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APPLICATION OF AGILE IN STEEL MANUFACTURING INDUSTRY

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ABSTRACT
To compete effectively in the global marketplace of the twenty-first century, manufacturing companies are trying to maintain a high level of flexibility and responsiveness to achieve agility and to remain competitive. Manufacturers are under tremendous pressure to improve productivity and quality while reducing costs. The new competition is in terms of reduced cost, improved quality products with higher performance, a wider range of products and better services all delivered simultaneously to enhance value to customers. In such environment providing good quality product at low cost for a medium scale industry has become very tough. To provide good quality product at low cost, small industries need a formulation of some manufacturing approaches like agile manufacturing to manufacture defect free products within their materials cost limit. Medium scale steel manufacturing industries like Magnum steel limited (MSL), banmore are facing problems of higher rejections in form of wastes so as to increase their cost. This paper aims to analyze the application of agile manufacturing in magnum steel limited in order to reduce wastages through implementing lean tools and techniques. An agility audit questionnaire is used for assessing the agility level of the company to identify the current level of performance within the company with respect to the key elements of agility. MSL's agile experience is reported including a list of recommendation for improving its competitiveness to offer solution alternatives not only to the current problems but also to the ones that may be encountered in the future.

Keywords: Agile Manufacturing, Lean technology, medium scale industry, audit questionnaire, cellular manufacturing.

INTRODUCTION

In the past, economies of scale ruled the manufacturing world and everybody knew that mass production and full utilization of plant capacity was the way to make money. This style of manufacturing resulted in inflexible plants that could not be easily reconfigured, and were associated with swollen raw materials, work-in-process and finished goods inventories. Since the early 1980s, in pursuit of greater flexibility, elimination of excess in inventory, shortened lead-times, and advanced levels of quality in both products and customer service, industry analysts have popularized the terms `world-class manufacturing' and lean production' .

The aim is to generate a framework that will reduce wastes and subsequently increase the flexibility in production. Customer Demand Uncertainty including lean and agile paradigms has been widely investigated so far and there are available research studies regarding this area.

Gunasekaran (2002) et.al [1] presents a case study conducted on agile manufacturing in the GEC Marconi Aerospace (GECMAe) company. The study provides the reader with an insight into the company and its agility level. An agility audit questionnaire is used for assessing the agility level of the company.

Nitin Upadhye, S. G. Deshmukh and Suresh Garg (2010) et.al [2] discusses the issues of MSMEs and presents a case to demonstrate the improvements achieved in an Indian mid size auto component's manufacturing unit after the implementation of LMS.

Fawaz Abdullah (2003) et.al [3] addresses the application of lean manufacturing concepts to the continous production/ process sector with a focus on steel industry

Debra A. Elkins, Ningjian Huang and Jeffrey M. Alden (2004) et.al [6] discuss two simple decision models that provide initial insights and industry perspective into the business case for investment in agile manufacturing systems. The models are applied to

study the hypothetical decision of whether to invest in a dedicated, agile, or flexible manufacturing system for engine and transmission parts machining.

Kalpakjian and Schimd (2003) et.al [14] define the agile manufacturing and suggests it need and importance in global context.

Mahesh Pophaley and Ram Krishna Vyas (2010) et.al present a classification, review and analysis of the literature on Plant Maintenance Management Practices (PMMP) employed in Automobile Industries.

RESEARCH METHODOLOGY

Once companies pinpoint the major sources of waste, tools such as continuous improvement, autonomous maintenance, just in time, fishbone diagram and others will guide companies through corrective actions so as to eliminate waste. Continuous Improvement is another fundamental principle of lean manufacturing. One of the effective tools for continuous improvement is 5S, which is the basis for an effective lean company. Japanese name of Autonomous maintenance is JISHU HOZEN. This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. Cellular manufacturing is one of the cornerstones when one wants to become lean. The Fishbone Diagram is an easy to use and effective cause and effect technique developed by Kauoru Ishikawa (1982).

