9.27			
I		Shot Blasting	SC 019	180.25	0.00	2500	0.00	2500	0.07	0.07	9.27	0.00	9.34			
V	22738001T	Turning	5500053434							2.75	9.34	0.00	12.09			
I		Reaming	SM 058	60.88	0.50	2500	0.01	101	0.6	0.61	12.09	1.00	12.86	1000	150000	0.01
														250	10000	0.03
I		OD Turning & Spot Facing	SM 057 - M273	58.49	0.50	2500	0.01	101	0.58	0.59	12.84	0.50	13.49	4000	200000	0.02
I			MD 005 - M273											1678	5000	0.33
														400	200000	0.00
I		Tapping (Twin Head)	SM 182	55.85	0.25	2500	0.01	101	0.55	0.56	13.49	0.50	14.12	644	5000	0.13
														3600	200000	0.02
														146	6000	0.02
I		HPW Cleaning	SC 033	201.25	0.00	2500	0.00	324	0.62	0.62	14.14	0.00	14.74			
				TOTAL									14.74			0.56

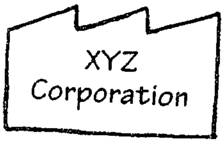
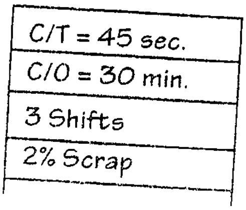
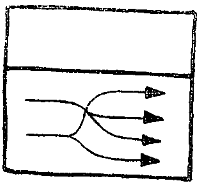
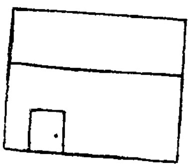
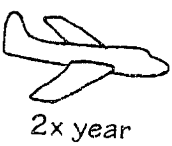
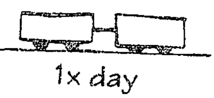
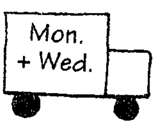
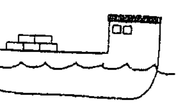
aving / component	Rs 0.32
ne / month	25000 Nos
aving / month	Rs 8000
aving / Annum	Rs 96000

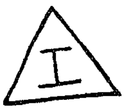
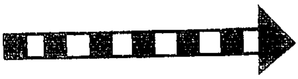
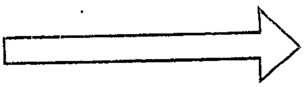
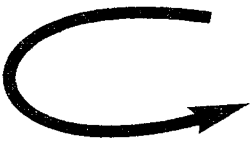
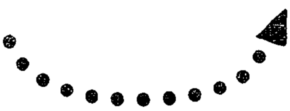
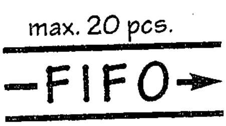
Current-State Value-Stream Map

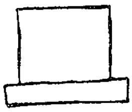
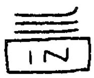




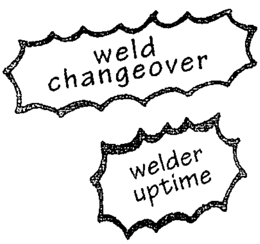
Michigan Steel Co.
6-week Forecast
Daily Order
PRODUCTION CONTROL
90/60/30 day Forecasts
Daily Order
State Street Assembly
18,400 pcs./mo.
-12,000 "L"
- 6,400 "R"
Tray = 20 pieces
2 Shifts
Daily Order
coil
Daily (Milk Run)
coil
20
20
20
OXOX
1x Daily
batch
bin
20
20
Coils
(at the press)
STAMPING
Changeover
EPE = 1 Shift
C/O < 10 min.
1.5 days
weld changeover
welder uptime
WELD + ASSY.
Takt = 60 sec.
C/T = 55 sec.
C/O = Ø
Uptime = 100%
2 Shifts
total work ≤165 sec
L
R
2 days
SHIPPING
Staging
1.5 days
1 second
1.5 days
165 seconds
2 days
Production Lead Time = 5 days
Processing Time = 166 sec.

