Development of Automatic Transfer Assembly

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Abstract— The project which is undertaken by us is a sponsored project by a company named SMT Systems LLP. This company is a machine manufacturing company which manufacture machines for ball bearing applications. Among the various machines available in the company, the time consumed by the cone oiling machine to do the desired task was to be reduced by automation. In this machine the cone was placed below the oiling station manually. This consumed more time. This problem was to be solved by automation.
Keywords: Automatic Transfer Assembly, Pneumatic System

I. INTRODUCTION

The manual operation caused misalignment while placing the cone exactly at the center. This would result in improper oiling of the cone. So, the company thought that this operation should be replaced by an automatic transfer assembly.

We then studied the operation and starting searching for different mechanisms available for the transferring like pick and place mechanism, conveyor systems etc. We then tried to apply the mechanisms to our machine. But there were some or the other problems for these mechanisms such as the mechanism wouldn't be placed in the place available. The area available to place the assembly was a major concern. So, then we got some help from the industry people and then with their suggestions we decided to make the assembly with the use actuators and plates. Also, there were other parts in the machine which were using actuators so also there was no need of any other additional air handling unit etc. Our aim was to create a simple assembly.

Then we came up with a rough design of how the combination of plates and actuators can be placed in the area available and how the movements would be given to the plates in the directions that would bring the cone to its location accurately and without any of the misalignment. Then with the help of our guide and the supporting guide we finalized assembly and the design was done accordingly. The designing was done by the design team of the company. Also, the company did not have in house manufacturing. The parts were designed and sent for manufacturing to different vendors. And the standard parts were purchased from the distributers or were ordered directly from the company. While doing this project we also got an experience of how actually the things work in industries and what procedure is followed during the follow up of the parts given for manufacturing to different vendors. After the parts arrive in the company, we did inspection of the parts in which the dimensions and all the machining process was checked. Also is the coating done correctly and uniformly throughout the part. After inspection assembly of the parts according to design was done. We assembled only the mechanical parts. All the electrical connections were done by the electrical team of the company. Also, the actuators air supply system was under the guidance of the project manager since it also included the air supply for the other actuators that were installed on the machine. This were used for oiling and drying purpose of the cone.

II. PNEUMATIC SYSTEM

A pneumatic system is a system that uses compressed air to transmit and control energy. Pneumatic systems are used extensively in various industries. Most pneumatic systems rely on a constant supply of compressed air to make them work. This is provided by an air compressor. The compressor sucks in air from the atmosphere and stores it in a high-pressure tank called a receiver. This compressed air is then supplied to the system through a series of pipes and valves.
Pneumatics is all about using compressed air to do the work. It is used as a working medium normally at a pressure of 6 kg/sq. mm to 8 kg/sq. mm. For using pneumatic systems, maximum force up to 50 kN can be developed. Actuation of the controls can be manual, pneumatic or electrical actuation. Compressed air is mainly used to do work by acting on a piston or vane. This energy is used in many areas of the steel industry.

III. ADVANTAGES OF PNEUMATIC SYSTEM

A. High Effectiveness

There is an unlimited supply of air in the atmosphere to produce compressed air. Also, there is the possibility of easy storage in large volumes.

B. High Durability and Reliability

Pneumatic system components are extremely durable and cannot be damaged easily.

C. Simple Design

The designs of pneumatic system components are relatively simple. They are thus more suitable for use in simple automatic control systems.

IV. OBJECTIVES

A. To Increase Labor Productivity

Automating a manufacturing operation usually increases production rate and labor productivity. This means greater output per hour of labor input.

B. To Reduce Labor Cost

Ever-increasing labor cost has been and continues to be the trend in the world's industrialized societies. Consequently, higher investment in automation has become economically justifiable to replace manual operations.

C. To Improve Product Quality

Automation not only results in higher production rates than manual operations. It also performs the manufacturing process with greater uniformity and conformity to quality specifications. Reduction of fraction defect rate is one of the chief benefits of automation.

D. To Reduce Manufacturing Lead Time

Automation helps to reduce the elapsed time between customer order and product delivery, providing a competitive advantage to the manufacturer for future orders. By reducing manufacturing lead time, the manufacturer also reduces work-in-process inventory.

