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Automatic Nut Detection Machine

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Abstract-*Atom Automation is a private company which is involved in manufacturing of different industrial jobs and giving automation solution as per the requirement of industries facing problems during their production. At present company has received a case regarding quality detection of a nut with M3 size. Currentlycustomer company uses visual inspection and some technical methods to determine the rejection of the Nut which is time consuming and possibility of error generation increases. Hence company needs to find out the solution for this problem. Hence our concern in the company is to find solution for the bottleneck that company is facing while giving an automation solution for detection of nut. Taking this problem as our I.D. project a solution for this problem which is based on reducing job detection time and giving customer satisfaction by using Time Study. In a new solution we would provide an automatic nut detection machine that would detect whether the nut manufactured is correctly tapped and is capable of withstanding a standard torque acting on it, which will help the firm to reach-up six-sigma level in nut detection.*

Keywords: *Six Sigma, Detection, Work Study*

I. INTRODUCTION

Automatic nut detection machine is a mechanical device which is used to detect the strength, tapping, threads in a M3 size nut. As far as concerned there is very shortage of nut detection machines in market which a small firm can implement. Further more no detection system have been potentially generated which uses simple mechanisms to check or to detect thread's strength of a nut. Obviously nut detection cannot be neglected as it is the basic requirement of any equipment. In the mean time industries are carrying out researches into new ways to increase productivity rather than emphasizing on the existing quality control tools which can help in both increasing the productivity as well as producing good quality of products. It is focused that detection method is always costly and time consuming but actually it is not when customer satisfaction is our prime duty.

Six sigma is the life blood of an industry through which a company can attain maximum production of a product as well as can achieve customer satisfaction in response to change in economic and competitive circumstances through which a company can sustain in market as well as can have an imperial reputation in the market.

The process of detecting a defect in moving parts where nuts are used reduces the productivity time because it is not initial basic feasible solution for a company to check each and every part. Any metallic or non-metallic any materialistic as well as non-materialistic thing uses nut for each and every basic operation.

II. LITERATURE REVIEW

A. Six Sigma

Six sigma is set of techniques, methods and tools for the improvement of the process. It was implied by engineer Bill Smith in 1986 when he was working in Motorola company. In the year 1995 Jack Welch made this idea a central business technique and implied idea in company named General Electric. Nowadays its used in many of the industries as an significant tool to improve productivity.

According to Miroslav R. and Ruzena K.(2011)[I];Six Sigma is a complex and flexible manufacturing system for achieving, maintaining as well as maximizing the profit of a company. Six Sigma mainly focuses on understanding needs of customer and their expectation, disciplined use of facts and statistics figures, data and efficient approach in managing establishing new business that can achieve higher profit.

According to M. Sokovic, et.al.(2006)[II]; purposeof this paper is to present a Six Sigma project, which is undertaken by company for production automotive parts, that deals with the identification and reduction of production cost in the manufacturing process for various die-castings and improvement of quality level of produced parts.

B. 7-QC Tools

The continuous quality improvement process assumes and requires that a team of experts work together for the company for leadership actively using quality tools in their improvement of production process. Presently the scenario is that there is significant number of quality assurance and quality management tools that are available in the market, so the

selection of best is not easy. Tools are basic requirement of a process and basic instruments for achieving the desired quality. Many companies have selected tools without proper planning and then faced the failures accordingly. Quality tools cannot face all kinds of challenges but can stand upto the remarks.

According to Varsh M. and Dr. Vilas S.(2014)[III] ; paper a systematic use of 7 QC tools. The central idea of this paper is to give an easy implementation of 7 QC tools in a company or in a small scale industry with the means of Collecting of data , analyzing of data , specifying root issues and measuring the results. these tools are related to numerical data processing .All the tools can provide promising process tracking and analysis which is very helpful for quality improvisations. These QC tools make quality improvisation easy, establish and track. Continuous use of QC tools enhances the personnel significances of the people that are involved. It enriches their ability to imagine and generate ideas, solve problem and introduce proper planning. Development of the people is very much important for enriching the environment of the company.

C. Gyroscope

A gyroscope is a wheel or disc in which the axis of rotation is presumed by any directional orientation itself when the disc spins or rotates around the axis. When the disc is rotating the orientation and the movement of the disc and its axis remains unaffected when the disc tilts or rotates the position and reason for that can be accepted as the law of conservation of angular momentum. The gyroscopes are useful mechanical devices for measurement or maintenance of the orientation of the disc and spinning wheel.

