CASE STUDY OF LEAN IMPLEMENTATION AT MODERN ENGINEERING COMPANY, COIMBATORE

BACKGROUND

Modern Engineering Company is manufacturing hospital furniture including cots, ICU cots and related accessories like trolleys and tables with the brand name of Meridian. The company owned and managed by Mr. Rajamahendran and Mr. Thirugnanam who have been in the field for over a decade.

At the time of initiating lean implementation, the company was facing severe delays in deliveries and as a result losing its reputation with customers. While the order book was full, Modern was unable to deliver the requirement on time and in full quantity. The management had its fire fighting on a daily basis to follow up and dispatch material and spending a lot of time in pacifying customers. Prioritizing orders each day based on customer urgency led to a vicious cycle resulting in unfinished material stranded everywhere on the floor. Because of this, Modern was unable to take new orders and have slowed down their marketing activities.

The main issue being delivery delays and inability of the factory to handle additional volumes, the owners set the following business goals for the year 2011-12:

1. To increase production capability by 100%
2. To streamline the factory and set up a system driven manufacturing process

It was expected that these twin 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 General Engineering Cluster in implementing lean under the Government of India's NMCP scheme and thereby supported Modern 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. Since the company makes multiple products, it was agreed that the concept of lean would be implemented and demonstrated for hospital cots which is the high volume and high growth potential product family. It was agreed that implementation could be internally extended later to other product families by Modern. Keeping in mind the twin business goals, the current state of the manufacturing process was defined in a Value Stream Map for the Hospital Cots.

The VSM was made using actual cycle times measured for each activity involved in the cot manufacturing process . The inventories, number of operators involved were also physically verified on the shop floor. The summary of the VSM is shown below.

Measure	**UoM**	**Current**	**Target**
Customer requirement	(Nos/month)	50	100
Demand rate	Nos per day	2.0	4.0
Takt time (one batch every)	Minutes	**240**	**120**
	Available resources		**Cycle time**
	Mcs / W. Stns	Manpower	(seconds)
Process 1 - Tube cutting for cot parts	1	2	4155

Round Pipe Processing - Leg Support, bows, screw cover and nut	1	2	475
Process 2 - Sheet Cutting for cot head & bed	1	2	5535
Process 3 - Angle Cutting	1	2	665
Process 4 - Flat Cutting	1	2	750
Process 5 - Frame welding	1	2	1450
Process 6 - Head Piece Welding	1	2	2500
Process 7 - Final Frame Assembly			
Process 8 - Powder Coating – Outsourced			
Process 9 - Final Packing	1	2	900
	Total time per unit output		**226 min**

Baseline Study

At the time of the diagnostic study (January 2011), the production rate for hospital cots was on an average 2 units per day; while the market potential was much higher, the company actually having to limit orders taken. Based on the business plan for FY 2011-12, it was decided that daily production target would be set at 4 units per day which translated to a takt time of 120 minutes per Cot. The diagnostic assessment now focussed on whether the company had sufficient potential within the existing resources to achieve this level.

1. Value Adding Ratio

Out of 81 activities noted for cot assembly, during the day, only 56 activities were value adding and the other activities included *Muda* like material transport, motion, marking and setting. This meant that there existed a scope to eliminate or minimize about 30% of the total activities and thereby reduce the cycle time.

2. Space

Of the total available covered Floor Space Area (FSA) totalling 6475 sft, the space utilized for value addition came to only 1100 sft or about 17% of the total available FSA. Sufficient space was therefore available for any expansion required to produce at a higher rate.

3. Human Resources

33% of the total man-hours was spent on non value adding activities and this meant that this time could be freed up for actual conversion work by eliminating the *Muda*.

