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INCREASING PRODUCTIVITY THROUGH LEAN MANUFACTURING SYSTEM IN INDUSTRIES

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ABSTRACT

Lots of small scale industries in India are facing various problems which are mostly dealt with quality issue, shortage of material, and the most important problem which is less productivity. The main purpose of this paper is to practice the lean concept in the industry and increase the productivity by reducing the waste. The concept of lean manufacturing is primarily designed for the manufacturing company who deals with serial production also for the other type production like a just-in-time. The methods used in this paper are Time Study, Motion Study, Kaizen, 5S, Takt Time and JIT (Just-In-Time).

KEYWORDS: Time Study, Motion Study, Kaizen, 5S, Takt Time and JIT (Just-In-Time).

INTRODUCTION

In modern manufacturing world for any manufacturer the most difficult challenge is to produce a product or part at low cost with higher quality, that means provide a product to customer with higher satisfaction. To be in the competition companies need to practice a production process which reduces waste and keep on improve on it (Continuous Improvement).[1]

The important part of lean manufacturing is to understand its different tools and use those tools which suits better to the company. For the present paper we carried out our project in ATLAS COPCO IND.LTD for line no.3.

The concept of lean thinking was introduced to the Western world in 1991 by the book "The Machine That Changed the World" written by Womack, Jones, and Roos. LEAN manufacturing is nothing but "A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection".[2]

I. WORKING METHOD

Following 5 steps have been carried out in this Project

1. Line design and balancing.
2. Continuous Improvement Process / Kaizen Mindset.
3. Quality Initiatives / Customer Quality Mindset.
4. Design for Quality, Manufacturing and Service in early project phase.
5. Specific issues improved by design for manufacturing.

1) LINE DESIGN AND BALANCING

The main hardware and vision of Line design and balancing are,

a) Increases FLOW and Efficiency(i.e. check whether the material is flow on the manner of one piece flow)
b) Reduces Work In Progress (standing units that may get damaged)
c) Introduction of TAKT Time & Andon System
d) Eliminate waste
e) Environment that brings problems to the surfaces (including 5S)
f) Place to display results and tackle problems systematically
g) Make a safe, ergonomic environment
h) Take smart decisions and think about future possible changes
i) Build in flexibility.

To achieve the above we have performed the following two methods.

1.1 Time Study

To check whether the given Takt time for each station is accurate, we performed time study on each machine for each station. To perform time study operation we used stop watch and carried out as follows.[3]

a) SELECT (The job to be timed)
b) DEFINE (The element, break the job into element convenient for timing)

c) OBTAIN AND RECORD (Detail recording method, operator, job and working condition)

d) EXTEND (Observed time into normal time (basic))

e) MEASURE (Time duration for each element and assess the rating)

f) COMPUTE (Standard time for the operation for defined job)

g) DETERMINE (Relaxation and personal allowance).

Table 1.1: Time study data for each machine.

Product	Station	Initial TAKT	Measured TAKT	Work Space estimation	Theoretic TAKT time station	Difference (TAKT time remaining)
GX 11 FF TM	1.0	42	19	90	17.1	24.9
CPM7, 5D	1.0	42	42	80	33.6	8.4
GX 4 PACK	1.0	42	25	95	23.8	18.25
CPM7, 5D	2.1	42	42	85	35.7	6.3
GX 11 FFTM	2.1	42	43	85	36.6	5.45
CPA 15 TM	2.1	42	34	95	32.3	13.7
GX 11 FFTM	2.1	42	20	80	16.0	26

By considering above all data of time study it is clear that the provided TAKT time for each station is higher than the actual TAKT time which is required on each station.

For example-In above table for GX 11 FF TM machine initial TAKT time for station 1 is 42 min but actual TAKT time which is require on that station is 19 min, so by studying all allowances and reducing all non working time we give 17.1 min TAKT time for that station and the difference between initial TAKT time and theoretic TAKT time is 24.9 min. Also by considering above all data it is clear that the work distribution for each station is non-uniform which is graphically shown bellow.