Material Icons	Represent	Notes
	Process	One process box equals an area of flow. All processes should be labeled. Also used for departments, such as Production Control.
	Outside Sources	Used to show customers, suppliers, and outside manufacturing processes.
	Data Box	Used to record information concerning a manufacturing process, department, customer, etc.
	Cross-Dock	Materials are not stored but rather moved from in-bound trucks to shipping lanes for out-bound trucks.
	Warehouse	Materials are placed in storage locations (binned) and then picked for out-bound shipment at some later point.
	Plane Shipment	Note frequency of shipments.
	Train Shipment	Note frequency of shipments.
	Truck Shipment	Note frequency of shipments.
	Boat Shipment	Note frequenc

Material Icons	Represent	Notes
 300 pcs. 1 Day	Inventory	Count and time should be noted.
	Movement of production material by pushing.	Material that is produced and moved forward before the next process needs it; usually based on a schedule.
	Movement of finished goods to the customer.	
	Milk Run	
	Expedited Transport	
	Supermarket	A controlled inventory of parts that is used to schedule production at an upstream process. The open side faces the supplying process.
	Withdrawal	Pull of materials, usually fro a supermarket.
	Transfer of controlled quantities of material between processes in a first-in, first-out sequence.	Indicates a method to limit quantity and ensure FIFO flo of material between process Maximum quantity should b noted.
	Buffer or Safety Stock	"Buffer" or "safety stock" must be noted.

Information Icons	Represent	Notes
	Control Center	Often a computerized system such as a Material Requirements Planning system.
	Phone	Usually for expedited information.
	Orders	Often in electronic form.

General Icons

	Operator	Represents a person viewed from above.
	Kaizen Lightning Bursts	Highlights improvement needs on a value-stream map at specific processes that are critical to achieving the value-stream vision; can be used to plan kaizen workshops.
	Go-See Scheduling	Adjusts schedules based on checking inventory levels.

GUIDELINES FOR CELL LAYOUT

- Place machines and workstations close together to minimize walking distance.
- Remove obstacles from the efficient operator walking path.
- Try to keep the inside with of a cell at around five feet to allow flexibility in reallocating work elements among team members. With a width of no more than five feet, team members can easily walk across the inside of the cell during their work cycle.
- Eliminate spaces and surfaces where work-in-process inventory can accumulate.
- Maintain consistent heights for work surfaces and points of use.
- Locate the leadoff and final processes near one another. This minimizes return walking for the next cycle and allows one operator to easily handle both the leadoff and final process. When this is possible it greatly aids line pacing.
- Avoid up-and-down and front-to-back transfers of the work piece. If possible, keep the sides of the machines open to allow horizontal transfers on the shortest path between them.
- Use gravity to assist operators in placing parts and moving materials whenever possible.
- Install flexible utility drops from the ceiling to make layout adjustments easier.
- Keep hand tolls as close as possible to the point of use and orient them in the direction that they are used by operators.

- Absolutely ensure safety and good ergonomics.

