CASE STUDY OF LEAN IMPLEMENTATION AT GEM EQUIPMENTS COMPANY, COIMBATORE

BACKGROUND

Gem Equipments is in the business of manufacturing cooling towers, Refrigerated Air Dryers, heat exchangers and radiators for industrial applications. Refrigerated Air Dryers is the main category of the product line constituting to nearly 50% of the volume.

We had an initial discussion with the promoters of the company to understand the vision and mission of the organization. It was agreed mutually that the lean implementation would focus on the assembly of Refrigerated Air Dryers which are carried out in 2 cells each producing 7 units per day. The following goals were fixed for the lean implementation:

1. To improve the productivity of the Refrigerated Air dryer cells to manufacture 14 units per day per cell. This would double the current capacity
2. To streamline the production process which would reduce the work-in-progress
3. To use the space effectively, thereby reducing the material and men movement

It was expected that these goals would be primarily addressed through the year long lean implementation exercise in turn supported by strategic investments and policy changes, where required. KIAP was appointed to guide the Light Engineering Cluster in implementing lean under the Government of India's NMCP scheme and thereby supported Gem Equipments through the year 2011-12 in achieving the said goals.

Diagnostic Study

The Lean journey commenced with a current state assessment and road map setting exercise. KIAP consultants did a plant walk through to understand the processes, the operations and the value stream of the refrigerated Air dryer cells. Keeping in mind the business goals, the current state of the manufacturing process was defined in a Value Stream Map. The VSM was made using actual cycle times measured for each activity involved in the manufacturing process. The inventories, number of operators involved were also physically verified on the shop-floor. The summary of the VSM is shown below.

Value Stream for Refrigerated Air Dryers

Measure	**UoM**	**Current**	**Target**
Customer Requirement	(Nos/month)	350	525
Demand rate	Nos per day	14.0	28.0
Takt time (one batch every)	Minutes	**34.3**	**17.1**
	Available resources		**Cycle time**
	Machines / Workstations	**Manpower**	**(minutes)**

Process 1 –Assembly	1	1	27
Process2- Brazing	1	1	7
Process 3 –Nitrogen	1	1	17
Process 4 –Gas Charging& Insulation	1	1	17
Process 5 –Electrical pre-assembly	1	1	30
Process 6 –Electrical connection	1	1	25
Process 7- Testing	1	1	25
Process 8 –QC testing	1	1	15
Process 9 –Finishing	1	1	6
Process10-CC testing	1	1	25
		Total time per unit output	**194**

Baseline study:

At the time of the diagnostic study (January 2011), the production rate for Air Dryer was 7 units per day per cell. Based on the business plan for FY 2011-12, it was decided that daily production target would be set at 14 units per day per cell which translated to a takt time of 17 minutes per Air Dryer. The diagnostic assessment now focussed on whether the company had sufficient potential within the existing resources to achieve this level.

Cycle time: The bottleneck operations include assembly (valve, condenser and compressor), electrical connections pre-assembly and connections and CC Testing.

Throughput time: While the work content per dryer is 194 minutes, the actual through put time was calculated to be 1255 minutes which meant a value adding ratio of 16% only. WIP before the electrical connection and testing area is a major cause. Also some of the assemblies are held up waiting for parts.

Space: Only 8% of the total space is used for value addition, the rest of the shop floor is cluttered with material.

People: The assembly workers utilized only 35% of their available time for value addition.

System Potential:

Based on the VSM and above analysis of the assembly area, there was a clear potential for making 14 units per cell per day with the existing resources. This would make the output, 28 no's per day which is double the current capability. A lean roadmap was then prepared which would be a step by step guide towards the final objectives.