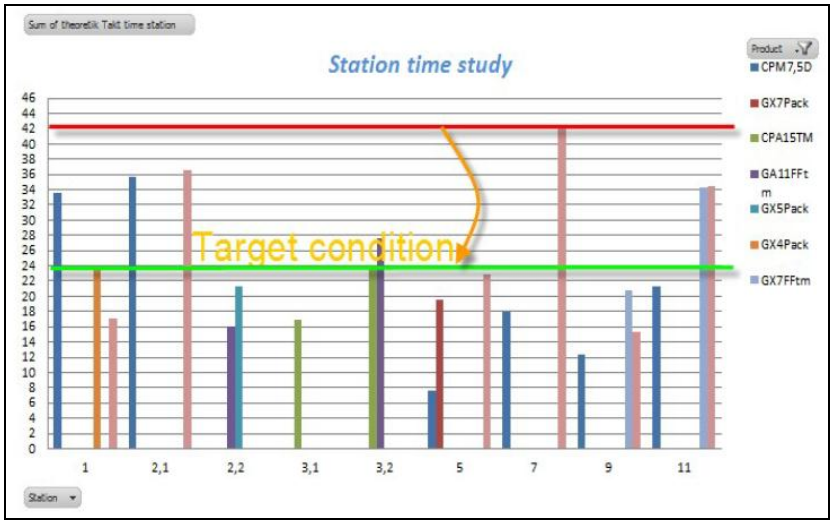


Fig 1.1: Old work distribution for each machine.

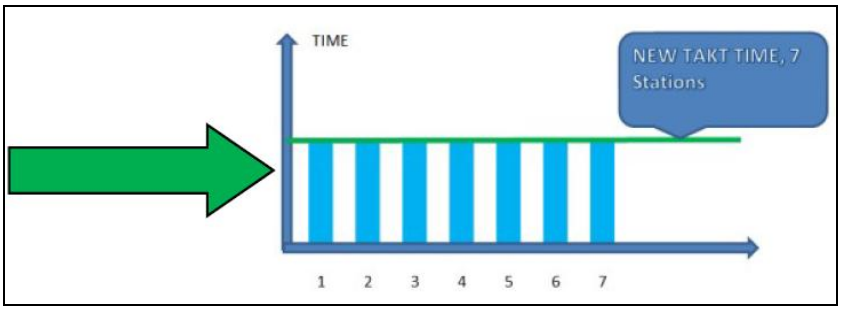
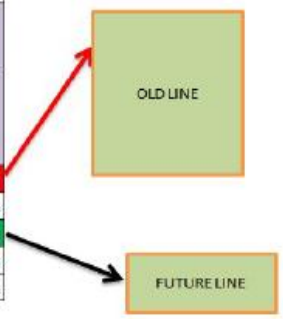


Fig 1.2: Target condition for work distribution.

As shown in the graph our target condition is to distribute the workload uniformly. So for this purpose we divide workload in all station uniformly by using the data which we gate in time study.

Table 1.2: Ideal calculation of TAKT time.

Idael calculation takt time						
station including sub assembly as seprate staion	work increses if less station	minutes work calculation	machine that could be produce	roundup	Actual productio n	used line capacity
9	100%	26	16.73076	17	9	54%
8	113%	29.25	14.87179	15		over 90%
7	114%	33.428	13.01282	13		over 90%
6	117%	39	11.15384	11		over 90%
5	120%	46.8	9.294871	9		over 90%



By the current work load and measured time study value for each station, we need to manufacture 17 machines per day but actually we manufacture only 9 machines per day. By this value it is clear that the used line capacity is only 54%. As per the capacity of the line if we work with 90% efficiency we can manufacture 19 machine per day but we does not require that much amount of machines per day as we do not have that much orders. Here we thought about reducing the work station. From table we can see that by reducing stations from 9 to 8 stations we can increase the work load of line 13% and we can manufacture 15 machines per day and we don't require that much amount of machine as well. So again we have reduced one more station and we divide the work load in 7 station. When we reduced the work stations to 7 the used line capacity is increased to 90% and we easily manufactured 13 machines per day which is our exact requirement.

It is very difficult to change full layout of line because it needs lots of investment. For this reason we were unable to reduce two stations. So we decide to make remaining two (8th and

9th) station as the shortage and repairing station. That means if some work is not performed on line due to some reason like shortage of material, shortage of time etc. then it will be completed on the reaming 2 station.

1.2 Motion study

It involves the analysis of the basic movement of worker performed by his hand, leg and body. It increases the efficiency and productivity of worker by reducing the all wasteful motion and activities.

1.2.1 Objective of motion study is given below

a) To reduce or eliminate nonproductive time.
b) To fix standard time for doing the job.
c) To develop standard data for future reference.
d) To improve method.

