



Vol. XII &amp; Issue No. 4 April - 2019

INDUSTRIAL ENGINEERING JOURNAL

## AUTOMATIC SCREWING UP OF A HEAVY WEIGHT DIE IN AN INJECTION MOULDING MACHINE

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### ABSTRACT:

*Injection Moulding is the one of the most common methods in producing plastic products for many purposes ranging from a daily product to high-tech equipments. This work is concerned with the design of parts from analysis of design, manufacturing and production in Plastic materials from a long time, it was found that injection moulding system using of permanent die was taking more time for exchange. The Experimental work is mainly focused on to reduce the manual effort of the employee by automatic wrenching. The final Result shows by doing experimental analysis of time involved in wrenching process. This will play a major role in changing the element.*

**KEYWORDS:** Automatic wrenching, Injection die moulding, Die exchanging

### 1. INTRODUCTION

In today's scenario, everything is moving towards automation in order to increase the production rate and to reduce the manpower fatigue, Injection Moulding is the one of the most common methods in producing plastic products for many purposes ranging from a daily product to high-tech equipments. This work is concerned with the design of parts from analysis of design, manufacturing and production in Plastic materials from a long time, it was found that injection moulding system using of permanent die was taking more time for exchange. The Experimental work is mainly concentrate on to reduce the manual effort the employee by automatic wrenching. The final Result shows by doing experimental analysis of time involved in wrenching process. This will play a major role in changing element in the moulding company.

### 2. LITERATURE REVIEW

#### 2.1. Introduction

There are various types of methodologies being followed in several companies to optimize the quality of the product produced and also the maintenance in the industry. Some of the tools or methodologies which are used in the industries are as given below:

1. 5S Methodology
2. FIFO
3. Gemba kaizen
4. Total production maintenance
5. Total quality management
6. Value stream mapping

#### 2.1.1. 5S Methodology

The 5S Method is a standardized process aims for properly implemented creates and maintains an organized, safe, clean and efficient workplace. Improved visual controls are

implemented as part of 5S to make any process non-conformance obvious and easily detectable. 5S is often one element of a larger Lean initiative and promotes continuous improvement. The 5S list is as follows:

Seiri / Sort: Separating of the essential from the nonessential items.

Seiton / Straighten: Organizing the essential materials where everything has its place.

Seiso / Shine: Cleaning the work area.

Seiketsu / Standardize: Establishing a system to maintain and make 5S a habit.

Shitsuke / Sustain: Establishing a safe and sanitary work environment (Safety).

The 5S Principles are recognized in many industries as effective tools for improving workplace organization, reducing waste and increasing efficiency. Organizations should be careful to not allow the 5S Principles to become viewed as the whole of the company's improvement efforts. Otherwise it could become the end goal of your company's improvement process instead of a key part of a larger continuous improvement journey. The greatest benefit from using 5S is realized when it is part of a larger initiative and the entire organization has adopted its principles. 5S is more than a system; it is a business philosophy and should be integrated into the organization's culture. Make work easier by eliminating obstacles.



Fig.1. 5S Frame work Methodology

### 2.1.2. FIFO: (First In First Out)

The FIFO method follows the logic that to avoid obsolescence, a company would sell the oldest inventory items first and maintain the newest items in inventory. Although the actual inventory valuation method used does not need to follow the actual flow of inventory through a company, an entity must be able to support why it selected the use of a particular inventory valuation method.

**Esko Niemi et al** - This paper studies lean manufacturing methods and how simulation is used to consider them. In order to do this, it reviews papers that study simulation together with lean methods. The papers that are reviewed are categorized according to the lean methods used and result types obtained. Analysis is performed in order to gain knowledge about the volumes of occurrence of different methods and result types. Typical methods in the papers are different types of value stream mapping and work-in-process models. An exploratory analysis is performed to reveal the relationships between the methods and result types. This is done using association analysis. It reveals the methods that are commonly studied together in the literature. The paper also lists research areas that are not considered in the literature. These areas are often related to the analysis of variation.

### 2.1.3. GEMBA KAIZEN

Gemba - short version

The real place or the specific place. Usually means the shop floor and other areas where work is done.

Gemba - long version

Gemba is a Japanese term meaning "the actual place" or "the real place". Japanese detectives call the crime scene gemba, and Japanese TV reporters may refer to themselves as reporting from gemba. In business, gemba refers to the place where value is created; in manufacturing the gemba is the factory floor. It can be any "site" such as a construction site, sales floor or where the service provider interacts directly with the customer.