According to Dunzhu Xia et.al (2014)[IV] ; the review shows micro machined type of gyroscope structure and circuitry type of technology. The micro machine gyroscope was the first whose principle was introduced. After that, different types of MEMS gyroscope structures, materials and fabrication technologies are introduced. Micro machined gyroscopes are mainly classified into micro machined vibrating gyroscopes (MVGs), piezoelectric vibrating gyroscopes (PVGs), surface acoustic wave (SAW) gyroscopes, bulk acoustic wave (BAW) gyroscopes, micro machined electrostatically suspended gyroscopes (MESGs), magnetically suspended gyroscopes (MSGs), micro fiber optic gyroscopes (MFOGs), micro fluid gyroscopes (MFGs), micro atom gyroscopes (MAGs), and special micro machined gyroscopes. The control circuits are further detailed into typical circuitry and special circuitry technologies.

D. Work Study

It is the systematic analyzing of the methods that are carried out in such a way as to improve the effective use of the available resources and to set the Standards for the performance of other activities that are carried out. Work study basically is the collection of various techniques that are used to examine the specified work – what is done? and how the work is done - so that there is a systematic flow for the analysis of all the elements, factors, tool and the relationships that are directly or indirectly affecting the efficiency and effectiveness of the work which is being studied.
Work measurement is nothing but the application of the set of techniques which is implied to establish the amount of work to be done by an operator in a given period of time for a specified task, under given specified condition and at the predefined level of performance.

According to Mutombozana T.et.al.(2013)[V]; The given paper emphasizes the use of work study techniques for the optimization of manufacturing plant. An overview of work study strategies from literature is done on the primary basis after that performance index for maintenances practices are shown. Availability of plant, downtime and performance of quality figures that are taken from January to December 2011 have shown that the company is experiencing issues. Hence ultimately the maintenance system is not that effective.

According to Prathamesh P. Kulkarni.et.al(2014)[VI]; The primary purpose of this paper is to present an overview on a new integrated methodology for an efficient improvisation in productivity with the help of various Work Study Methods that are associated with Lean Manufacturing Principles & Tools. For eliminating wastes this method is very significant. controlling quality and improving entire performance of any machine, system or process in any industry with the full assurance of great annual profit margins. This prescriptive paper gives correct solutions & concepts for implementing Work Study Methods and implementing associated lean manufacturing tools in any industry, covering the technical, engineering, and manufacturing aspects as well as the business affairs.

According to PatangeVidyut Chandra (2013)[VII]**;** This paper puts efforts on the area of productivity improvisation with the use of work study technique along with modern delicate skill techniques. Management should understand the application not only from production improvement point of view or finance improvement or resource utilization, but also should show crucial and soft side of workers mentality to give the best in order to accept the productivity solutions, and also be a part on forefront during actual implementation to make the study really worth its time and effort.

E. Quality Control/Quality Assurance (QC/QA)

Quality Control/Quality Assurance (QC/QA) can be defined as the planning and the activities in systematic manner for fulfillment of quality requirements are focused with the QC/QA. The product and services are covered with the range of matters widely. Reliability and accuracy and the timeliness of the reported results of test is defines the quality of the product in medical laboratory.

According to Paliska G.et.al(2008)[VIII] ; in order to confirm effectiveness as well as the capability of its management system of quality control and quality management system a company should conduct the process data analysis and the acquisition and it is to be involved in a continuous improvement of process. Based on the facts continuous process for the quality of product improvement assume appropriate quality tools application which sound decision making process is enabled.

F. Detection of nut

Detection plays a very important role in order to define the quality of a product. Detection method is the most important method used in each and every industry to not only improve the quality but also to check the defects in the process and helps to remove the bottleneck.

According to ShrutiP.& SandeepS. (2013)[IX]; Humans are better choice in various places like in the field of the recognition. But as there is increment day by day there is need of the efficient machine recognition system. So, there are plenty of research going on to machine recognition. This paper deals with the distinguish method to sort the mechanical objects in automation industry. This paper deals with sorting of various mechanical components in order to attain very high efficiency.Artificial neural network which is a popular artificial intelligence technique that is used for recognition of the wavelet component object.