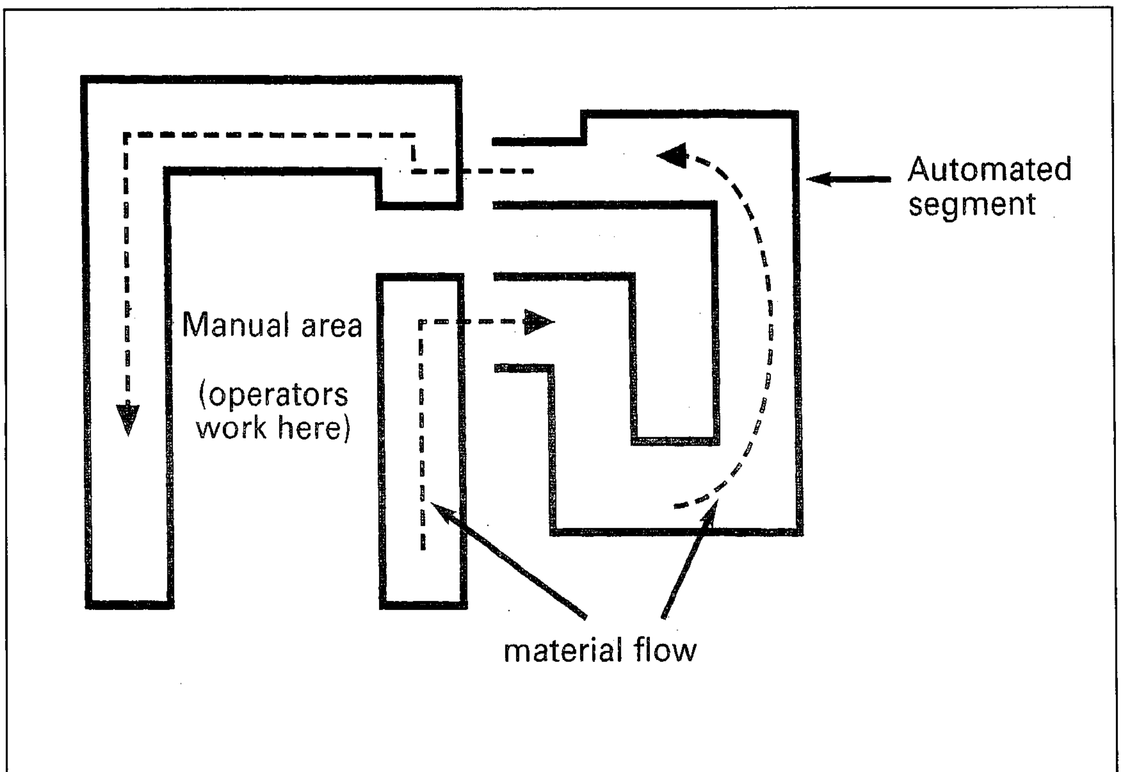
  A lean process is designed to support the operator and value – added working. Poor ergonomics is undesirable from a human standpoint and contributes to waste.

- Keep manual, operator – based work steps close together to allow flexible work element distribution and value-added operator work.

- Segregate level of 5 automation and continuous-cycle operations from manual operators or operator-based work flow, as shown in the diagram below.

  Note that an automated segment incorporated into a cell in this manner must be highly reliable. If reliability is poor and hard to improve, begin by placing the automated segment in a separate area and regulate its production with a pull loop.

Incorporating automated segments into cells.



GUIDELINES FOR MACHINES

- Use small equipment dedicated to a single task rather than large, multi-task equipment.

- Introduce auto-eject whenever operators must use both hands to handle the part.

- Install one-touch automation where possible. One-touch automation means that an operator can place a part in a machine, initiate the machine cycle and move on.

- Avoid batching. Ideally, machines should be able to process one-piece at-a-time in less than tact time.

- Incorporate sensors to signal abnormal conditions and even automatically stop machines if necessary, so operators don't need to watch machines during their cycle.

- Design in maintainability. This means machine designs that are easily accessible for maintenance and repairs, and can be fixed quickly.

- At the pacemaker process, strive to devise machine changeovers between different end items that take less than one tact time cycle.

GUIDELINES FOR MATERIALS MANAGEMENT

The essential companion to these guidelines for layout and machines are guidelines for material handling. As apex's team works on the physical design of the fuel line cell it also need to take a look at its system to getting the require parts and materials to their 'point of use' in the cell. When you use the following materials elements as efficiently as possible.

- Present parts as close as possible to the point of use, but not in the walking path of the operator.

- Present parts so operators can use both hands simultaneously.

- Try to keep all part variations at the operators fingertips at all times to eliminate changeover time.
  Use fail-safe storage mechanisms when different parts look almost the same to prevent the wrong parts being assembled.
  When you cannot keep all part variations near the point of use because they are too bulky or numerous, increase the delivery frequency for those parts or sequent their delivery to match the end item assembly mix running through the pacemaker. For example, deliver sequenced parts every pitch of work.

- Do not have operators get or restock their own parts. With the possible exception of refilling screw pouches inside the workstation, use a material handle on a regularly scheduled, standardized route to deliver parts and take away finished goods.

- Keep no more than two hours of materials at the point of use.
  If the material handler fails to deliver on schedule, the cell or line will soon stop, forcing managers to address erratic material flow.

- Do not put additional parts storage in or near the process because this makes the operation of the cell or line harder to understand and encourages operators to get their own parts. This can reintroduce the evil of out – of – cycle work.