**P. Gurway et al** - Thousands of small & medium scale industries are present in India. All are facing certain problems resulting in lack of productivity, greater lead time, processing time, stock out situations etc. The paper contains basis definition of Kaizen philosophy & a brief review of kaizen concept & its implementation. The purpose of this paper is to represent Kaizen, its related terms in a concrete way & its implementation in improving the overall effectiveness of small scale organization situated in India. This paper illustrates about kaizen implementation in small manufacturing industry & also focuses on the scenario of Indian manufacturing company while implementing Kaizen. The paper also reviews some of the papers which basically focus on implementation of kaizen technique in small manufacturing companies. For detail justification a case study is conducted on the small manufacturing company who is dealing with manufacturing of PVC & HDPE pipes. The company is currently facing with the

problem of increased lead time and stock out situation. In order to solve the faced problem we emphasize on two major alternatives & select Kaizen as a main productivity improvement tool. This implementation is focuses on reducing the lead time of sales order processing by mean of which the productivity of organization will be improved.

### 2.1.4. Total Production Maintenance

In industry, total productive maintenance (TPM) is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization.

#### Objective

One of the main objectives of TPM is to increase the productivity of a factory and its equipment with a modest investment in maintenance. Total quality management (TQM) and total productive maintenance (TPM) are considered as the key operational activities of the quality management system. In order for TPM to be effective, the full support of the total workforce is required. This should result in accomplishing the goal of TPM: "Enhance the volume of the production, employee morale and job satisfaction." The main objective of TPM is to increase the Overall Equipment Effectiveness (OEE) of plant equipment. TPM addresses the causes for accelerated deterioration while creating the correct environment between operators and equipment to create ownership. OEE has three factors which are multiplied to give one measure called OEE

Performance x Availability x Quality = OEE

Each factor has two associated losses making 6 in total; these 6 losses are as follows:

Performance = (1) running at reduced speed - (2) Minor Stops

Availability = (3) Breakdowns - (4) Product changeover

Quality = (5) Start up rejects - (6) Running rejects

The objective finally is to identify then prioritize and eliminate the causes of the losses. This is done by self-managing teams that solve problem. Employing consultants to create this Culture is common practice.

**Yuniawan Sulistyoadi et al** - Implementation of Total Productive Maintenance (TPM) being realized and become as an essential matter to resolve maintenance issue incurred in Injection Moulding Company. The basic impact given by down time issue was manufacturer would not able to achieve the targeted production. To overcome the case, it is required the maintenance program to be performed in accordance with TPM ideal concept so that the production activity of injection machine would be operated in optimum stage. The fundamental of TPM implementation are laying on 5S and 8 Pillars Methodology. The implementation of TPM is requiring full supporting of top management to ensure its working as well the support of all employees from all level escorting the TPM to be carried in proper way and practice. It is also noticed, in order to

achieve the maximum objective against the implementation of TPM, it is required controlling on TPM implementation has to be reviewed once in 3 months.

### 2.1.5. Total Quality Management

Industry believes that quality begins and ends with the customer. This means identifying customer needs and comprehensively meeting them. For the company, quality is not just conformance to drawings or specifications but ensuring customer satisfaction and further Customer satisfaction and further Customer Delight. This belief forms the basis of its approach to Total Quality Management (TQM). Quality Assurance methods like Advanced Product Quality Planning, Statistical Process Control Techniques, and Effective Tool Management System, Process capability Improvements, Preventive Maintenance, Producer Control and Small Group Activities form the backbone of the system approach adopted.

**Vikash Dwivedi et al** - Total quality for continuous improvement for reliable products is used by many industries for improvement of service and quality of product. In the previous decade, a novel based philosophy known as "Six Sigma" has been incorporated and very well established in many companies. The goal of "Six Sigma" in any regime or technical aspect i.e. designing, manufacturing, processing, marketing or testing, improves effort to obtain a durable or long term defect rate of only 3.4 defective parts per million manufactured. The Present study focuses on the quality improvement of one of the major defect in Plastic Injection Moulding of components. One of the main defect which is the causes of the rejection is "Black specks" (small dark particles on the surface of the opaque parts), on the appearance of the product. In order to study the problem a research has been carried out by studying the literature review on TQM, Six Sigma and other references for this analysis and research method.