According to Ravindrasingh R. et. al. (2012)[X]; The governor should maintain speed of the engine in thegiven specified limit whenever the load variation occurs. In almost every vehicle this device is used. The spindle displacement and the various elements of the spindles displacement is calculated and is plotted on the graph. In this paper there is the effect of the weight of the arms is primary concern of the study and all the calculations like centrifugal force acting on the centroid of arms, force on governor assembly is carried out. The analysis is done on governor assembly arms of the governor when the governor is in rotation. The stress analysis is done on different parts of governor assembly suggesting the materials that should be used for governor on the basis of theoretical value.

III. PROBLEM STATEMENT & OBJECTIVE

A. Problem Statement

Atom Automation is designing a solution for detecting an M3 size nut automatically as per the requirement of the customer company, where they have come across a problem in which they are unable to find a proper mechanism for auto detection of a nut.

B. Objective:

- Study entire automation procedure.
- Find a mechanism which can detect a nut correctly with required criterias.
- Satisfy customer company with the proposed Automation Solution.
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IV. DATA COLLECTION

A. Process Flow Diagram of Manufacturing of Nut

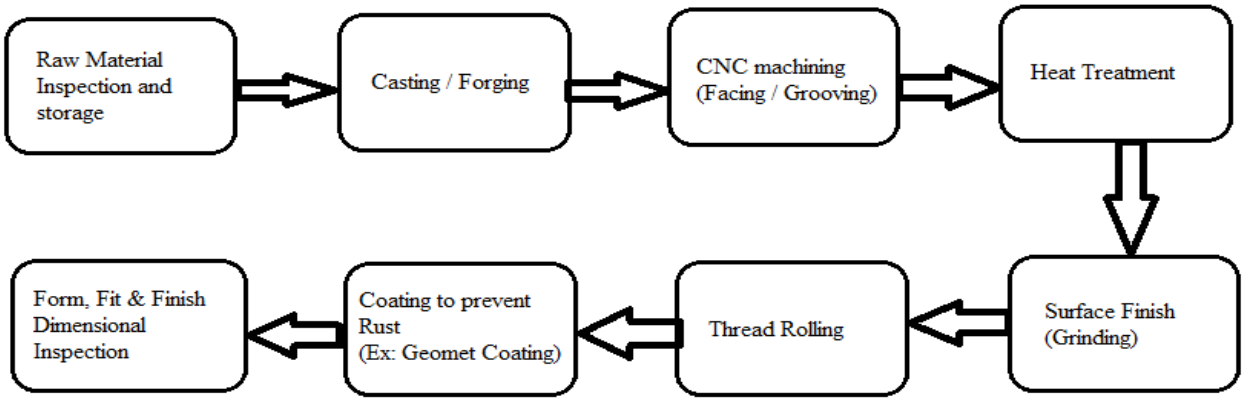

Figure 1 Process Flow Diagram

B. Torque Failure Complain Analysis (2012-2016)

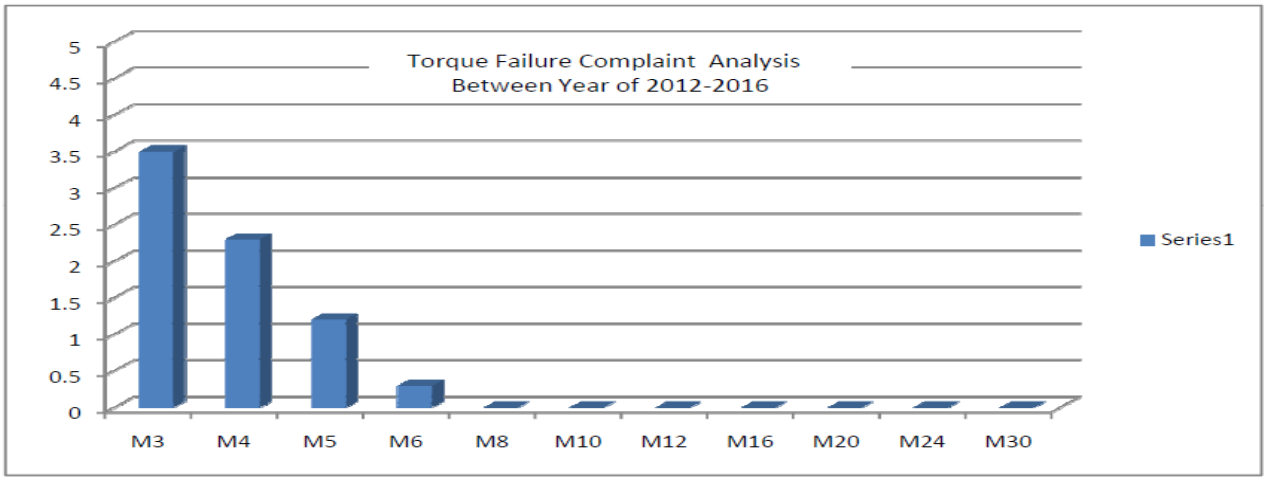

Chart 1 Torque Failure Complain

C. Material used in Existing method

At present the customer company manufactures the Nut by cold forming and tapping process, from material carbon Steel Grade 8.8 of IS 1367 (Part III)-2002.
The specification of the material used is as follows:
IS 1367 (Part III) - 2002. Property class 8.8

a) Nut Type: Metric Thread Hex Nut.
b) Size: Thread size, length and other dimension as specified in drawing.
c) Material composition of requirement.
   1. Material - Carbon Steel grade 8.8
   2. C - 0.25 % Min.
   3. P - 0.05 max
   4. S - 0.06 max
d) Hardness test: 250 to 320 VPN.
e) Note:-
   1. 8.8 Grade will be with Heat Treatment.
   2. Material specification to be given with supply either carbon steel with Min 0.25% or with BORON additive.

V. DATA ANALYSIS

Analysis is done by customer company on the basis of the problem that is faced by their customers when the product is used by them. There are various problems like Damaged nuts , Nuts without thread, Torque failure & etc. But the maximum percentage of the complains are all about the torque standing capacity of the nuts and threading of them.

Table 1 Customers Complain from 2012-2016

Customer complain analysis of nut manufacturing industry from year 2012-2016	
Types of rejection	Percentage %
Damage nuts	2
Without thread	4
Tight thread	6
Torque failure	8
Improper platting	1
Wrong nuts	2
Less quantity	1
Burrs on nuts	1

From the above table a customer complain chart is prepared which represents the maximum problem faced by the firm.