E. To Improve Worker Safety

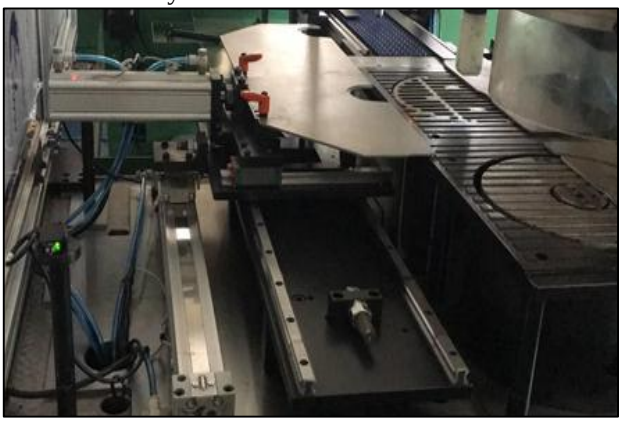
By automating a given operation and transferring the worker from active participation in the process to a supervisory role, the work is made safer.

V. CALCULATIONS

1) For pneumatic cylinder - $F = P \times A$…(i)
where F = Force required by the actuator to move the plate
P = Pressure in the actuator in Bar
A = Area of the cylinder while extension in square meters.
from this equation we find the required bore diameter
here the force required will include the weight of the plates
F = mg
m = mass is in kilograms
= 32 kg
G = gravitational acceleration
= 9.81
F = (32) × (9.81)
= 322 N
Pressure of 4 bar is to be selected as a standard according to the company.
∴ P = 4 bar
For extension,
$A = (\pi/4) \times D^2$
where D is the Bore diameter
Substituting values of P and F on equation (i)
$F = P \times A$
$322 = 4 \times 10^5 \times (\pi/4) \times D^2$
∴ D = 32 mm
Stroke length = 135 mm
For Master Cylinder
m = 20 kg
Substituting the values in equation (i)
$F = P \times A$
$196.2 = 4 \times 10^5 \times (\pi/4) \times D^2$
∴ D = 25 mm
Stroke length = 300 mm

VI. EXPERIMENTAL SETUP

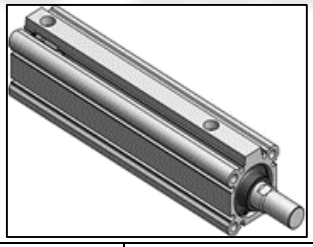
The setup is clean and simple. The setup consists of two pneumatic actuators. One actuator gives moves the transferring plate in Z-axis and the other moves the assembly of first actuator and other components which are connected and which help in the transferring of the cone of the bearing in X-axis. The working of the machine is simple. The master actuator is used to move the base plate 2 and all the parts that are assembled on the base plate 2 in X-axis. To reduce the friction and the load which will act on the actuator rod, the guideways are used. The guideways have rails and blocks. The blocks are connected to the parts that will move in their desired direction and the rails will be fixed with the help of bolts to the base plate. The combination of rails and blocks is used to reduce the relative motion between the moving parts and also to reduce the force due to friction. Also, it supports the rod of the actuator by taking the weight of the parts above it. There are shock absorbers provided to absorb the shock and to protect the parts from getting damaged. The order of working of the parts is, first the pneumatic cylinder will be actuated and it will expand and the transferring plate will be moved forward and will hold the cone in the notch. Then the master cylinder will expand and the cone will be moved to the oiling station. Then the pneumatic cylinder will retract and then the master cylinder will also retract.



The machine is designed such that a provision is provided so that if the customer decides to use the same machine for cone of bigger diameter then he can use it just by changing the transferring plate and the size of cone holder in the drying machine. The actuators are also selected by considering this provision. The actuators can do their work smoothly even if the weight is increased.

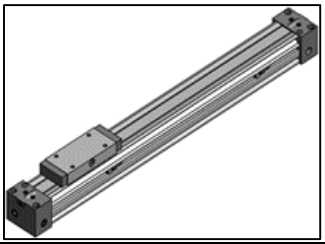
VII. COMPONENTS SPECIFICATIONS

A. Pneumatic Actuator



Bore	32 mm
Stroke	135 mm
Component Manufacturer	SMC
Mounting	Both ends tapped
Action	Double Acting
Body Option	Standard (Rod end male thread)