CASE STUDY

This research work is carried out in Magnum steel limited (MSL) located at banmore industrial area near Gwalior. The purpose is to perform an agility audit on the company using the questionnaire to identify the current level of performance. So first of all lean philosophy is implemented in MSL in order to minimize the wastages. As seen in industry, during production the maximum rejection occurs near about 14 % per month of total production in these rolling mills. The data has been analyzed for year 2013 so as to find out the areas of rejection. After analyzing the data, there are 10 areas are identified which contributes the maximum rejections during the whole processes.

S.N	Process	Defects	% Rejection
1	Raw Material	Plastic, Claw etc	1.17
2	Casting	Penal, Crack, Slag etc	1.28
3	Welding	Piping, Clay, Slag, Balancing	1.76
4	Furnace	Max Temp, Thermal Insulation etc	1.27
5	Peeling	Popper, Overheating	1.26
6	Roller	Gapping, Bearing Failure	2.93
7	Conveyor	Jamming, Bearing Failure, Bending	5.71
8	Pushing	Mishandling	1.79
9	Cutting	Over cutting, Cracking	2.02
10	Inspection	Gauge, Eye	0.80

Table 1: process wise rejection of leave spring in 2013

Change Team is formed within the plant. Change teams includes mill in charge, supervisors and maintenance personnel. First of all, fishbone diagrams are drawn for each areas of rejection which are shown below:

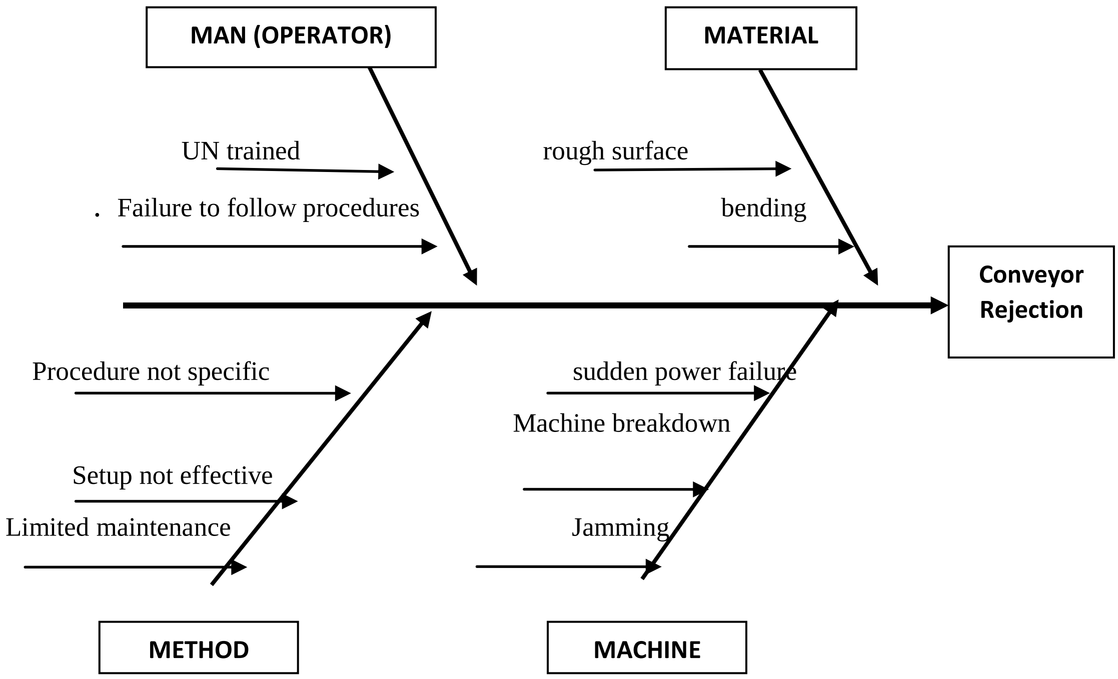

Figure 1: Fish bone diagram for conveyor rejection

DATA ANALYSIS

Data collected for the past three months. The operation is based on one shift per day. Every shift is for eight hours. The planned down time is 10 minutes per hour during shift for cooling and tiding up the work area. The collected data is shown in given tables:

S. No	Name of the process	% Rejection in various months		
		Oct 13	Nov 13	Dec 13
1	Raw material	5.90	5.85	5.86
2	Casting	6.48	6.37	6.44
3	Welding	8.84	8.78	8.90
4	Furnace	6.38	6.44	6.34
5	Peeling	6.26	6.34	6.31
6	Roller	14.60	14.65	14.57
7	Conveyor	28.50	28.61	28.55
8	Pushing	8.96	8.88	8.99
9	Cutting	10.10	10.16	10.15
10	Inspection	3.97	3.91	3.88

Table 2: % Rejection in various processes from Oct 13 to Dec 13

The focus is on individual areas of rejections, finding causes and suggests solutions and implements lean techniques in order to minimize wastages. After applying the adopted methodologies, providing the necessary training to the workers, supervise them and strictly follow the work instructions, the defects are reduced

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RESULT & DISCUSSIONS

So after implementing lean tools and techniques on selected rolling mill (16"/10"), there is a reduction in rejected pieces from 13.94 % to 11.26 % in the month of January and February 2014. This results in saving of Rs. 891000 (per piece cost Rs 2700 at that time) due to reduction of defects in February month (368 more pieces were produced in February 2014).

The detailed result is shown in tabulated form.

S. No	Leave spring	Before Lean			After Lean	
1	Month	**Oct 13**	**Nov 13**	**Dec 13**	**Jan 14**	**Feb 14**
2	Total production	12245	11990	12176	12183	12211
3	Total defected pieces	1707	1677	1694	**1440**	**1364**
4	% of total Production	13.94	13.99	13.91	**11.82**	**11.26**

Table 3: Total production and % of defects after Lean from Jan 14 to Feb 14

S. No	Leave spring	Before Lean			After Lean	
1	Month	**Oct 13**	**Nov 13**	**Dec 13**	**Jan 14**	**Feb 14**
2	No of rejected pieces	1707	1677	1694	**1440**	**1364**
3	Amount in rupees	4608900	4527900	4573800	**3888000**	**3682800**
4	**Reduction in defects**				**254**	**368**
5	**Saving in terms of Rupees** (× Rs 2700)				**685800**	**891000**

Table 4: Total rejection in pieces and rupees after Lean from Jan 14 to Feb 14

S. No	Type of Rejection	Before Lean			After Lean	
		Oct 13	**Nov 13**	**Dec 13**	**Jan 14**	**Feb 14**
1	Raw material Rejection	1.18	1.17	1.18	**1.13**	**1.09**
2	Process Rejection	18.82	18.83	18.82	**15.88**	**15.00**
3	Total Rejection	20	20	20	**17.01**	**16.09**

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Table 5: Comparison chart for type of rejection (in %) before and after Lean