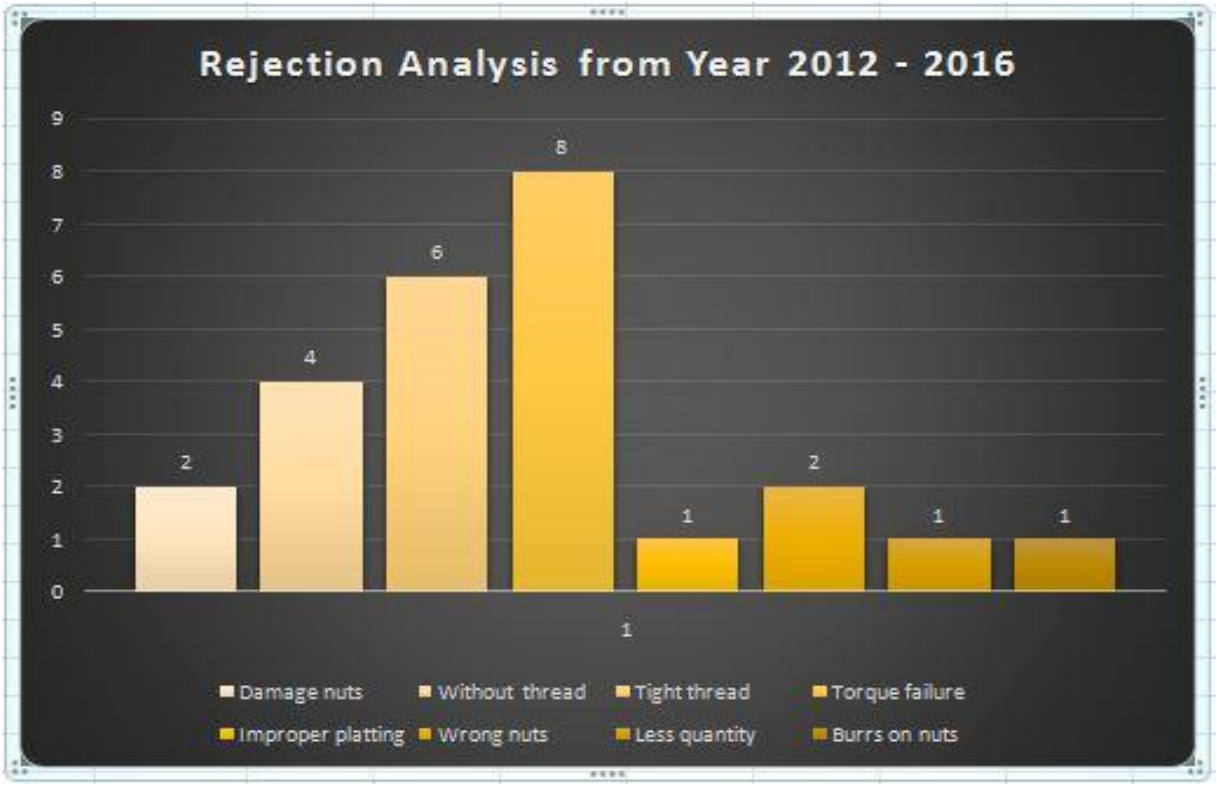

Chart 2 Customers Complains from 2012-2016

VI. COMPANY'S APPROACH TOWARDS SOLUTION

❖ **Preventive Solution:**

Customer Company thought of implementing some solution to eliminate customer complaints and achieve a good reputation by customer satisfaction by finding problems at occurrence stage and remove it.
Customer Company concluded that changing raw material and introducing new furnace can be beneficial. Hence details regarding these solutions are as follows.

A. Raw Material Details

Description

Nut manufactured by cold forming and tapping process, from material carbon Steel Grade 8.8 of IS 1367 (Part III)-2002.

Specifications

IS 1367 (Part III) - 2002. Property class 8.8

a) Nut Type: Metric Thread Hex Nut.
b) Size: Thread size, length and other dimension as specified in drawing.
c) Material composition of requirement.
   1. Material : Carbon Steel grade 8.8
   2. Carbon : 0.58% Min.
   3. Phosphorous : 0.06% Max.
   4. Sulphur : 0.06% Max.
d) Hardness test: 350 to 400 VPN.
e) Note:-
   1. 8.8 Grade will be with Heat Treatment.
   2. Material specification to be given with supply either carbon steel with Min 0.25% or with BORON additive.

B. Furnace Details

Induction furnace Temperature capacity : 850°C
Heating time : 22 hrs.

Barrel Capacity : 25 Meter Cube, 250kg(Max.)
Temperature variation : +/-0.025% of seatable value
Service life : 10 Years
Furnace cost : 4500000 INR
Service life :10 Yrs.

❖ **Detection Method Solution:**

Along with a preventive solution at occurrence level customer company also thought of implementing Detection Method Solution as an alternative.
In this solution company thought of establishing a Complete Automatic system for Detecting each and every nut.