System Potential

Based on the VSM and above analysis it was clear that Modern could produce at least 6 cots per day using the existing resources. It was therefore very much possible to achieve the twin business goals by implementing lean. 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	Fe	Ma	Ap	Ma	Ju	Ju	Au	Se	

			b	r	r	y	n	l	g	p	
1	Out of 81 activities noted for cot assembly, during the day, only 56 activities are value adding others are being movement, marking and setting.	Eliminate the non-value adding activities of movement by work station design and re layout and establishing the flow.									Reduction of throughput time by 10% from 226 mins to 200 mins.
		Reduce the setting / marking time by using Kaizens and SMED principles.									Further reduction of through put time by 30% from 200 min to 140 mins.
2	**Cutting and Welding** are the major activities consuming 47 minutes and 23 minutes respectively.	Improve the processes and reduce the cycle time by workstation design and kaizens. .									Doubled output from 2 cots to 4 cots a day.
3	Holding materials in the form of Semi-finished goods for completing the urgent orders.	Establish the Heijunka or Level scheduling and Kanban, minimise the inventory level (WIP and OSP components).									Reduction in inventory carrying cost by 33% and freeing up of floor space by 20%.
4	Create Pull	Takt based production, Kaizen, 5S, Poka-Yoke									Pull based production
5	Synchronisation	Align support activities with flow production – Establish SOPs, visual management, customer order monitoring systems, etc.									Lean Manufacturing – streamlined and system driven process delivering required output.

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. Change from batch layout to single piece flow layout
2. Reduction in cycle time in bottleneck activities through workstation design
3. Eliminating non value adding activities through kaizens
4. 5S for standard work practice
5. Lean planning, scheduling and material management

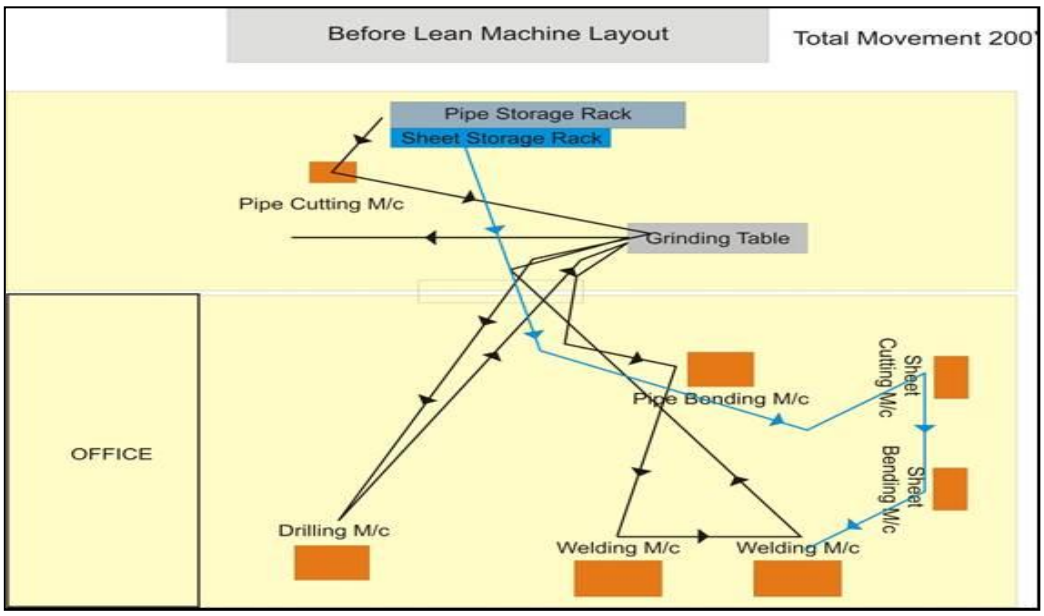
Improvement Projects

Project 1 - Change to single piece flow layout

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 processing has three main parts:

1. Sheet, tube preparation and welding of cot frames
2. Powder coating (done outside at a vendor unit)
3. Final assembly and packing