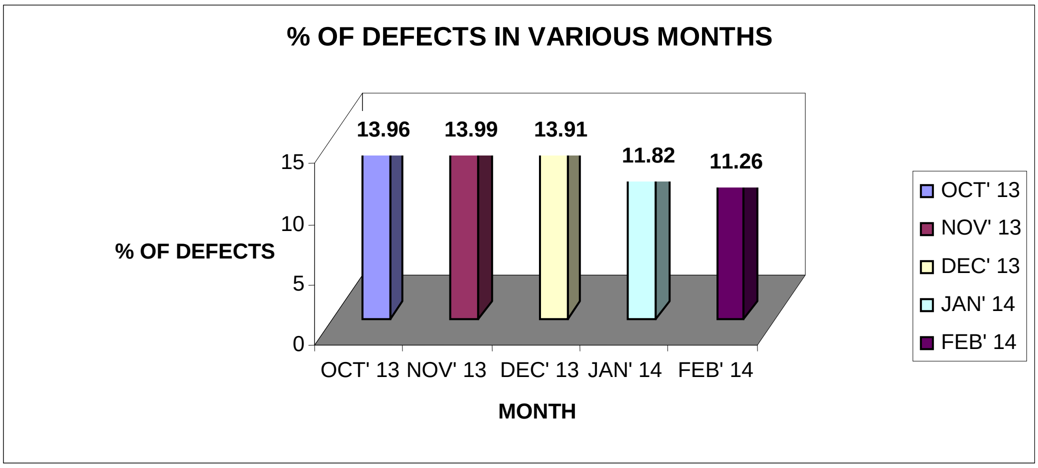

Figure 2: % of defects in various months

SUGGESTIONS FOR REDUCING WASTAGES

S. No	Process	Types of Defects	Reason of Rejection	Suggestion
1	Row Material	Plastic, Claw. etc	Row Material is not as per order and specification.	Proper checked to be carried out before using the raw material.
2	Casting	Penal, crack, slag	Crack penal cannot be used because of improper casting	Proper material to be used for casting and correct heat treatment to be given
3	Welding	Piping, Clay, Slag, minor Crack	Due to improper welding because of unskilled technicians.	As per the material correct type of welding is to done
4	Pushing	Bend, Bearing failure, Patches, Gear box failure	Material failure and improper handling of work causes the defects.	Proper and specified material for a particular work to be used
5	Furnace	Temperature maximum, Thermal Insulation, Low heating	Improper temperature and incorrect insulation	Correct temp .and specified insulation to be incorporated
6	Peeling	Popper	Incorrect heat treatment causes the defect.	Specificities temp. is to be maintained.
7	Roller	Gapping, Bearing failure,	Improper machining causes gapping and bearing failure.	Rollers to be checked for correctness of positioning.

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8	Cutting	Blades deflection, Belt loosing, Gear breaker stop, Wheel Cracks, Flat guide failure	Imperfect handling of machine.	Machine to be checked for proper maintenance
9	Conveyor	Jamming, Bearing failure, Bending, Cracks in conveyor rollers	Overloading and improper maintenance of bearing causes its failure. While roller fails due to sudden loading and rough surface of the object to be loaded.	To be cheeked for maintained spiffed to be correct heat treatment
10	Inspection	Gauge ,Quenching	Inspection instrument should be maintained timely. Quenching should be properly done.	Calibration of instrument should be done regularly.

Table 6: Defects, reason and suggestions for defects in various processes

AGILTY AUDIT QUESTIONNAIRE

After approaching towards lean mindset, the current level of agility is to be investigated with the help of a standard audit questionnaire administered within the company studied, Magnum steel limited (MSL) with respect to the five key elements of agility are Enriching the customer, Co-operating to enhance competitiveness, Mastering change and uncertainty, Leveraging people and information and Manufacturing advancement and Safety aspect.

Results for **enriching the customer** (MSL) (maximum possible score=12; current performance for enriching the customer=6/12=**50%** agility index; suggested performance for enriching the customer=11/12=**91%** agility index)

Results for **co-operating to enhance competitiveness** (MSL) (maximum possible score=9; current performance for enhancing competitiveness=4/9=**44%** agility index; suggested performance for enhancing competitiveness=9/9=**100%** agility index)

Results for **mastering change and uncertainty** (MSL) (maximum possible score=8; current performance for mastering change and uncertainty=2/8=**25%** agility index; suggested performance for mastering change and uncertainty=(7,1/2)/8=**94%** agility index)

Results for **leveraging people and information** (MSL) (maximum possible score=14; current performance for leveraging people and information =4/14=**28.5%** agility index; suggested performance for mastering change and uncertainty=13/14=**93%** agility index)

Results for **manufacturing advancement and Safety aspects** (MSL) (maximum possible score=12; current performance for leveraging people and information=(4,1/4)/12=**35%** agility index; suggested performance for mastering change and uncertainty=12/12=**100%** agility index)

RECOMMENDATIONS

After analyzing the questionnaire, the some recommendations made for improving the agility level of the company. One of the most important suggestion is to apply a cellular manufacturing approach to shop floor for established products to reduces wastages, throughput time and hence unit cost. Consequently, cellular manufacturing would go a long way towards improving the turn/around delivery times as well. A short attempt is made to suggest the layout which is shown in given figure.