- Utilize kabana to regulate parts replenishment. The material handler comes regularly but will only bring those parts that have actually been used as indicated by kabana. No kabana, no parts.

handler or the supplying process. The operators are the ones creating the value. Everyone else is at best incidental work.

- Do not interrupt operator work cycles to replenish parts. Parts should be replenished in small containers from outside the cell and wherever possible should slide to the point of use by gravity-feed racks or chutes. Design these so an empty container taken off the flow rack causes next full container to slide into position. The operator then slides the empty container down a return chute to exit the cell or line.

CHAPTER-V

RESULTS

5.1.1 LEAN SIGMA IMPROVEMENTS

S.lo.	Metrics	Description	Before	After	%improvement
1	Inventory	Pump body (Aluminium - PDC)	14.0 Days	3.5 Days	76.00%
		P.C. Plate (Aluminium - PDC)	8.5 Days	4.0 Days	51.00%
		Control Shaft (En 19A Steel)	55.0 Days	10.0 Days	82.00%
		Rotors (Sintered parts)	62.0 Days	33.5 Days	46.00%
2	Space Saving	Assembly area	200 Sqft	110 Sqft	40.00%
		Stores area	32 Sqft	19 Sqft	40.60%
		Component Mfg area	180 Sqft	110 Sqft	38.80%
3	Man Power saving	Assembly Line	6	4	33.33%
		Machine shop	2	1	50.00%
4	Lead Time reduction	Critical comp mft to end product delievery	62.5 days	33.3 days	46.60%
5	Throughput improvement	Output/Hour/Opr	20 Nos.	30 Nos.	50.00%

5.1.2 FINANCIAL BENEFITS SUMMARY

Cost Saving

Value in Mn

Sl.No.	Partname / Name	SIX SIGMA PROJECTS	Target	Actual savings
1	Pump body & P.C. Plate	Die casting blow holes & Porosity problem. (Pump body & P.C.Plate)	0.286	0.299
2	P.C. Plate	Solving Vibration mark & tapper problem in Double disc milling process	0.2	0.27
3	Drive Gear & Driven	Tip clearance quality issue	0.12	Refer Assy Impvts
4	Control shaft	Solving nitriding growth & M6 Thread tight problem (Salt deposition) in nitriding process	0.103	0.111
		TOTAL	**0.709**	**0.68**

5.1.3 FINANCIAL BENEFIT SUMMARY

Values in Mn

Part name / Name	LEAN TASK	TARGET	ACTUAL SAVINGS
JMP BODY	Combining die casting, shotblasting and Turning process at M/S. Hybrid auto cast. (MPP)	0.02	0.008
C. PLATE	Combining die casting, shotblasting Process at vendor end		
JMP BODY	Creating Super market before reaming process Creating kit system before assy	..	..
JMP BODY	Cell formation : Reaming, OD Turning , Spot facing & Taping	0.12	0.096
ontrol Shaft	Creating MPP & Super market Reduction of Inventory including setup change over time at M/S.KALA AUTO tex	..	..
2735010 & 13 2734010 & 13 2737010 & 13	Lead time reduction & Setup change over time reduction at compacting, sintering & Sizing by 50%	0.04	0.02
	Reducing setup change over time in DD grinding process	0.04	0.01
ssembly line	Yield improvement to avoid nick marks & damages in rotors	0.529	0.516
ssembly line	Combining of two assy line into single line		
ssembly line	Make single piece flow in assembly line & introducing KANBAN System from machine shop to assy line		
ssembly line	Line Balance		
coming spection	Redusing inspection leadtime	0.015	0.012
	Total	**0.764**	**0.662**

5.1.4 FINANCIAL BENEFIT SUMMARY

Value in Mn

Sl.No.	Area	Estimated Savings	Achieved savings
1	Six Sigma projects	0.709	0.68
2	Task & Kaizens	0.764	0.662
	Total savings in Mn	**1.473**	**1.342**

5.1.5 COST SAVING DATA

LEAN SIGMA COST SAVING DETAILS		
1	Assembly line improvements	516,122.00
2	Implemented Suggestions At QE - Plant3	12,822.15
3	Control shaft reduction of Nitriding rework / Rejection	111,867.60
4	PC Plate Reduction fo Vibration Rework / Rejection	277,387.58
5	Pump body machine layout changing	96,000.00
6	Inventory Reduction	4,426.72
7	Setting time reduction	18,661.70
8	Material Movement Transaction	3,351.68
9	Pump body & PC Plate die casting rejection reduction	299,076.50
	Total Cost Saving Per Annum	**1,339,715.92**

5.2 DISCUSSION

- **Extending and Institutionalizing Lean Sigma**

Once people in the company become more comfortable into lean sigma should look for ways to extend its use.