1.2.2 Steps for motion study

a) Observe an average worker when he performing a job by determining his movement.
b) Difference between productive and unproductive movement
c) Cut all unproductive and wasteful movement.

It is necessary to have detailed knowledge about the motion study to perform it. In lean manufacturing is important that the worker should not perform wasteful motion which is increases his manufacturing time. So on the basis concept we found that there are lot of motion for tooling system is performed by worker which are wasteful for TAKT time. Also the truly for tooling is not proper there is a lot of time wastage in finding a required tool in the truly. The truly having rack system for tooling to it is increases time when worker opens the racks each time for use of tool.

Considering above all thing we decide to provide proper place for tooling which make reduce unwanted motion of worker for tooling and also reduce finding time of tooling.

1.3 Design a “Smart” Lean Line

LEAN is not only a set of techniques for eliminating waste, but a process by which managers as leaders develop people so that the desired results are achieved again and again”

1.3.1 Objective of Smart LEAN line

a) One piece flow, design for flow
b) Smart kitting, sequence logistics - challenge lead time
c) Tools distance and walking distance reduction
d) Define best possible parts locations
e) Correct fast tooling for operations
f) Build in quality gates
g) If possible no sub assembly
h) Low parts inventory (watch out for shortages)
i) Andon efficiency "in TAKT" => track issues and solve root cause
j) Reduce work space if possible

It is important to implement above all objective to make a "smart lean line", so compare above all objective with present line.

a) One piece flow, design for flow

It is necessary in lean manufacturing that the material which is available on line for manufacturing is goes in one piece flow, so it reduces material handling time on line. But actually the material which is available on the line is not flows with one piece so for making it one piece flow we redesign the kitting location.

b) Smart kitting, sequence logistics => challenge lead time

It is important that the kitting truly is having proper location on it for each material but actually there is no proper place for the material so for this we provide bins on the kitting truly for material.

c) Tools distance and walking distance reduction

It is important that tooling distance is near from the working place also the worker does not travel lot of distance for the tool so we relocate tool place, which reduces walking distance.

d) Define best possible parts locations

We define the best location for part and also done standardization for the part which are common for the each machine.

e) Correct fast tooling for operations

We provide proper tool for the operation if it is not available on the line for each station.

f) Build in quality gates

The part which is supplied by supplier is must be tested ok. That means each part should be checked by supplier before he supply the part to company.

g) If possible no sub assembly

Canopy comes in plant with open condition from supplier but we give instruction to supplier that we require the canopy with assembled.

Fig 1.3: Old arrangement of tooling Fig 1.4 new arrangement of tooling.

h) Low parts inventory (watch out for shortages)

We give instruction to supply chain department to reduce the shortage by finding and solve root causes for it.

i) Andon efficiency "in TAKT" => track issues and solve root cause

We increase the Andon efficiency by finding the root causes for it and solving these problem.

Andon man is busy solving the problem

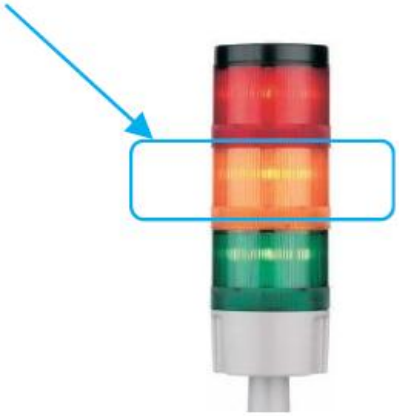


Fig. 1.5: Andon system.

j) Reduce work space if possible

There is a lot of waste of space by placing the material at any place so we allocate a better place for material and reduces space.

By considering above all object made some changes in lean line to make it "smart" lean line. The old and new design of line is given below,

