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Case Study on Micro Drill Hole Inspection using PLC

[1] Harsh R. Vernekar, [2] Namrata R. Mone [3] Rohan R. Patil, [4] S.A.Soundattikar
[1][2][3] Student, [4]Asst. Professor,
Department of Mechanical Engineering, DKTE's Textile and Engineering Institute, Ichalkaranji (INDIA)

Abstract- **With the advent of automation and to remain in the global competition, the industries are manufacturing the components at higher rates with customer demanding the best quality products. So, the inspection must be quickly, economically and accurately done for better customer satisfaction and providing him defect free products in right quantity and at right time. This calls for automated inspection which not only reduces the inspection and labour but also ensures accurate product delivery by introducing interlocks in the system where the system gives an alarm if any defective product is present in the system This paper includes the case study of automated micro drill inspection process using PLC for overall control and the advantages of automated inspection over conventional process.**

Key Words: **Automated inspection, PLC, 100% inspection, customer satisfaction**

I. INTRODUCTION

Automation is defined as a technology that is concerned with the use of mechanical, hydraulic, pneumatic, electrical, computer based systems in the operation and control of production. This technology includes transfer lines, mechanized assembly machines, feedback control systems and robots.

Automation is broadly classified asManufacturing automation and Service automation. The main benefits of automation are it saves labour, time and gives good inspection control. Automation applications can be classified into home, offices and industrial applications these include.

a. Pick and place automation
b. Material handling
c. Automated inspection
d. Automated transfer lines
e. Automated spot welding, CNC machine, microwaves, washing machines, robots, etc.

1.1 Advantages:

a. Increased predictability of quality.
b. Reduced direct human labor cost and expenses.
c. Increased productivity, improved quality and increased consistency of process.
d. Ensures high degree of accuracy.

1.2 Automated Inspection:

Inspection has become an essential part of any manufacturing. It is the part of rejecting non-conformities and assuring good quality products.Traditional methods used labor intensive methods which were time consuming and prone to errors but now most of the industries and product buyers insist on 0% defect policy which means there is 100% requirement for complete precision and accuracy.

This calls for 'Automated Inspection' which is defined as the automation of one or more steps involved in the inspection procedure.The use of 'Automated Inspection' has grown in past few years providing numerous applications to help companies eliminate error costs. vInspection automation ranges from simple vision systems for checking the tolerance of components to counting and measuring systems right through to complete detection and monitoring systems.

II. PROBLEMS WITH CURRENT INSPECTION PROCESS

The job containing micro drill is currently machined on SPM. It consists of 8 stations wherein each station performs its individual operations. The various operations performed are:

a) component loading
b) component clamping
c) centering
d) slotting
e) Drilling

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f) micro hole drilling
g) **Idle Station**
h) unloading

Following are the main problems which take place in inspection process-

a) **Breakage of Micro-Drill-** The main jet component consists of a micro drill in its design. Sometimes,the drill breaks and the jobgoes unnoticed which eventually increases rejection.

b) **Sampling Inspection-** This Sampling Inspection results in acceptance of faulty components.

c) **Manual Fatigue-** The inspection of various jobs causes fatigue for workers, thereby letting some products go unnoticed.

These problems can be taken care off by using an ***inspection setup*** during the ***idle station*** which performs the in process microhole drill inspection thereby eliminating the defects and increasing the productivity.

III. METHODOLOGY ADOPTED:

a) The setup is to be installed at the idle station.The setup itself consists of a pin which is clamped in a collet which will travel down with the reverse stroke of the cylinder mounted at the bottom of the slide.

This is shown in fig 1

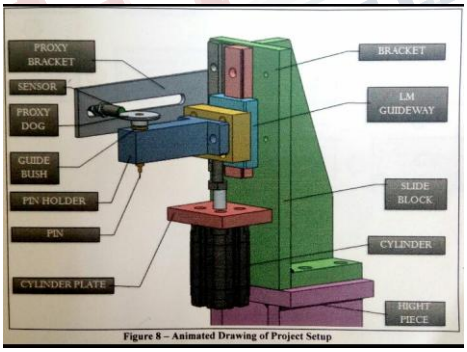
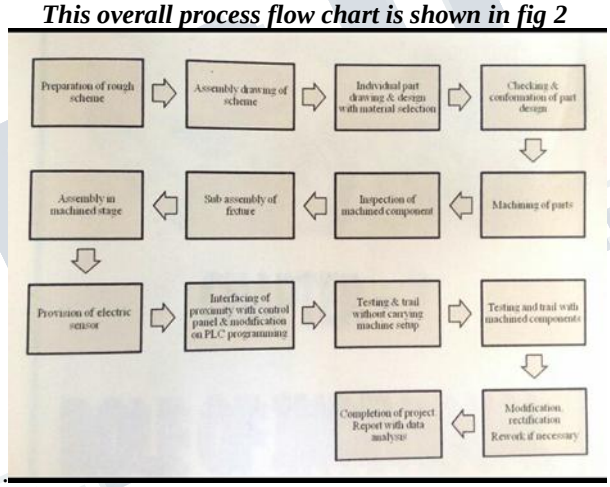


Figure 8 – Animated Drawing of Project Setup

b) The moment of the feed rate of this pin is specially kept very low to ensure that there is no further breakage of the pin.
c) The Proximity Sensor is located to detect the undrilled position and drilled position.The feedback of this sensor will be given to the PLC through which monitoring of drill breakage is done.
d) If the pin passes without any obstruction in downward direction, there is no need for machine stop but, if the pin doesn't pass then the appropriate proximity sensor will sense that action and the machine will stop indicating that there is an obstruction

This overall process flow chart is shown in fig 2



3.1components Used:

Various mechanical, pneumatic and electronic components are used in this setup.

