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Reduction In Lead Time Of Automated Gas Fired Kit Fitting Box Using QC Tools And Strategies

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Abstract

Recently in a competitive manufacturing sector, lead time is the most important factor in order to compete in the market. This leads every manufacturer to decrease production time and increase quality of the product. Due to improper work cycle delay of a product occurs. The major changes required are operation sequence, flow of material in the workshop, work cycle, etc. In this paper, the authors have delved into the causes of excessive lead time and suggest practical inexpensive strategies for reducing it. Recommendations are based on detailed study of manufacturing facility and processes for a time period of 6 months in the industry. After describing the relationship between lead time, material flow time and variance and reviewing potential methods for reducing lead time by reducing mean flow time of material and operation time of an automated gas fired kit fitting box (hereafter termed as "box"). The aim of this paper is also to demonstrate the use of QC tools and Kaizen in the industry as to tool for improvement in manufacturing sector especially in small to medium scale industries.

Keywords: lead time reduction, Kaizen, material flow time, workplace management, 5s, Pareto analysis.

1. Introduction

In globalization era, industries are determined for reducing time and cost and increasing the satisfaction level among customers. Therefor manufacturing time is key aspect of the industry. "A **lead time** is the latency between the initiation and execution of a process."[2] Less manufacturing time with low cost is economical for both, industries and customers. In case of sheet metal working, time is largely reduced by designing punch and dies for multiple operations. Gas fired water heater is one of the major products manufactured by warm stream. In order to optimize gas usage and efficacy of water heater, one of the major aspects is automation of the water heater. Considering this, the company has developed an automated gas fired kit. To protect the fragile circuit and instruments, a cover is provided. Method study is to be done in order to identify various processes in the shop. This cover, made of sheet metal,

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consumes lot of time in manufacturing; hence the less number of boxes is manufactured. Time includes various operations and required lots of tool changes to perform this operation. For this purpose, identify various operations, their expected time and standard time. Comparing standard time with the actual time and finding slack processes to eliminate it. Analysis of time and motion charts will lead to suggestions in current design. It is suggested that either eliminate some operations or can have a new design for automation gas fired kit fitting box. Work should be done in this area so that overall manufacturing time can be reduced with the optimal material consumption and comparatively low cost so that company can take the maximum number of orders and maximize profile. This also helps to improve working conditions workshops. The aim of this project is to increase efficiency of the company and the workers. to get the maximum output, cause-effect diagram and various data representation techniques are used.

2. Process study

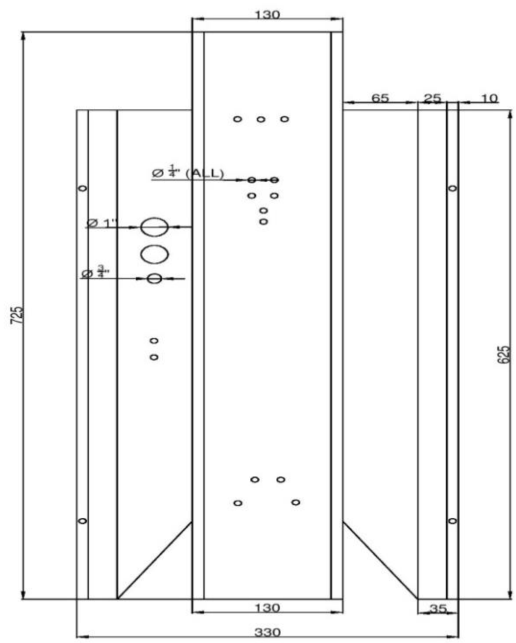


Fig. 1. Drawing of part

Table 1: Existing operation sequence for manufacturing of a box.

Material specs: G. I. Sheet (350×750 mm) Stack size: standard stock (width 1000 mm) Part name: automation gas fired kit fitting box			
Sr. No.	**Description**	**Tool**	**Machine**
1	Cutting required blank from stock (350×750 mm)	Snip Cutter	-
2	Marking	Pen, measure tape, ruler	
3	Cutting actual blank after marking (a)	Snip Cutter	-
4	Punching prior to drilling	Punch and hammer	-
5	Drilling hole of ¼" (b) diameter (15 no.)	¼" H.S.S. Drill	Hand drill
6	Drilling holes of ¾" diameter (3 no.) (b)	1" H.S.S. Drill	Radial drilling machine
7	Drilling hole of 1" diameter (1 no.) (b)	¾" H.S.S. Drill	Radial drilling machine
8	Marking for bending operation	Pen, measure tape, ruler	-
9	Bending along marked lines (c)	V dies	Press brake bending machine
10	Riveting	Hammer, Rivets (¼")	-
11	Deburring and finishing	-	Grinding machine