### 2.1.6. Value Stream Mapping

A value stream map illustrates the flow of materials and information from supplier to customer. Value stream mapping (VSM) is a lean manufacturing technique used to analyze, design, and manage the flow of materials and information required to bring a product to a customer. VSM helps identify waste and streamline the production process. The first step in value stream mapping is to create a current state map. This map can help identify waste such as delays, restrictions, inefficiencies, and excess inventories. These are then eliminated in the ideal state map, which gives the organization a working plan to achieve lean efficiency.

Anup P. Chaple and Balakrishna E Narkhede proposed their ideas for applying value stream for making improvement in discrete Manufacturing organization. A systematic methodology is presented in this paper for selecting product family and processes for improvements. A current state map is developed after critical observations, calculations, and analysis for identifying wastes in current system.

From the above literature study it was observed that there are different types of tools used in industries to improve the productivity. The success of these tools depends upon the level of employees and their learning attitudes. Hence in this paper attempt has been made to improve wrenching time while exchanging the dies in moulding operation with the help of hydraulic wrenches which is attached to the single arm robot.

## 3. OBSERVATION OF STUDY

- We observed that the need for automation is necessary to minimize the time taken to exchange die in the injection moulding machine, in order reduce the human fatigue.
- The time taken to exchange the die was about 45 minutes and thus during the time of the exchange, the production was completely stopped.
- The overhanging crane (hoist), is used here to lift the weight of the heavy weight die of about 450Kg
- Thus the human fatigue required is more and the chance of producing the required torque may not be attained.

## 4. OBJECTIVE OF THE PROBLEM

- To reduce the time taken for exchanging the die during the production time.
- To reduce the manpower wastage and to eliminate bending fatigue of labours while wrenching

## 5. IDENTIFICATION OF THE PROBLEM

### 5.1. Man Power Safety

- Accidents due to slipping of spanner while wrenching the bolt into the thread. Injury due to the chipping of scrap material from the spanner. Fracture or swelling due to the mishandling of tools while doing the operation. Labour fatigue due to bending and wrenching. Sometimes may cause damage to work piece if there is an absence in concentration of labour.

### 5.2. Material Handling

- Transportation of the die to the next stage of service becomes a fatigue for the employee.
- Lifting die weighing 450 kg onto the trolley and pushing it towards the next station is a weary task.

### 5.3. Data Collection

- The first step in analysing any process for the scope of improvement is to understand the current status of the process "what is the current problem". Only by understanding the present status of the process we can plan for improvements. Data collection is the first step for the approach towards the project.
- Data collection is much essential stage which makes the

systematic flow in the project

#### 5.4 Injection Moulding Machine Specification

- It differs from machine to machine. As machine differs, its clamping component also differs and the dimensions of the component also differ as such.

##### 5.4.1. Specifications

1. Platen dimension: TD 150/510
2. Smallest mould permitted 300mm diameter
3. Location diameter = 125H7 mm
4. Maximum mould weight permitted 1250Kg
5. Moving plate capacity: maximum of 800Kg
6. Opening stroke distance: 450mm
7. Maximum gap between moving plates: 550mm
8. Minimum gap between the moving plates: 200mm
9. Opening on M/C bed: 950mm
10. Bolt type used: M16
11. Bolt length: 80mm
12. Clamping force: 600 KN
13. No of plate maximum used: 7 (Including fixed and moving plate).

#### 6. DESIGN OF SINGLE ARM ROBOT:

In this paper attempt has been made to explain the design and fabricate single arm robot for automatic screwing of heavy weight die using hydraulic wrenching operation in order to simplify the work of operator with the help of automation using AUDRINO.

##### 6.1. Single Arm Robot:

Industrial robots are the most manufactured and used types of robots in the production industry these days to minimize the labour cost. Many industries must have the benefit of using them for their batch production. In order to enhance its performance improvement of design of industrial robots is required, which will direct the further enhancement in the Robotics industry.