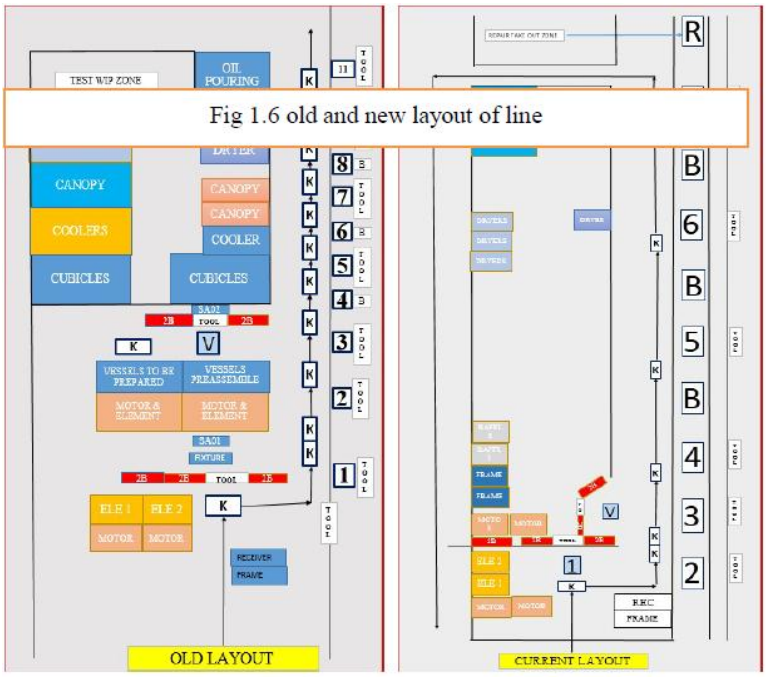


Fig 1.6 old and new layout of line

2. Continuous Improvement Process/Kaizen Mindset

2.1 Kaizen

A philosophy that advocates continually improving products, processes, and activities of a business to effectively and efficiently meet or exceed changing customer requirements and standards set by the organization. Continuous improvement focuses on the elimination of waste or non-value added activities throughout the organization. Conversely, it also attempts to alter processes for the purpose of adding value.

2.1.1 Stages Kaizen

There are basic 5 stages which are used in Kaizen

a) Identify the business case.

b) Set goals.

c) Select the team.

d) Collect baseline data

e) Plan to support the Kaizen activity

2.1.2 Objective of Applying Kaizen

a) Develop workforce that continuously learns & improves to adapt to its environment.

b) Develop Standards

c) Continuous Improvement

a) Develop workforce that continuously learns & improves to adapt to its environment

Provide coaching to worker for improving their working skill and by the improvement of their skill achieve the target which is to be fixed. Develop a workforce that is ready to learn continuously and ready to improve their own skill level.

b) Develop Standard

It is an important thing to develop standards on a line and company, these counts for each process of a company. It helps workers and management to do work by the standard which is to be developed. If there are standards for each process then there are less chances of making mistakes in the process or accident and also reduces quality issues.

Examples- standard worksheets, TAKT time etc.

Atlas Copco	Work instruction		WIB ID:	WIB - Line 3 - 7 stations		
Workstation : 1	Product: Ga 7-	Paraf	Edition:	1	Date:	11-12-2015
Safety						
	DIB	Beschriving	!	Start time in takt		
Seq 1		Take pasport, checklist, prepare compressor map				
Seq 2		Prepare motor fixture, put motor on and add support				
Seq 3		Fix suppoirt with bolt and washers and mark				
Seq 4		Mount element tensionning treathed bloks handtight				
Seq 5		Lift element and fix to support with bolts and washers				
Seq 6		Remove caps and paper from element plate				
Seq 7		Remove motor shaft tape and clean				
Seq 8		Apply torque with wrench				
Seq 9		Remove pulley caliber and mark torqued bolts				
Seq 10		mount pulley on motor shaft with soft hammer and press				
Seq 11		Mount nipples in element and mount non return valve				
Seq 12		Mount sensor in element				
Seq 13		Mount belts and set belt tension, fix and mark tensioning bolts				
Seq 14		Mount final cover support and fix bolts				
Seq 15		Fill in passport, checklist and PC				
Seq 16		Put the assy on the kitting trolley				

Fig 2.1: Standard worksheets.

c) Continuous Improvement

For continuous improvement we start one problem solving method which Manage deviations from standard using Kaizen Board.