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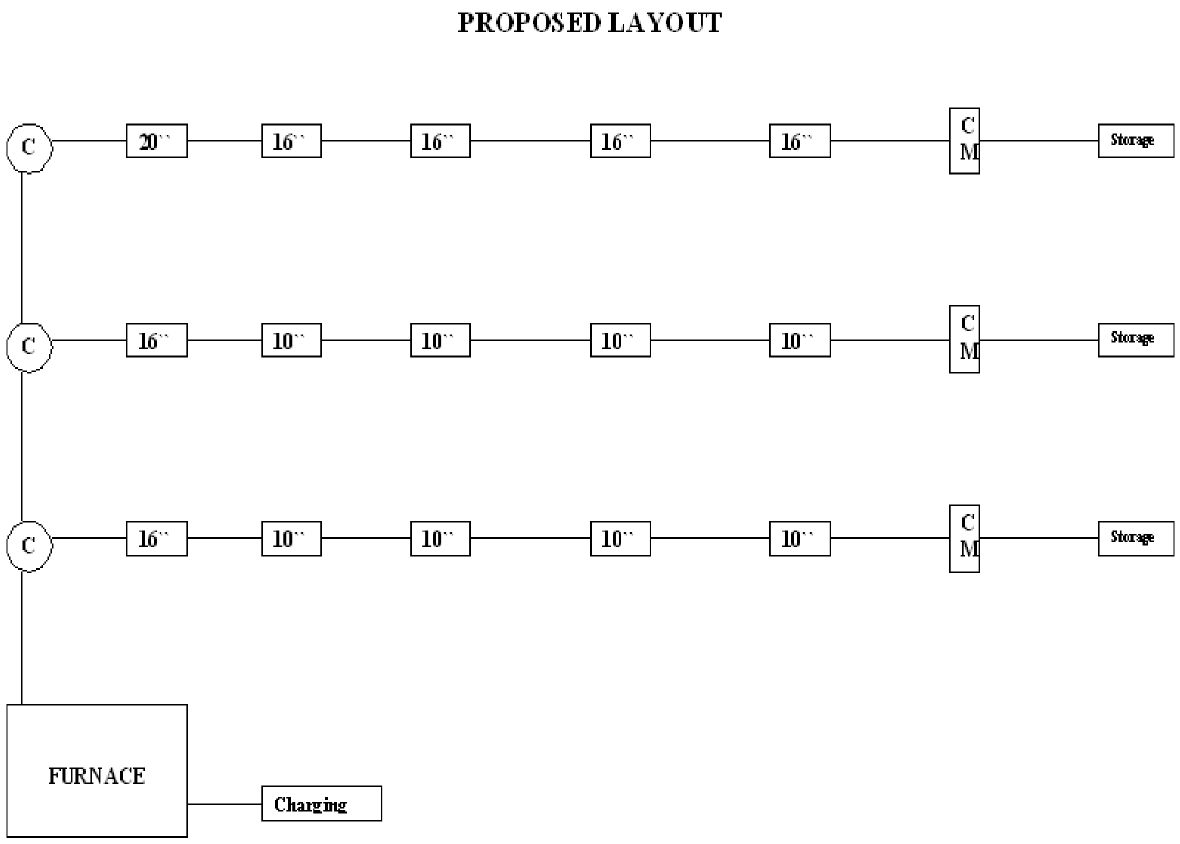

Figure 3: Proposed layout

CONCLUSION

The data collected from the questionnaire have led to the conclusion that cost is a key parameter for both production (the company) and more importantly, the customer. As cost is the primary issue, one should be in the mode of 'thinking lean'. To reduce costs, along with cellular manufacturing, adoption of other valuable concepts and technologies should also be considered. The market for Magnum steel limited (MSL) is by no means as turbulent, e.g. the mobile phone industry where there is a definite requirement to be agile and to remain so. This is not to say that agility is only applicable to new products and the leanness should be purely applied to older products. Quite the opposite, various enablers of agile manufacturing such as Lean manufacturing, Maintenance management, Supply chain management, Integrated production, Information systems and concurrent engineering are quite useful to employ in a company like MSL.Changes are being made in light of overall business perspective and market, not necessarily to become more agile, but simply because it make sense to change.

We have made a number of recommendations to MSL with the objective of improving its overall business competitiveness. Not all of them, however, need to be incorporated, or be implemented at the same time. Some of the recommendation have been reviewed at MSL, bearing in mind the future opportunities and threats to the business.

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