VII. COST ANALYSIS

❖ **Data Provided by company for its analysis**

Total Production Capacity/Day = 20000 Pcs.
Total Working Days/Month = 25 Days
Total Working Days/Year = 300 Days

A. Cost analysis of current method

1. Cost Analysis as per material used

Material - Carbon Steel grade 8.8

a) Carbon : 0.25 % Min.
b) Phosphorous : 0.05 % Max.
c) Sulphur : 0.06 % Max.

Hardness test: 250 to 320 VPN.
Cost of material/Kg. = 65 INR
Weight of nut/Piece = 1 gram

Table 2 Cost of Material used in making a Nut

Cost of Material Used		
Sr. No.	Description	Cost (INR)
1	Material cost/Piece	0.065
2	Material cost/Day	1300
3	Material cost/month	32500
4	Material cost/year	390000

2. Cost analysis for Manufacturing

The total manufacturing cost of the nut involving each and every process from material handling to the hardening process, from raw material input to final output product, from the wages of the worker to the wages spent on dispatching the product to the customer are as follows:

Table 3 Cost of manufacturing a Nut

Manufacturing cost		
Sr. No.	Description	Cost (INR)
1	Manufacturing cost/Piece	0.05
2	Manufacturing cost/Day	1000
3	Manufacturing cost/month	25000
4	Manufacturing cost/year	300000

3. Heat Treatment cost of nut

Table 4 Cost of Heat Treatment Process

Heat Treatment cost		
Sr. No.	Description	Cost (INR)
1	Heat Treatment cost/Piece	0.025
2	Heat Treatment cost/Day	500
3	Heat Treatment cost/month	12500
4	Heat Treatment cost/year	150000

B. Cost Analysis of Preventive Method

1. Cost Analysis of Material Replaced

Material - Carbon Steel grade 8.8

a) Carbon : 0.58 % Min.
b) Phosphorous : 0.06 % Max.
c) Sulphur : 0.06 % Max.