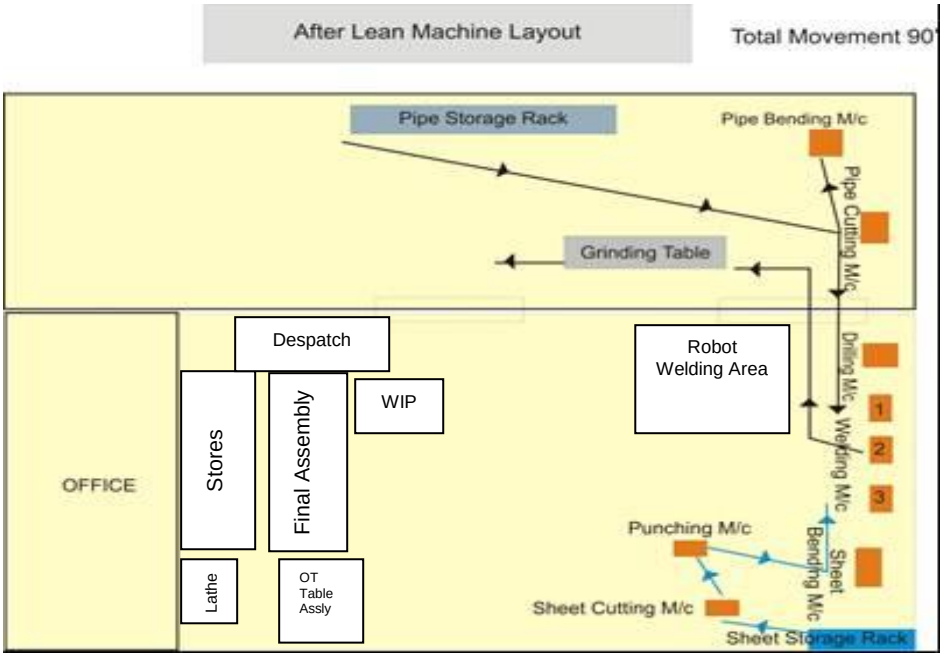
The team recorded that the material moves 200 ft altogether inside the premises during the process and prepared a material flow diagram (shown below)



The team analyzed and found the root cause(s) of the material movement to be

1. Grouping of machines type wise for e.g. all welding machines together
2. As machines were added, they were located wherever space was available

The solution implemented at once – machines / workstations were moved and aligned in accordance with the sequence of operations. The space cleared by reducing WIP was utilized to bring down the stores from the mezzanine floor. The changed layout is shown below:



Project Results

By changing the layout, material movement has reduced from 200 feet to 80 feet.

Project 2 - Reduction in cycle time of bottleneck operations

Welding of the cot was found to be the bottleneck operation during the VSM exercise. A cross functional team did a detailed observation of the welding operation and recorded the data in standard operations table format. Each major observation was then analysed and appropriate solutions implemented.

1. Tag welding

Observation : Frames are initially tag welded. After checking the squaring correctness, the frames are welded on the fixture. This is a case if over processing and the double activity increased the cycle time of welding operation.
Root Cause: No provision to ensure 90 degrees corners

Action Taken : A fixture with clamping arrangement was made on a work table. The frames were then fixed on to the table automatically ensuring the right angled corners and welded straightway avoiding tag welding totally.

2. Welding on floor

Observation : Welding the cot frame was a tedious job – keeping tubes on floor, operator has to go in and out of the frame to several times just to weld one frame.

Root cause: Welding at floor level means operator has to sit down and therefore sits inside the frame for ease of reach.

Action Taken: Welding tables were designed to work at a comfortable level without bending. Fixtures were made such that the operator should work on one side of frame only once. Cut tubes are fed to the welding table in a trolley and the completed frames will be put on another trolley for next operation.

3. **Welding torch handling**

Observation: After each side, operator had to keep the welding torch down on the table and pick it up again which was strenuous and unsafe.

Action Taken: A stand was provided at the corner of the table to keep the Welding Torch thereby reducing the strain of reaching for the torch from the center of the table each time.

Project Result: Welding cycle time reduced from 47 minutes to 30 minutes

Project 3 - Eliminating non value adding activities through kaizen

The team spent a day in observing the entire process from raw material cutting until completion of welding. Out of the 81 activities noted, 56 activities were found to be value adding. The other 25 activities included Muda like operator movement, marking and setting before the cutting/drilling/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.