The first step taken towards identification of problem in workshop, i.e. To identify our task and break it into a number of elements so that element which has more lead time can be determined. Based on observation, followings were obtained:

I. Operation sequence: a step by step procedure of manufacturing automation gas fired kit fitting box in engineering point of view, it involves various tools, methods and techniques used during operations. An operation sequence sheet is prepared as per observations taken at the workshop.[3]

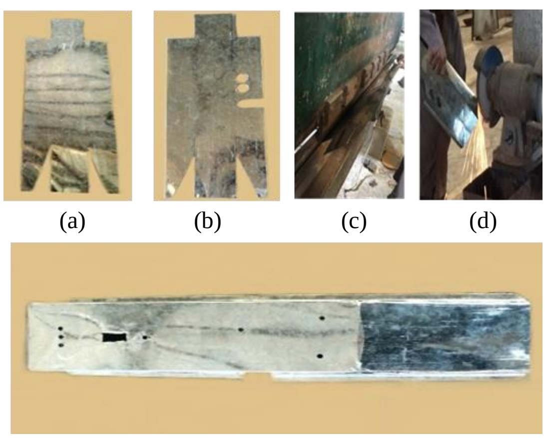
II. Flow process chart: a study of the flow of material or workpiece on shop floor indicating movements for each operation is shown to help of this tool.

Currently, a worker uses above sequence of operation to manufacture one cover box. Hand tools which worker uses are hammer, file, snip cutter and chisel. Each time workpiece has to move from one shop to another.

3. Methodology

3. 1 Data collection:

The data that was collected was setup procedure, setup time, cutting time, drilling time, riveting time, bending time and finishing time. The process of data collection was: 1) *Identify work to be measured.* 2) *Break up the work into finite elements for easiness in observations.* 3*) Define observation sheet for noting down time against each element.* 4) *Take a stopwatch and an observation sheet.* 5*) Discuss time for taking observations such that all possible factors affecting.* 6) *Observe each activity of the worker and note down the time.* [11]



(a) (b) (c) (d)

(e)

Fig. 2: Pictorial representation of process

Table 2: Average manufacturing time for a box.

Operation	Average time (seconds)	% of total
Cutting	36	1.54
Marking	70	3.00
Cutting	426	18.24
Drilling	503	21.53
Marking	94	4.02
Bending	555	23.76
Riveting	489	20.93
Debarring & Finishing	163	6.98
Total	**2336**	100%

Table 3: FPC for current flow of material in workshop

FLOW PROCESS CHART	PART :- AUTOMATION GAS FIRED KIT FITTING BOX						
Sr. no	ACTIVITY DESCRIPTION	Symbolic representation					
		○	⇨	□	D	▽	TIME (Seconds)
1	Cutting from blank	•					22
2	Transporting to the table		•				40
3	Marking operation	•					25
4	Actual blank cutting for box	•					432
5	Punching prior to drilling	•					136
6	Drilling hole of 1/4"dia	•					216
7	Transporting blank to drilling		•				40
8	Drilling hole of 1" diameter	•					207
9	Drilling hole of 3/4" diameter	•					133
10	transporting blank to table		•				40
11	Marking for bending	•					180
12	Transporting job to bending		•				48
13	Actual bending operation	•					234
14	Transporting box to table		•				36
15	Riveting operation	•					229
16	Transporting to grinding m/c		•				22
17	deburring and finishing	•					132
18	Inspection			•			263
19	Storing of produced box					•	74

Table 4: Description of FPC

Sr. No.	Description	Symbol	Count
1	Operation	○	11
2	Transportation	⇨	7
3	Delays	D	0
4	Inspection	□	1
5	Storage	▽	1
6	Total time		35:21 (minute)

Table 5: Non-value added time in process

Sr. No.	Description	Average time (Sec)	% of total
1	Move workpiece from one shop to another shop	78	28.57
2	Deeside orientation of template	20	7.33
3	Deeside cutting sequence	15	5.49
4	Change tool for next operation	10	3.66
5	Inspection for right approach	10	3.66
6	Deeside number of covers to be produced	20	7.33
7	Acquire needed tools from the store	55	20.15

Observations are done on random periods in order to gain maximum information about different factors affecting process time and movement of material is also recorded as shown in table 3. It represents the movement of material throughout the cycle. Above data are collected over a period of time at random intervals and scenarios in the industry, and presented here as summary of observation.

3.2 Data analysis:

The purpose of data analysis is to find out the critical activities, i.e. Activities which take more time compared to other activities involved in the setup process. **Two minute analysis** tool was used for the analysis of captured data. The method includes breaking down the video into intervals of two minutes. Then activities completed in particular interval are noted down. During observations, information about the various causes and their frequency, i.e. how many times a given case has contributed in increasing working time and the amount by which time has increased because of the combination of various causes. The cause - effect diagram[10] is one of the important tools for representing causes for a general effect. Here is a cause-effect diagram for manufacturing a box.