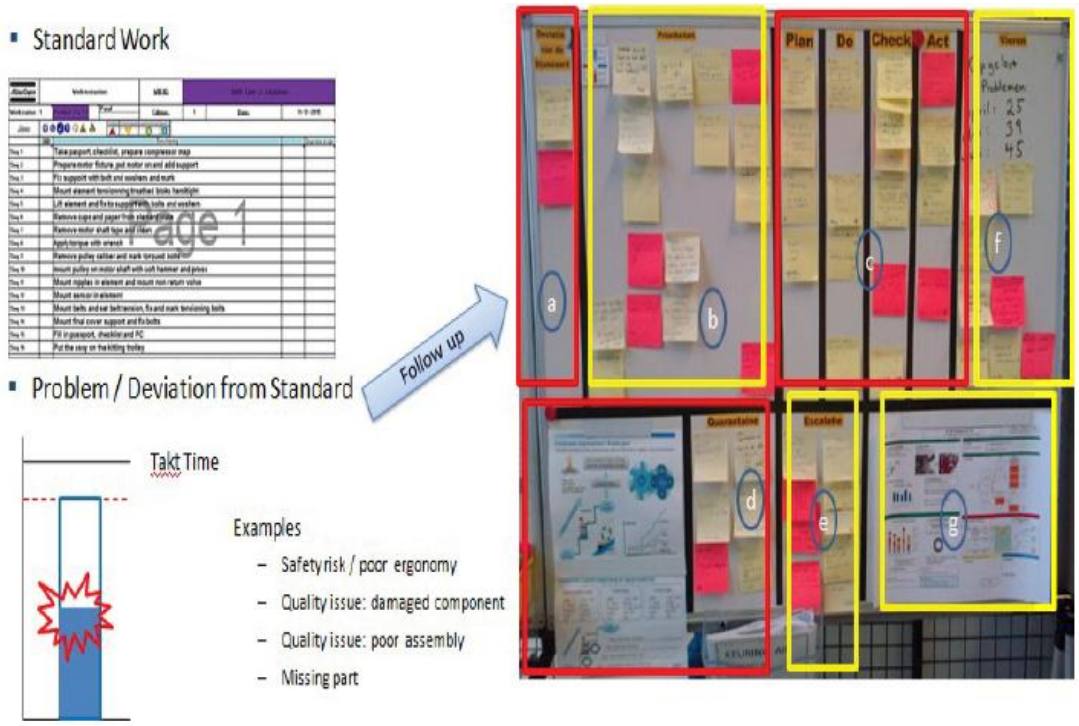


Fig 2.2: Continuous improvement board.

List down all deviation which comeduring manufacturing from FTR (First Time Right), Andon calls and observed problem which are foundduring manufacturing any part or machine.

a) Prioritize

Decide the Which deviation shouid give first prioritize by In line with Target Condition and Impact vs. Effort.

b) Plan/Do/Check/Act (Limit actions to avoid overburdening workforce)

Apply the process for solving the deviation in the process which is Plan/Do/ Check/Act. This is the one of thebest method of solving the problem. => give directives, who will do the action and when should it be implemented to push the timing and people involvement

c) Quarantine

Theire are some deviation which we want to do but we dosentsolve them because of some problems likewise: solving the deviation takes a long period or investment.

d) Escalate

The issues which we want to solve that requires lots of investments to solve or to do some changes to solve the issue, where we need to consult various departmentsor senior authority

that belong to this issue. Its important to consult with other departments and seniour authority's to do the changes which will solve the issue and requirer large amount of investments.

e) Celebrate

Measure how much problems you have solved and celebrate the achievement with the group. (Ex- Give small gift to all group member/cut a cake).

f) Complex A3 Problem Solving

Complex problems should be breaked down in small parts of a problem to find the root cause, then we start solving them part per part in the continuous improvement format written above.

2.2 Develop a LEAN Mindset

When we think lean development we only saw the points like lean techniques, lean tools, lean method, lean process and we only changed these things but it is necessary to consider point like: Workers behavior, mindset of them, culture, unwanted rules and habits in continuous improvement. It is necessary to develop the mindset of the production line workers. It's Also is necessary that change the habits, unwanted rules, culture, assumption that are not beneficial for the manufacturing process.

Give the responsibility and owner ship to each member of manufacturing system: by this way he work like this company is his own and it is the responsibility of his own to do a better work and increase efficiency of company and to perform, in the way his performance increase the profit for the company.

The control command in the company is not like a top to bottom but it is necessary to like a top down and bottom up. There is no need of white and black collar method means there is necessary that conversation form in between top to bottom of company employee.

3. QUALITY INITIATIVES/CUSTOMER QUALITY MINDSET

Quality plays a vital role in manufacturing system. If we manufacture any product and we have some quality issue and if we send this product to the customer then it's makes a bad impact on the company product. All employee of company should need to think that it's my own responsibility to maintain quality of company product and help stand company in market.