Hardness test: 350 to 400 VPN.

Table 5 Cost of Material Used in making a Nut

Cost of Material Used		
Sr. No.	Description	Cost (INR)
1	Material cost/Piece	0.085
2	Material cost/Day	1700
3	Material cost/month	42500
4	Material cost/year	510000

2. Cost analysis of new introduced furnace

Furnace Specification

Induction furnace having capacity of 850°C Temperature,
Heating time 22 hrs.
Barrel Capacity : 25 Meter Cube, 250kg(Max.)
Temperature variation :
+/-0.025% of seatable value
Service life 10 Years
Furnace cost = 4500000 INR
Service life = 10 Yrs.
Total Production of nut/10 Yrs. = 60000000 Pcs.

Table 6 Cost of Furnace Replaced

Cost of New Furnace		
Sr. No.	Description	Cost (INR)
1	Cost/Piece	0.075
2	Cost/Day	1500
3	Cost/month	37500
4	Cost/year	450000
5	Cost/10 yrs.	4500000

C. Cost Analysis for Detection method

Fully automatic detection machine cost : 500000 INR (Approx)
Service Life : 5 Years
Total production/5 Years : 30000000 Pcs.

Table 7 Cost of Complete Automation

Cost of Detection Method		
Sr. No.	Description	Cost (INR)
1	Detection cost/Piece	0.017
2	Detection cost/Day	340
3	Detection cost/month	8500
4	Detection cost/year	102000
5	Detection cost/5 yrs.	510000

D. Cost Analysis of all Approaches

Table 8 Cost Comparison among Existing, Prevention & Detection Method

Process Description	Cost of Manufacturing of Nut (Paise/Nos.)		
	Existing Method	By Occurance Method	By Detection Method
Material Selection (With increasing in hardness and carbon percentage)	6.5	8.5	6.5
Furnace Replacement	0	7.5	0
Manufacturing Cost	5	5	5
Heat Treatment Process Cost	2.5	2.5	2.5
100 % Inspection Cost	-	-	1.7
Total	14	23.5	15.7