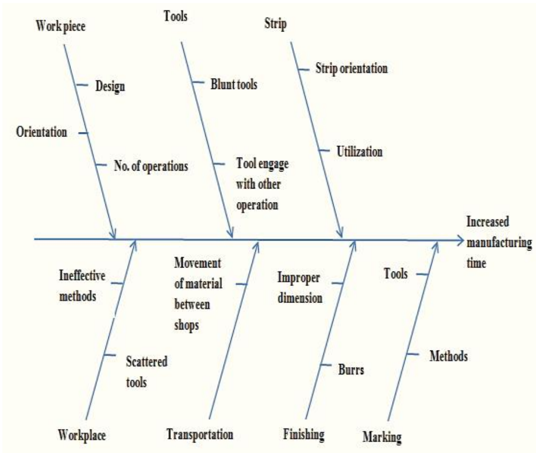


Fig. 3: Cause – Effect diagram for finding the root cause

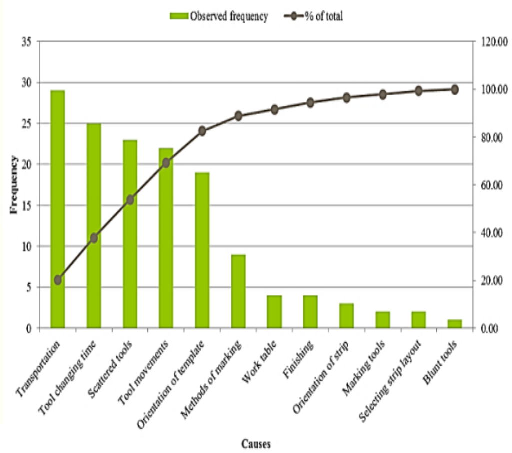


Fig. 4: Pareto analysis for finding most affecting cause

Also, as it can be seen in fig. 2, there are too many causes which increase the time, but there are some which have more impact on increasing time. Hence, using Pareto analysis[10], priorities can be decided on basis of most affecting causes which may be in smaller occurrence but have a large effect on the process. Using this data, following chart represents a Pareto curve. It has been identified that following 5 causes needed to be taken into considerations: 1) transportation, 2) orientation of the template, 3) scattered tools, 4) tool changing time and 5) tool movements. As shown in curve, these 5 activities/causes are responsible for a 82.52 % increase in time.

3.3 Brainstorming

For the brainstorming session, our team, including our mentor and workers has suggested various ideas to decrease manufacturing time. In this session, each critical activity was studied thoroughly and the problems for delay of activity were found out. Accordingly, solutions were identified, discussed and finalized for implementation in an actual procedure. Most effective suggestions are as follows:

3.3.1 An assisting fixture for supporting cutting of sheet metal with the help of template.

A template which can be used for marking only, what if that same template is used for cutting the required blank? Carrying objective of this research, i.e. suggestions for economical solutions, several methods were discussed. Among them, best and easiest one is this. Here, a skeleton type structure, which has the same dimensions as required piece, is placed upon the blank. The bank will be fitted with this tool and hold firmly against all possible directions. To assist efficient cutting, one clamp on the left side of the skeleton and one on bottom or top. This fixture is manufactured from scrap available in the workshop.

Fig. 5: Fixture for supporting marking and drilling operations

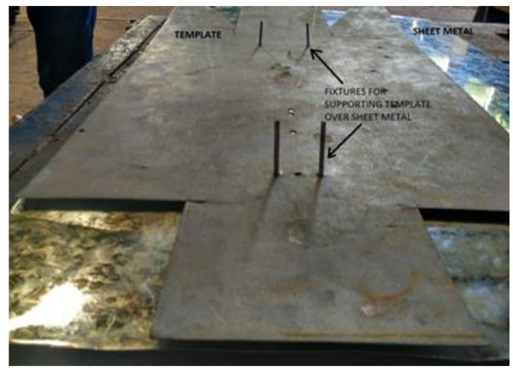


Fig. 6: Setup of fixture on worktable.

Sequence to follow:

1) Cut sheet metal from stock, according to requirement.
2) Place the master template on the sheet metal and drill four holes at specified locations.
3) Place jig for table and hold sheet metal into the rods.
4) Place secondary template oven the sheet metal and fix it so that it won't slip during operations.
5) As workers can get the reference of the template itself, marking operation is not needed, thereby saving time from marking and in some cases repetitive marking.
6) After cutting sheet metal with the help of snip cutter, take a hand drill of ¼" H.S.S. drill.
7) Locate the hole on secondary template and start drilling on each of the hole. As hole size is bigger than actual drill, it will facilitate the drilling tool to drill without interfering with sheet metal.