fig 6.1.1. View of Single Arm Robot

##### 6.2. Basic Block Diagram of Working Hydraulic Pump:

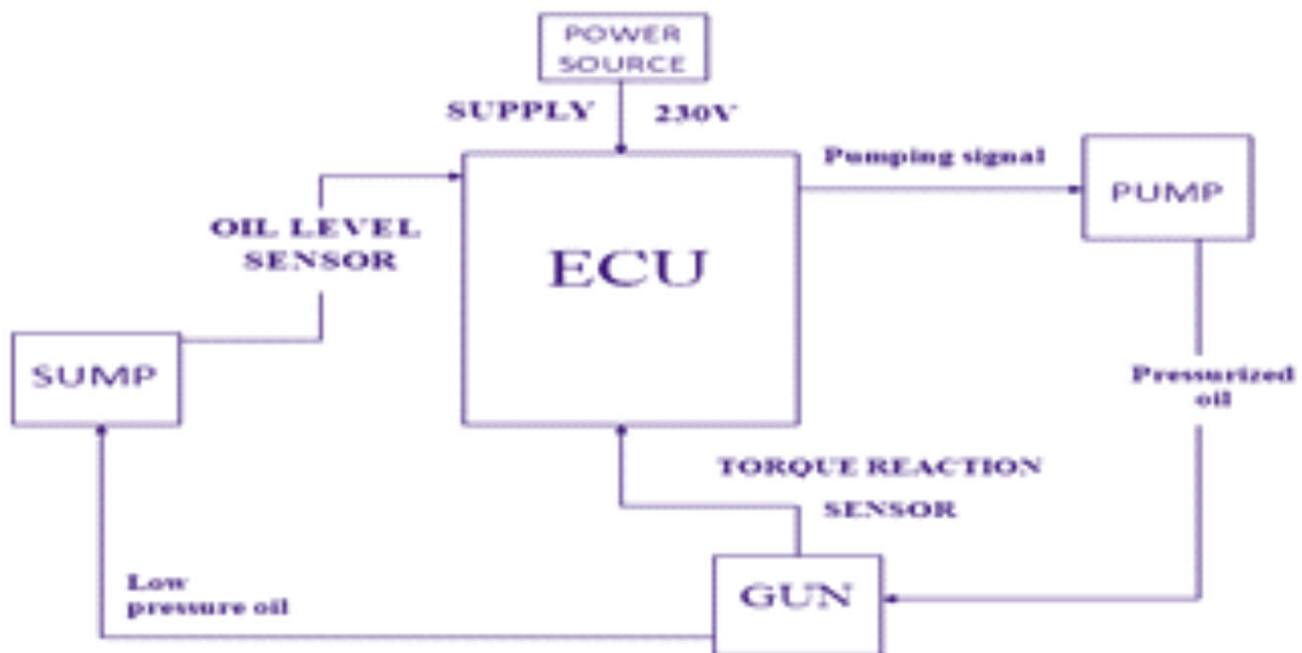


fig.6.2.1.Schematic Diagram of Electronic Hydraulic Pump Circuit



### 6.3. Arduino Code Made For The Machine:

### 6.4. General Code For Robotic Arm Function:

```
include <Servo.h>
Servo servo1; //Servos
Servo servo2;
Servo servo3;
const int LED1 = 2; //LEDs
const int LED2 = 3;
const int LED3 = 4;
const int LED4 = 7;
const int LED5 = 8;
const int button1 = 12; //Buttons
const int button2 = 13;
int button1Presses = 0; //Button values
boolean button2Pressed = false;
const int pot1 = A0; //Potentiometers
const int pot2 = A1;
const int pot3 = A2;
int pot1Val; //Potentiometer values
int pot2Val;
int pot3Val;
int pot1Angle;
int pot2Angle;
int pot3Angle;
int servo1PosSaves[] = {1,1,1,1,1}; //position
saves
int servo2PosSaves[] = {1,1,1,1,1};
int servo3PosSaves[] = {1,1,1,1,1};
void setup()
{
    servo1.attach(5); // Set up everything and will
    run once; attach servos and define the pin modes
    servo2.attach(6);
    servo3.attach(9);
    pinMode(LED1, OUTPUT);
    pinMode(LED2, OUTPUT);
    pinMode(LED3, OUTPUT);
    pinMode(LED4, OUTPUT);
    pinMode(LED5, OUTPUT);
    pinMode(button1, INPUT);
    pinMode(button2, INPUT);
    Serial.begin(9600);
}
void loop() {
    // put your main code here, to run repeatedly:
    pot1Val = analogRead(pot1); // This will read
    the values from the potentiometers and store it...
    pot1Angle = map(pot1Val, 0, 1023, 0, 179); // ...
    and this will map the values from the
    potentiometers to values the servos can use and
    store it for later use
    pot2Val = analogRead(pot2);
    pot2Angle = map(pot2Val, 0, 1023, 0, 179);
    pot3Val = analogRead(pot3);
    pot3Angle = map(pot3Val, 0, 1023, 0, 179);
    servo1.write(pot1Angle); // These will make the
    servos move to the mapped angles
    servo2.write(pot2Angle);
    servo3.write(pot3Angle);
    if(digitalRead(button1) == HIGH){ // This will
```