Measuring, marking and checking each piece

Observation	Measuring, marking & Checking takes as much time as actual cutting or drilling
Why? 1	The material has to be cut into different lengths, holes drilled at specified distance and bending to 90 deg for frame making. The points have to be marked after measurement.
Why? 2	Without marking the point of cutting/drilling/bending cannot be accurately found out. Marking cannot be done without measurement.
Why? 3	No other provision available for directly locating the points.
Solution	Provide template based fixtures so that the tube/sheet can be directly clamped and cut/drilled/bent

Observation (before)

Measuring and marking piece on floor before drilling operation. Strain to the operator making it likely for him to make errors.

After Kaizen

Operator using locating fixture to directly drill the piece while standing comfortably.

Observation (before)

The bows which form the head of the cot are bent and drilled separately. They are difficult to handle.

After Kaizen

A fixture was made in which the bow can be checked for proper bending and drilled simultaneously with ease.

Observation (before)	After Kaizen
	
Bow hole is drilled after forming the frame; the frame is large and difficult to handle.	The hole is now made during initial drilling using the template made for this purpose.

Project Result: The total number of activities reduced from 81 to 60.

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

Tools were scattered at various locations; operators had to search for tools.

Tool board made and all tools placed in marked location making it search free and visible.

Observation (Before 5S)	After 5S
	
The fly press was kept outside far from the sheet cutting and bending machines. Tools are jigs were not arranged.	The press brought inside the flow – near to the sheet cutting and bending machines. All the jigs and tools are arranged near to the press – easy to pick up eliminating searching.

Observation (Before 5S)	After 5S
	
There was no WIP area designated. There were more WIP and stored all over the floor.	WIP area earmarked.

Observation (Before 5S)	After 5S
	
The output sheets from sheet cutting machine will fall on the ground – making it difficult to pick up sheeets from the ground. Sheets will be picked up one by one and transported to punching machine or bending machine.	A trolley was provided at the collection point so that the cut sheets will fall one above another. It became easy to move the sheets through the trolley to the next workstation.

Project Results: 5S score increased from 57% in first audit to 75% in second audit.

Project 5 - Lean planning, scheduling and material management

Having started one piece flow manufacturing of cots, the planning and scheduling also needed to be changed to be Lean. The system was redesigned to fit in and increase flexibility as well as support customer deliveries On Time In Full.

Customer Order Processing

A systerm for monitoring and follow up of cutomer orders was designed and implemented. A format is designed with the work order number as the base and with committed date and present status for follow up. As part of visual management, this follow up mechanism is displayed in a larger board at the conference cabin - visible from the CRM / Marketing, Purchasing department cabins.

Planning and Procurement

Optimum monthly production volume was arrived based on expected demand. A matrix of product types and relative number of units planned was worked out. For the entire product mix, BOM was updated and from the BOM, the monthly Raw material requirement was arrived – Variant wise.

Based on supplier Lead time, the materials are grouped into two –

- Daily Purchase Materials are those that can be procured within one day and this comprises > 95% of items. These will be procured one day before they are required as per production plan.
- Stock Materials have lead time of 15 to 30 days and constitute 5% of total items. Orders will be placed on reaching minimum defined stock level, generally once in 15 days.

It was found that in stock materials, the variants of a product family (say for example cots) share 95 % as Common Materials and only 5% are unique components. For the Common Stock Materials, their monthly stock requiremetns are fixed as +10% of planned quantity. For Special Stock Components, the monthly requirement was fixed as +20% of the planned quantity of the sub group.

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 lean	Improvement	Impact on business
Material movement (Ft)	200	80	60% reduction	Reduced strain and increased productivity
Welding cycle time (minutes)	47	30	36% reduction	Increased output
Cutting cycle time (minutes)	23	15	35% reduction	Increased output
Throughput time (min)	200	80	60% reduction	Reduced inventory levels and cost, faster delivery

Business Level Benefits

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

Parameter	Before	After lean	Improvement	Business Impact
Production rate (Nos/day)	2	8	300%	Turnover goes up by fulfilling more orders
Man -Productivity (cots per person per day)	0.5	2	300%	Cost per cot reduced
Floor Space (sq. ft) usage	6000	2000	66% free	Space available for further expansion

The benefits obtained have spurred Modern 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.