- **Enforcing a common language**

Making terms such as DMAIC, metrics, dashboards, Net Present value lean, variation and cycle time part of everyday language when discussing existing operations or future improvements.

- **Integrating lean sigma plans with business plans.**

Ensuring that lean sigma is incorporated into existing strategic plans, operating plans, and budgets. In this way, lean sigma projects will all directly align with existing business strategy and existing business needs.

- **Extending lean sigma with entire supply chain**

The suppliers and some intermediate customers are part of the larger value stream. If necessary, training shall be provided to black belts for the customers / suppliers or lending them one of our own if they will commit to process.

- **Addressing the need for Lean Sigma in the design process.**

Lean sigma can both speed up the product design/development processes and help to improve the designs of products and processes. Since the majority of the cost associated with a product is determined in the design stage, applying lean sigma in those areas can have a dramatic effect on reducing costs.

5.3 CONCLUSION

Lean sigma is a discipline that has learned from past mistakes. And one of the mistakes make by previous improvement methodologies was to ignore management support, including factual data. Initially, a lot of us found ourselves thinking that lean sigma efforts are some how "Stealing Resources" that they would rather devote to the 'real work'. But once we saw the kinds of rapid and sustainable gains earned when well-trained people work on high-priority projects we quickly become enthusiastic supporters of training and education on Lean Sigma.

Lean Sigma companies focus on systems and processes, begins at the top, to achieve it's aggressive goals on process improvements – breakthrough and innovations.

5.4 RECOMMENDATION

Ten Steps to Lean Sigma

It is to be noted that the lean sigma does not lend itself well into a ten steps programmed, as it is in every way an ongoing process, which is continuously undertaken. The following ten steps should therefore be thought more of an implementation summary.

1. Initially consultants are required to help us on this path, but they should easily pay for themselves over the long run. We can should however, expect significant returns within the first year of application. Hence the first step is to go and get help.

2. Big Hairy Andacious Goals: need to be set by the MD or CEO. Management engagement into lean sigma occurs and is to occur in a big way. These goals are broadcast to the company during a "transformation event" which is quite an accurate description.

3. Selection of the practitioners: Selection of the black belt term is an art form in itself and wants to be done carefully. The best people should be selected and should represent the future business leaders of the company.

4. Training, training, and training: The master black belt is ultimately responsible for the training of the black and green belts. Quite a lot of training is necessary and we should be preparing for this. At first we should hand onto our consultants for this purpose.

5. Kick-Off – Company-Wide-Vision : It's time to bring those andacious goals in to action and make sure that everyone understands them and that we and the

6. Project Selection and Implementation : Firstly the "value streams" that show the most promise for growth are identified, which is quickly followed by projects that will most likely yield the greatest benefits in those value streams.

7. Monitoring Teams Performance : Since the Lean Sigma is a financial improvement strategy, which talks the language of the senior management, it is easy for them to monitor and ensure that the teams are providing the necessary improvements. Simple software tools can be used to roll up all those lovely cost savings.

8. Improving Team Performance : Reviewing the structure of our teams and in particular the ability of our black belts to perform as team leasers is fundamental to success, team realignment and training in soft people skills is always required.

9. Making it Stick : Ensuring that the improvements initially gained continue to roll-in can be difficult for many firms. Making sure our initial enthusiasm doesn't wane is key to continued success.

10. Rolling out into the supply chain : After successful projects have delivered real benefits to the company, we will start to notice that more and more problems are surfacing due to external variations. Projects involving the supply chain will be more frequently suggested, remember here that it is supply chains that compete not companies.

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