It's important to any company that makes their image clear about quality in market. It's important that when the customer think about purchase of product then only one name need to come in his mind and it's only possible by the quality of product and service which we provide to our customer. We need to set customer mindset that our quality of product and services is the one of the best in the world. It's an important thing that we give the best service to our customer before and after the guarantee period, because we stand by our customer and it's our responsibility to give them a better product quality and services.

The following thing needs to do in quality focus meetings:

a) **Quality Focus Meetings with Line workers and Auditors:** The most important thing to improve our quality is that Change the mindset of employee and worker, that mean's develop a quality culture in company.

b) **Explain the worker customer quality requirement:** By the past experience, survey and customer complaints explain the worker that what is their responsibility towards making the product and what is the requirement of customer.

c) **Show quality issue detected from production audit:** Show all quality issue to worker and who related to this issue which you find bye the production quality issue which we make after the final manufacturing step of product should be done.

d) **Inform work members top issues to focus on it:** Find out which issue are most important which is important to solve on priority base. After deciding the important issue which is on priority base Inform the work member that it is the important issue and which we need to solve on priority base.

e) **Visualize key issues at specific stations:** Visualize the key/important issue on station on which the issue occur and inform the worker about that issue and make sure that this issue should not occur at next time.

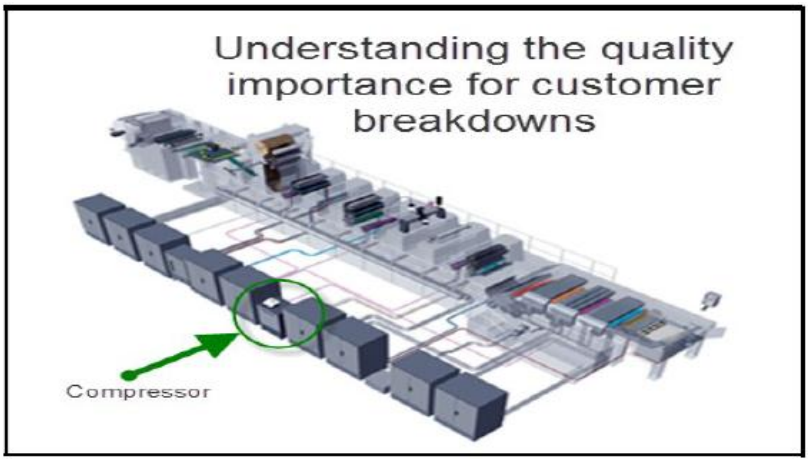
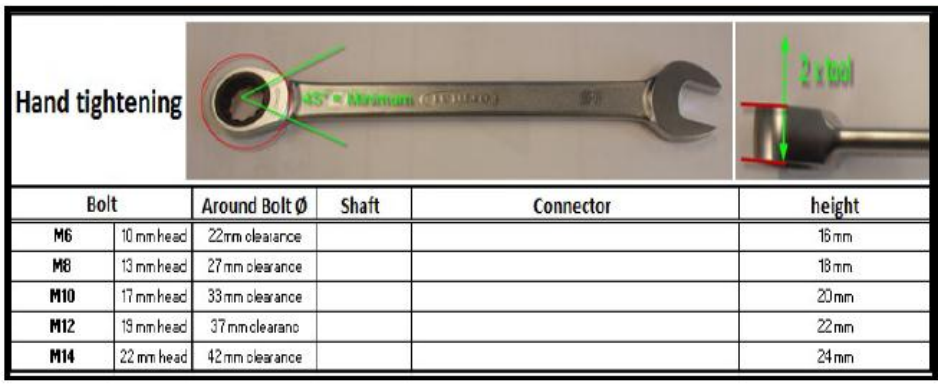


Fig 3.1: Importance of customer breakdown.

The previous figure shows the printing machine in that a compressor play an important role if the breakdown of compressor take place then whole machine should be break down so it's important that customer breakdown. Also this condition is necessary to explain to operator so they try to give those best and help to maintain quality of compressor.

4. DESIGN FOR QUALITY, MANUFACTURING AND SERVICE IN EARLY PROJECT PHASE

In this step Input from customers, service, and line workers before and during product development taken. From this input analyze the current situation and preferred situation and make change in design. Involve all departments in this process which related to the activity which performed.