B. Master Actuator



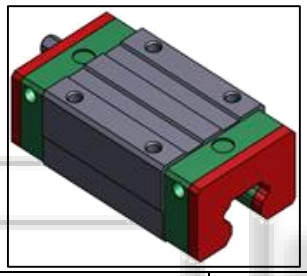
Bore	25 mm
Stroke	300 mm

Component manufacturer	SMC
Mounting	From Top
Action	Double Acting

C. Linear Guideways

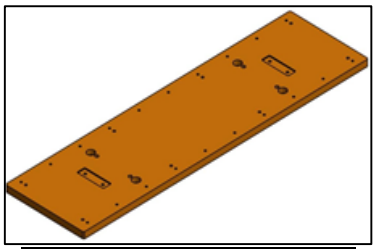
Component Manufacturer	Hiwin
Series	HG
Model Size	15
Mounting	From top
Rail length	210 mm
Rail Type	Special Rail

D. Linear Guideway Block



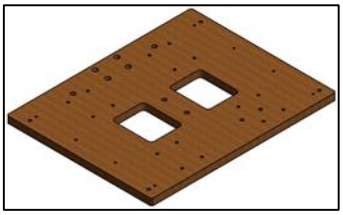
Component Manufacturer	Hiwin
Series	HG
Model Size	15
Mounting	From top
Block type	Square Type
Load type	C (Heavy load)

E. Base Plate 1



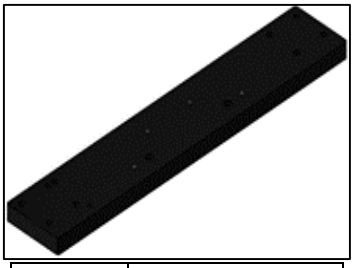
Length	58
Width	16
Height	1.2
Material	Hardened MS C45
Machining	Gas cutting, drilling
Coating	Blackodising

F. Base plate 2



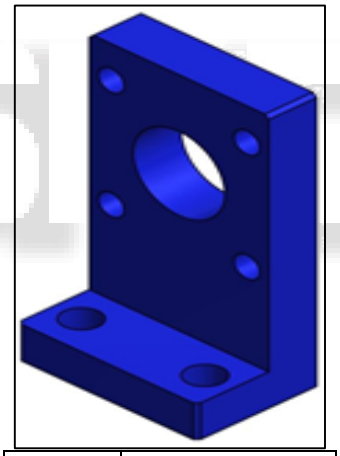
Length	28
Width	22
Height	1
Material	Hardened MS C45
Machining	Gas cutting, drilling
Coating	Blackodising

G. Base Plate 3



Length	28
Width	5
Height	2
Material	Hardened MS C45
Machining	Gas cutting, drilling
Coating	Blackodising

VIII. BRACKETS FOR MOUNTING ACTUATOR AND SHOCK ABSORBER (MS)



Length	4.5
Width	3
Height	8
Thickness	1.2
Material	Hardened MS C45
Machining	Gas cutting, drilling
Coating	Blackodising

IX. OBSERVATION

Observation No	Time required manually (in seconds)	Time required by auto transfer assembly (in seconds)
1	20	11
2	22	11
3	23	11
4	21	11
5	20	11
6	21	11
7	20	11

Time required to do the whole process manually –
Average time required for the process manually

$$\frac{\text{time required}}{\text{No of observation}}$$

$$\frac{20 + 22 + 23 + 21 + 20 + 21 + 20}{7}$$

= 21 seconds
Average time required for the process by auto transfer assembly

$$\frac{\text{time required}}{\text{No of observation}}$$

$$\frac{11 + 11 + 11 + 11 + 11 + 11 + 11}{7}$$

= 11 seconds
No of cone's oiled in 1 hour manually

$$\frac{60 \times 60}{\text{Average time required for the process manually}}$$

= 171.42 ≈ 172 cones
No of cone's oiled in 1 hour automatically

$$\frac{60 \times 60}{\text{Average time required for the process manually}}$$

= 327.27 ≈ 328 cones

X. Results

We can see that time required is almost reduced by 50%
Also, the productivity per hour of the machine is increased.

	Manually	Automatic Assembly
Time required	21 seconds	11 seconds
No of cones oiled per hour	172	328

XI. Conclusion

The Auto Transfer Method that we developed has increased the productivity of assembly process, increased the reliability of process, decreased the time required to assemble a single bearing and maintains the quality of the bearing assembly.

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