LEAN ROADMAP

S No	Current State Observation (Muda Identification)	Action Plan									Expected Results
		Action	Feb	Mar	Apr	May	Jun	Jl	Aug	Sep	
1	***Creating Flow:*** Condenser assembly, compressor assy,	Debottlenecking of the mentioned operations through ***process study***									Doubling the current throughput Capability

	electrical connections and CC testing are the bottleneck operations – more than 17 minutes	***and Muda elimination***									
2	Reduce the through-put time of the cell from 192 minutes	***Load leveling*** of the operations and balancing the lines									50% reduction in the through-put time.
3	Brazing operation is carried out in the shopfloor – near the PUF panels – Safety concern	Workstation / process design will be suggested so as to make the operation safe for the plant – ***Work place Design***									Improvement in safety
4	Employee has to bend down to assemble the components – increases fatigue	Suitable arrangement would be made to eliminate fatigue and improve productivity									Improvement in productivity
5	***Create Pull***	***Takt based production, Kaizen, 5S, Poka-Yoke***									Pull based production
6	***Synchronisation***	Align support activities with flow production – Establish ***SOPs, visual management, monitoring systems***, etc.									Lean Manufacturing

Implementation Methodology

KIAP has a unique intensive workshop methodology to improvement and problem solving in strategic areas. 2-3 day workshops were conducted in each stage taking up projects in accordance with the lean roadmap. During these workshops, process improvement and Problem Solving are accelerated thereby giving significant improvement.

In each workshop, cross-functional teams were formed, each team working on improvement of one strategically important area. Over a one-year period, participation was ensured from all functions including finance, stores, marketing and HR. The participants in the workshop simultaneously learn the relevant lean tools and techniques by actually implementing them. Top Management (owner) commitment is the pre-requisite for the success of any such initiative and this was obtained by their physical presence during the presentation/ experience sharing sessions at the start and end of each day of the workshop.

Standardization of the improvements made was reviewed within 3-4 weeks after each workshop. In Stage IV and V, concepts like 5S and Autonomous Maintenance/Planned Maintenance were introduced to ensure long term sustenance of all improvement made in the unit and bring in the culture of continual improvement.

Internal kaizen champions were identified at the outset and they coordinated with KIAP consultant as well as participated in all workshops as they would be responsible for sustaining and building upon this initiative in the long run. These champions will have therefore learned all

relevant tools, techniques and concepts as well as understood from KIAP the process for bringing about and sustaining change.

A list of major improvement and sustenance projects is given below; each project is detailed out in the following section for better understanding:

1. Reduce throughput time by one piece flow production
2. Reduction in cycle time of bottleneck operations through workstation design
3. Eliminating non value adding activities through kaizens
4. 5S for standard work practice
5. Pull based material management

Improvement Projects

Project 1. Reduce throughput time by one piece flow production

The existing process was observed by a cross functional team right from raw material receipt to finished good storage. A *Muda* walk was done where the team followed the material as it moved through various stages in the plant.

The team analysed and found the root cause that the material planning was lagging and this has created lot of Semi-finished dryers lying on the floor by reducing the value adding place in the shop floor. This has resulted in creating lot of strain to the human resource and also more transport of materials. Also, FIFO system could not be followed and the U shaped cell was a real congestion and affecting the flow.

The team changed the layout. This really reduced the distance of material movement. U shaped has been changed to single flow straight linewith provision for FIFO based production especially pre and post vaccum and leak testing which is a batch process.

Layout
Before Lean - U shaped cell - No FIFO
After Lean - Single line flow – FIFO

Project Results :

By changing the layout, the material movement has reduced 1000ft to 500ft and also clarity of work area has been achieved. Floor area has been utilised properly could follow FIFO system.

Project 2. Reduction in cycle time

During the VSM exercise, a cross functional team did a detailed observation of Air Dryer assembly operation and recorded the data in standard operations table format. Each bottleneck operation was observed in detail and recorded in operations analysis table format. Root cause analysis was done and appropriate solutions implemented.

1.Creation of WorkStation

Observation: During the observation it was found that the assembler has to move around in search of tools and also for assembly materials.

Root Cause: No proper arrangement for the materials and also BOM not available.

Action Taken: First, work stations created for each type of activity in the assembly process. Sub-assembly is processed in advance to support the main assembly to achieve the takt time.
Trolley has been arranged for tools and also for fasteners, etc.,

2.No kit no cut concept

Observation : 1) The operators do their job with the materials available and keep the Air dryers in semi-finished condition if there is shortage of few materials.

Root cause: 1) Material synchronization difficult as parts are produced in different plant as well as purchased from vendors

Action : 1) Parts kit prepared and sent along with the Air dryer assembly trolley. The concept of 'NO KIT NO CUT' was implemented to avoid any WIP choking the line.