Bolt		Around Bolt Ø	Shaft	Connector	height
M6	10 mm head	22mm clearance			16mm
M8	13 mm head	27 mm clearance			18mm
M10	17 mm head	33 mm clearance			20mm
M12	19 mm head	37 mm clearano			22mm
M14	22 mm head	42 mm clearance			24mm

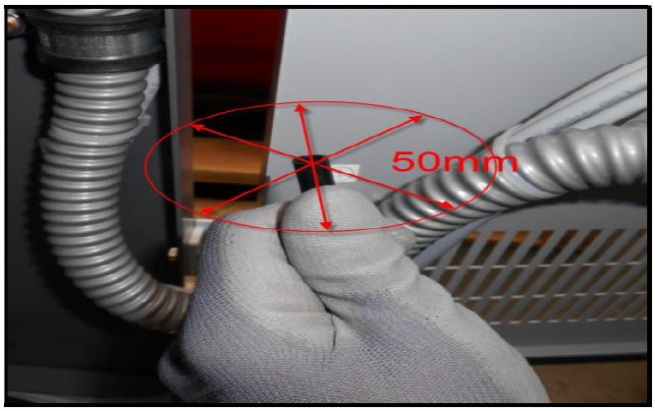


Fig 4.1: Tooling dimension.

5. SPECIFIC ISSUES IMPROVED WITH NEW DESIGN

In this step various problem which occur due to faulty part are solved by redesigning of that part. The redesign of any part is better, if the repair or damage cost of the material is higher than the redesign cost. In this process various departments are to be involved like Engineering Method, Quality etc.

Firstly found that is the really part is faulty and if the part is faulty then is the redesign of part beneficial or rework is better on it. After deciding any one process in between them then the part is to be redesign or rework operation perform on it. Examplea).

a) During Electrical control panel assembly problem occur. The connector not as good quality so it fitted properly and if it is attached it loosened after some time. So for this reason company make change in the design of connector.

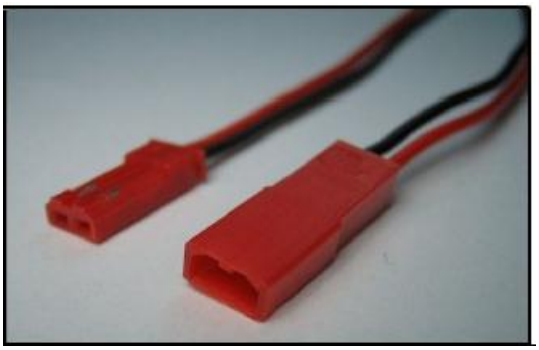


Fig. 5.1: Old connector.

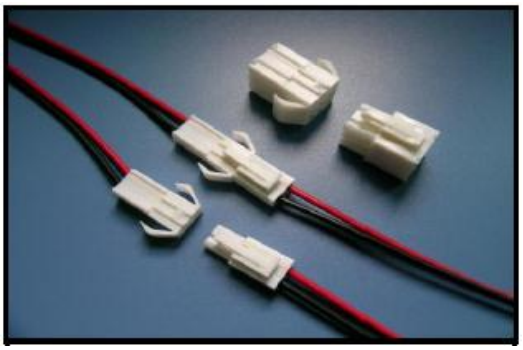


Fig. 5.2: New connector.

CONCLUSION

1. The main objective of Lean manufacturing is to meeting established demand, by achieving a master schedule that is intended to match actual customer orders, which we have achieved by reducing two work stations in current work.
2. Lean manufacturing is a team work which we have achieved by making people mindset towards continuous improvement (Kaizen).
3. The 5M of production system i.e. Man, Machine, Method, Metrics and material were optimized by lean manufacturing tools.

FINDING

Finding of this research paper is productivity of line increased by 36% by proper use of Lean Method.

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REFERENCES

1. Roman BEDNÁR. "individualisation of lean concept in companies dealing with mass production".
2. "The Machine That Changed the World" written by Womack, Jones, and Roos.
3. Allen, H.M.; Slavin, T.; Bunn, W.B. III. "Do long work hours impact health, safety, and productivity at a heavy manufacturer?", in Journal of Occupational & Environmental Medicine, 2007; 49(2): 148–171.
4. T. Karkoszka, J. Honorowicz. "Kaizen philosophy amanner of continuous improvement of processes and products".
5. Rajesh Gautam, Sushil Kumar and Dr. Sultan Singh. "Kaizen Implementation in an Industry in India: A Case Study".
6. Manuel F. Suárez-Barraza, Tony Lingham. "Kaizen within Kaizen Teams: Continuous and Process Improvements in a Spanish municipality.
7. Lonnie Golden. "The Effects of Working Time on Productivity and Firm Performance.