Before implementing this solution, marking time was 6% and punching and drilling time was 27% of the total manufacturing tim e. This in turn also includes the elimination of non-manufacturing lead time, i.e. setup time, tool preparation time, auxiliary movements of tool and workpiece. These mentioned non-manufacturing lead times were 45.45% of the total non-manufacturing lead time.

3.3.2 Methodology for process improvement

Recent developments in industries, in particular, Japanese, this type of methodologies are used to reduce the non-processing time and increase productivity.

3.3.2.1 Sort: Various obstacles are eliminated. Elimination of inappropriate tools, scrap disposal, scattered tools, measure tape and other non-performing equipment. Given eliminations of obstacles will provide following benefits to workers.

1. The chances of being disturbed by obstacles will be reduced.
2. Prevention of unnecessary accumulation of scrap and tools.
3. Necessary items will be on hand during the process.
4. Defining areas of where scrap can be disposed temporarily so that workers don't have to move every time to dispose of scrap.
5. Wastes are removed.

KAIZEN SHEET

(WHERE)	Machine:	Marking
	Unite:	Worktable
	Date:	10-10-2016

Kaizen Theme: (WHAT AND WATCH)	TO ELIMINATE TIME FOR MARKING AND DRILLING	**Target and Target Data: (HOW MUCH AND WHEN)**	PROVIDE FIXTURE FOR EASY CUTTING AND DEILLING FOR SHEET METAL. 10/10/2016

Problem: CURRENT PROCEDURE IS TO DO MARKING BEFORE CUTTING OPERTAION. WHICH IS TIME CONSUMING AND IF MARKING LINES AE NIT VISIBLE THEN THIS STEP IS REPEATED.

Analysis:

INCREASED LEAD TIME
WHY? ↓
REPEATITIVE OPERATIONS
WHY? ↓
MARKING REQUIRED
WHY? ↓
NO PROVISION FOR DIRECT CUTTING

Root Cause: Marking lines were invisible most of the time and repetitive marking.

Idea: A FIXTURE TO SUPPORT TEMPLATE OVER SHEET METAL FOR REFERENCE CUTTING

Counter Measure: A fixture to fix template on sheet metal for easy cutting and drilling

Before Counter measure: (HOW)

After counter measure: (HOW)

Benefits/Results after implementation

TIME FOR CUTTING = 220 seconds
TIME FOR DRILLING = 140 seconds
NUMBER OF PIECES PER HOUR = 5
TOTAL TIME AFTER IMPLIMENTATION = 1800 sec
TOTAL TIME BEFORE IMPLEMENTATION = 3011 sec
SAVINGS = RS. 8.746 PER HOUR

Scope and plan for horizontal deployment:

MACHINE	TARGET DATE	RESP	STATUS
CUTTING AND DRILLING	10TH OCTOBER , 2016	A.R., D.V., A.J., R.K.	IMPLEMENTED

Implemented by: (WHO)	ABHISHEK RANA, DHAVAL VITHANI, ROHIT KHAIRNAR, AJAY	**Kaizen No: 1A**

3.3.2.2 Set in order: after eliminating obstacles, remaining objects are to be organized in such way that a worker should find appropriate tools at the appropriate time. Hence this is the most important step toward reducing time to find an appropriate tool during operations and placing them near to the worker. In this area, tools are placed at appropriate locations on the work table. For this purpose, a team has identified and provided suggestion on how to arrange tools and workplace

3.3.2.3 Shine: now, after deciding and eliminating various obstacles, it is left with proper arrangement and cleaning of the work table. After every small batch of production, the worker should clean his working area. It includes cleaning of the worktable, snip cutters; drilling machines (removed metal) and other tools used during processing. However, this should be maintained by the worker himself without the interference of others.

3.3.2.4 Standardize: maintaining standard procedures for each process is necessary for completion of the task in the given time. time for sheet metal cutting operation for a standard worker is 90 seconds for cutting length of 1 meter sheet. Now, as per observations, it has been derived that cutting the time under present circumstances, is on average 6 minutes and 30 seconds and total length to be cut is 2200 mm or 2.2meters.

3.3.2.5 Sustain: maintain given solutions throughout life cycle to ensure results of giving suggestions. Workers should maintain their workplaces and equipment/tools to have maximum efficiency and regular maintenance of tools is necessary.

4. Conclusion

With the use of the flow process chart, nearly 10% transportation and operation time was reduced. With the help of jigs, auxiliary movements of tool and workpiece are eliminated, hence reducing setup time. Various methods that have been used are 5s, Kaizen and process charts along with new suggested improvements in methods, techniques and tools, total manufacturing time can be reduced by 50%. Further, by changing the technique to this suggested, the company will save approximately ₹ 1400 per year. According to the cost slop of TQM, after certain optimal improvement, the cost of improvement will be increased.

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