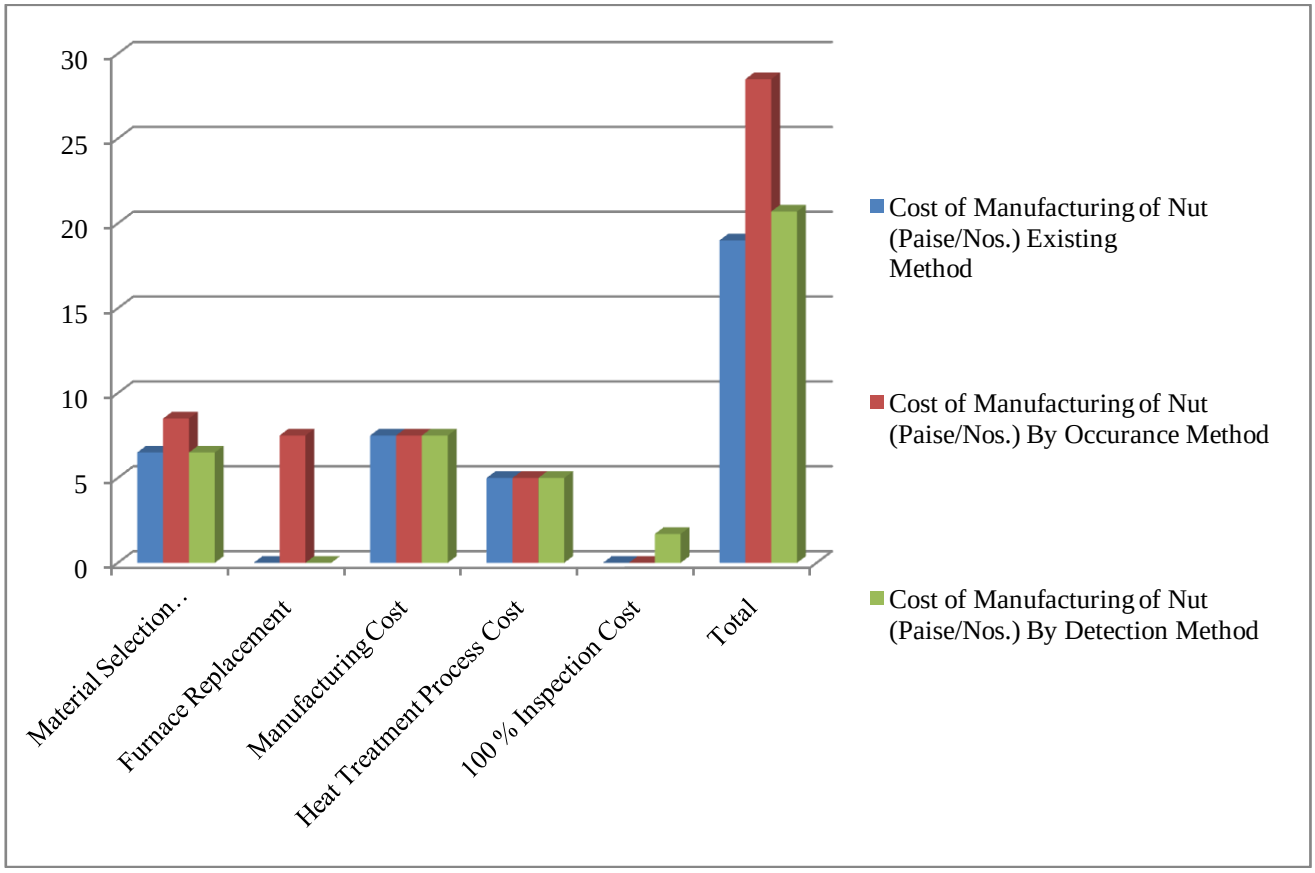

Chart 3Cost Comparison among Existing, Prevention & Detection Method

VIII. DESIGN OF DETECTION METHOD

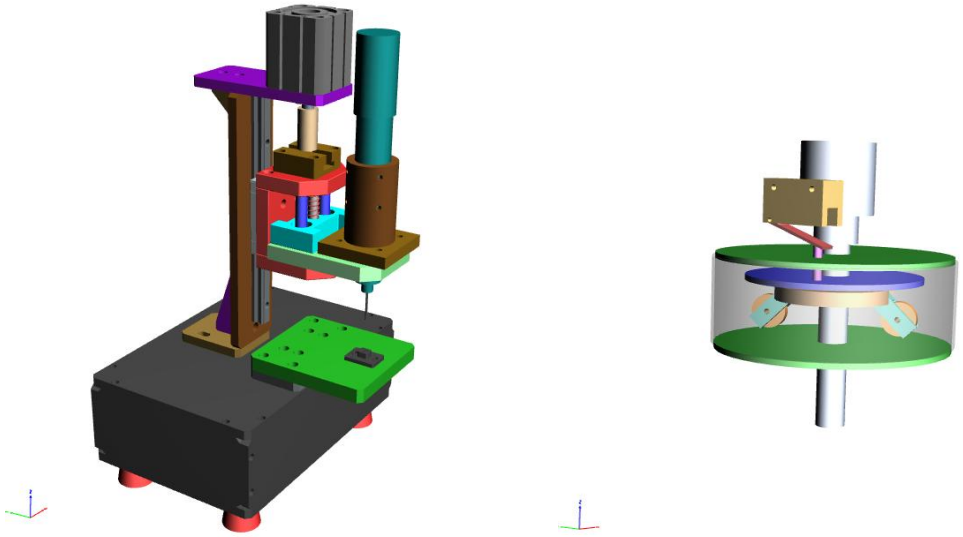

Figure 2Prototype and Mechanism of Machine

The basic principle on which the machine works is the gyroscopic effect. The machine operates on the principle of centrifugal force is generated by the electric motor.