2) Dryer box arrives from sheet plant with the door screwed on, the assembler has to un-screw and remove the door for doing his work. The door is again rescrewed at the end of the line.

Action: Dryer box started to come in the form of kit and saving the operators time. Suitable fixtures also made to ease the process. Doors in kit form →

Project Result: The type of activities has reduced the assembly process cycle time. The cycle time has reduced from 68.5 minutes to 34.5 minutes with 2 work stations thus achieving time of 17 minutes per operation as per target.

Project 3. Eliminating non value adding activities through kaizen

The team spent a day in observing the entire process from tank fabrication to final assembly. The team observed the value adding and non-value adding activities. The non-value adding activities included Muda like operator movement, bending operations and Muri (strain) of

lifting heavy materials and working in uncomfortable posture. The major observations were analyzed in detail and kaizen based solutions were discussed and implemented for these.

Observation (before)	**After Kaizen**
The operator bending to do some assembly work	The operator has been given stool to sit on it to do the assembly
	

Project Result: The operator is free from strain and able to do the job precisely.

Project 4. 5S for Standard Work Practice

Once the layout was changed and non value adding activities minimized the process was ready to be standardized and sustained. At this stage 5S was implemented by the team keeping in mind the arrangements required for the lean flow manufacturing. 5S is a cultural change issue and hence all parts of the unit including office was included and the concerned people trained. Two 5S audits were done by KIAP consultants to review and support the implementation after which the initiative was handed over to the internal kaizen champion.

Observation (Before 5S)	After 5S
	
Flanges kept as it is, without any identification.	Flanges kept in the board and suitable identification given.

Observation (Before 5S)	After 5S
	
Materials kept at the assembly area creating hindrence to the flow.	Stored materials removed and shifted to respective area and cleared for the flow.

Observation (Before 5S)	After 5S
	
The line was not clear and Fifo couldnot be followed.	Flow line has been clearly marked and FIFO could be followed.

Project Results : Operators strain reduced. Line clarity created and FIFO flow has been achieved

Project 5. Pull system for internal components

Base Frame with sheets fabricated for the Air dryer box

The fabrication is done in the sheet plant in the same premises. The team carried out a detailed observation and modified the fixtures used for fabrication. This resulted in the cycle time reduction from 40minutes to 20 minutes and in-turn increased the out-put to match the higher requirement of the lean assembly line.

The team also introduced the system of Pre-assembly of the box before it is sent for powder coating. This will allow the powder coating section to send all the sheets forming the box in kit form to assembly area.

Heat Exchangers

Heat Exchanger was identified as the critical component for assembly. The team pbserved a lot of variation in the model and heavy physical strain during the process. This led to the delay in supply to assembly. Also, the system of Puf filling was tedious and the operator has to wait for the curing to continue is work for the next one.

With the lean concept and kaizen knowledge gained through the assembly implementation , the GEM team could themselves implement the lean flow in this section. They separated the the area for the bigger heat exchanger and for the smaller one. In the area of Puf filling the team created two or three fixtures for puf filling. This resulted in On Time In Full supply of heat exchangers to assembly line.

Other Components

A bill of activity has been introduced along with the bill of material as per the variation in the model of the Air dryers. The assembler has to verify the materials with the bill of materials and take them for assembly. This has really reduced the Semi-finished Air dryers on the shop floor.

Pull: Specific areas have been earmarked for each component with space for one day stock.

SUMMARY OF RESULTS OBTAINED

Process Level Results

The improvement projects done had a direct impact at the process level since the focus was on improving methods of work through eliminating and minimizing Muda and Muri across the value stream. A summary of the main results is given below:

Parameter	Before	After	Improvement
Material movement (ft)	1000	500	50% reduction
Cycle time in Ref Dryer Assembly (min)	68.5	34.25	50% reduction
5S Score	48%	64%	16% increase

Business Level Benefits

The process level results in turn combined to benefit Gem Equipment's business as a whole in the following aspects:

Parameter	Before	Current	Improvement
Production rate (Nos/day)	7 per cell	20 per line	285%
On Time In Full Delivery %)	80%	100%	25%
Manpower Productivity	34	46	35.3%

The benefits obtained have spurred Gem Equipments company to start taking in more orders and increased their focus on business development. An internal lean champion is now carrying on the lean initiative to sustain the gains made in year one.