3.1.1Mechanical components are as follows:-

a) ***Height piece*** – It is the base on which entire assembly is mounted.

b) ***Bracket-*** It is mounted on the height piece. Sensor plates, L.M. guideways and pin holder is attached to it.

c) ***Slide blocks-*** It is mounted on the L.M. Guideways which are fitted o the bracket.

d) ***Pin holder-*** It holds the pin and is provided with a bush.

e) ***Guide bush-*** It is fitted inside the pin holder.

f) ***Proxy Dog-*** It is placed on the top of the pin, and is

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sensed by the proximity sensor in case of undrilled component.

g) ***Pin***- It is the main component which is used to check whether the micro drill has correctly performed or not.

h) ***Cylinder Plate***- The cylinder is attached to this.

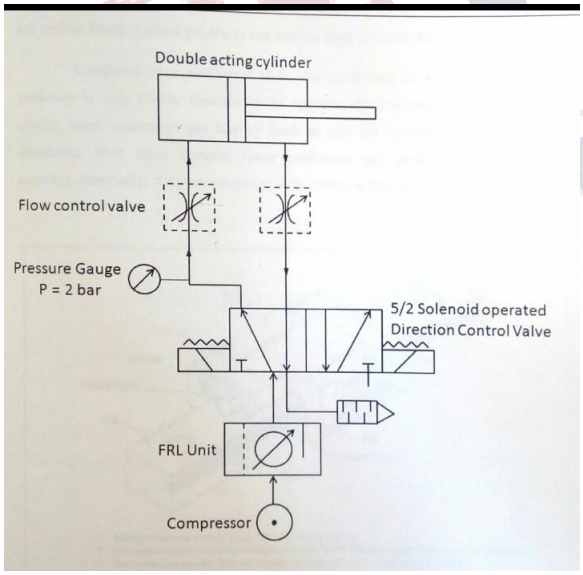
i) ***Proxy Bracket***- It is the plate which is fixed to the bracket and the proxy sensor is fitted in it

j) ***L.M. Guide ways***- A linear guide-way allows linear motion by making use of rolling elements between the rail and the block. By using re-circulating rolling elements between rail and block, a linear guideway can achieve high precision linear motion.

The L.M.Guideways in this setup are used to achieve up and down motion of the pin holder with the pin which in turn results in passing of pin through the micro drill hole.

3.1.2 Pneumatic components:- The pneumatic components used are pneumatic cylinder, flow control valve, 5/2 directional control valve, FRL,compressor.

The Pneumatic circuit is shown in fig 3.



3.1.3.Electronic Component:

1. ***Proximity Sensor:*** - A proximity sensor has the ability to sense the presence of the nearby objects without having any physical contact.The setup uses a proximity sensor of TEKNIC EUCHNER.The sensor is an inductive proximity sensor which is used to detect the movement of a proxy dog about predetermined limit in case of undrilled component. In such case, the machine will stop.

2. ***Programmable Logic Controller***- PLC is a special form of microprocessor based control system that uses programmable memory to store instructions and to implement logic, sequencing, timing, counting and arithmetic in order to control machine and processes

Use of PLC in Project set up- The rotary machine has its own PLC. In this project PLC is mainly used for turret indexing and movement of L.M. Guideways. The inspection setup will be connected to the PLC by writing logic for it. The original logic of the machine will not be changed only the program for new setup will be added in it.The ladder program for the inspection process is as shown in fig

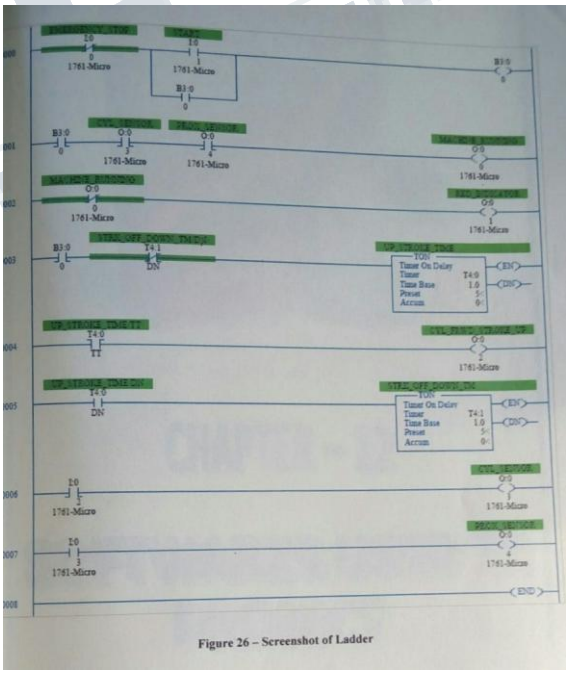


Figure 26 – Screenshot of Ladder

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IV. RESULTS AND CONCLUSIONS:

This setup has given following results:

a) Instantaneous detection in case of micro drill breakage.
b) 100% inspection.
c) Machine stops in case of burrs hence easy to detect and removal of burrs.
d) Saving the cost of labor.
e) Avoid fatigue to worker.
f) Eliminating cost of poor quality.

The total rejection in the industry was 845 components approximately. Considering cost of each as Rs5 the total cost of rejection was Rs 4225with the cost of manual labor being Rs 5500 approximately. Additional production cost due to rejection was Rs1500 & hence the total expenses due to rejection were Rs 11225. The total setup cost was around Rs 31000 & hence cost of the setup could be recovered in 3-4 months thus causing profit thereafter.

From this it can be inferred that industrial automation not only increases productivity, reduces errors, improves accuracy but also reduces manual labor, thereby allowing us to clearly conclude that low cost automation results are very profitable.

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