From the starting point nut is placed inside the fixture which is fixed on the table. We use fixture to tighten the nut so as while performing the machining the nut don't displaced from its position.
When the nut is fixed to its position, Actual mechanism starts. As soon as the starting button is pushed the cylinder moves in downward due to the pneumatic action. When the cylinder is pushing down the accessories mounting on it there is a linear bearing mechanism which opposes the flow of the cylinder to its maximum limit so as to prevent the tool from breakage. The electric motor is connected to the ball and lever mechanism. There is a switch pivoted between the electric motor whose direct connection is given to the PLC circuit. The switch is then connected to a spring which is connected to the governor mechanism. When the machine is in operating condition the balls lift up due to the action of centrifugal force provided by the motion of the electric motor. When the balls of the governor is lift up at the same time the electric screw driver is being pushed inside the nut which detects whether the threads of nut are proper or not. When electric screw is being inserted inside the nut and at the same time when circuit also completes then there is an automatic connection is made between the connecting rod and lever of the switch. There are certain criteria fixed for nut detection inside the PLC which determines whether the nut is properly tapped or not.

When the nut is properly tapped PLC gives signal to the Tower light which shows green light signal which signifies nut is properly tapped. When there is defect in tapping like absence of thread inside the nut, semi threading in nut then the electric screw driver keeps on rotating inside the nut as well as time taken by PLC exceeds the defined criteria. When pitch of the nut are not uniform, PLC stops Timer Before the Defined criteria and It gives signal as Red light which indicates that nut is rejected.

Prototype Design Details

A. Machine Specification

1) Actuator: Pneumatic Actuation

2) Pneumatic Cylinder
   a) SMC(Japan) Make, Bore Dia. Ø50mm, Stroke : 25mm
   b) Output Force Capacity at 5 Bar Pressure : 98 kg/cm^2

3) Controlling Device
   a) Solenoid valve double acting type
   b) Push button, Emergency switch
   c) PLC

4) Electric screwdriver

a) Electric screwdriver with torque capacity of 0.2N-m to 1.2 N-m.

5) Input air pressure :5 Bar

IX. EXPERIMENTAL RESULT

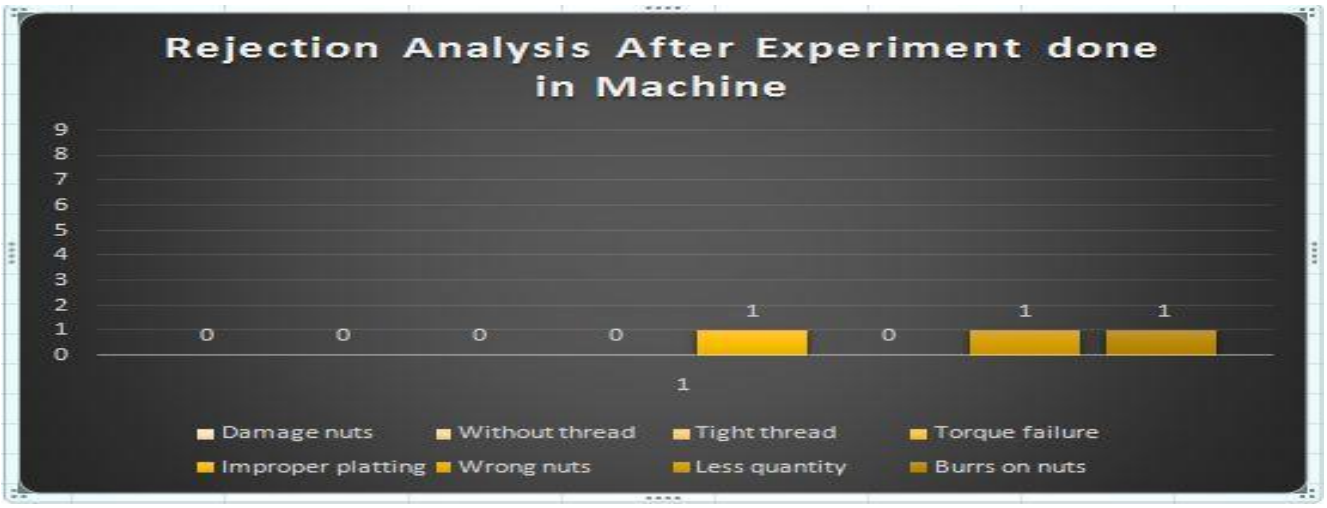

Chart 4 Rejection Analysis

X. CONCLUSION

In the proposed solution required specifications of the nut gets detected automatically and hence nut gets rejected if it doesn't satisfy the required criteria's of given specifications. After implementing this, the variations shown by the M3 size nut like torque failure, tight threads, without threads and all defects were reduced and hence better customer satisfaction was achieved.

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