check how many times button1 is pressed and save the positions to an array depending on how many times it is pressed; switch/case works like a if statement

```
    button1Presses++;
    switch(button1Presses){
        case 1:
            servo1PosSaves[0] = pot1Angle;
            servo2PosSaves[0] = pot2Angle;
            servo3PosSaves[0] = pot3Angle;
            digitalWrite(LED1, HIGH);
            Serial.println("Pos 1 Saved");
            break;
        case 2:
            servo1PosSaves[1] = pot1Angle;
            servo2PosSaves[1] = pot2Angle;
            servo3PosSaves[1] = pot3Angle;
            digitalWrite(LED2, HIGH);
            Serial.println("Pos 2 Saved");
            break;
        case 3:
            servo1PosSaves[2] = pot1Angle;
            servo2PosSaves[2] = pot2Angle;
            servo3PosSaves[2] = pot3Angle;
            digitalWrite(LED3, HIGH);
            Serial.println("Pos 3 Saved");
            break;
        case 4:
            servo1PosSaves[3] = pot1Angle;
            servo2PosSaves[3] = pot2Angle;
            servo3PosSaves[3] = pot3Angle;
            digitalWrite(LED4, HIGH);
            Serial.println("Pos 4 Saved");
            break;
        case 5:
            servo1PosSaves[4] = pot1Angle;
            servo2PosSaves[4] = pot2Angle;
            servo3PosSaves[4] = pot3Angle;
            digitalWrite(LED5, HIGH);
            Serial.println("Pos 5 Saved");
            break;
    }
}
if(digitalRead(button2) == HIGH){ // Pretty
self-explnatory here
    button2Pressed = true;
}
if(button2Pressed){ // if the boolean
button2Press is true, then the servos will run
though all their saved positions
    for(int i = 0; i < 5; i++){
        servo1.write(servo1PosSaves[i]);
        servo2.write(servo2PosSaves[i]);
        servo3.write(servo3PosSaves[i]);
        Serial.println(" potentiometer Angles: ");
        Serial.println(servo1PosSaves[i]);
        Serial.println(servo2PosSaves[i]);
        Serial.println(servo3PosSaves[i]);
        delay(1050);
    }
}
delay(300);
}
```

**6.5. Code For Wrenching Operation:**

```

const int Q1 = 8; // Defining Digital Input Pins from
DTMF Module
const int Q2 = 9;
const int Q3 = 10;
const int Q4 = 11;
const int D1 = 4; // Defining Digital output Pins for
Relay Board
const int D2 = 5;
const int D3 = 6;
const int D4 = 7;
int SoQ1 = 0; // Defining variable to store the
status(HIGH/LOW) of above inputs.
int SoQ2 = 0;
int SoQ3 = 0;
int SoQ4 = 0;
int oldCon = 0; // Variable to know what was the last
button pressed.
void setup() {
pinMode(Q1, INPUT); // Defining pins as input.
pinMode(Q2, INPUT);
pinMode(Q3, INPUT);
pinMode(Q4, INPUT);
pinMode(D1, OUTPUT); // Defining pins as output.
pinMode(D2, OUTPUT);
pinMode(D3, OUTPUT);
pinMode(D4, OUTPUT);
}
void loop() {
    SoQ1 = digitalRead(Q1); // Reading status of Input
Pins. It can be LOW or HIGH
    SoQ2 = digitalRead(Q2);
    SoQ3 = digitalRead(Q3);
    SoQ4 = digitalRead(Q4);
    If ( SoQ4==LOW && SoQ3==LOW &&
SoQ2==LOW && SoQ1==HIGH ) // Condition for
Button 1. It is equal to Binary - 0001
    {
        if(oldCon!=1){
            digitalWrite(D1, HIGH);
        }
        oldCon=1;
    }
    else if(SoQ4==LOW && SoQ3==LOW &&
SoQ2==HIGH && SoQ1==LOW ) // Condition for
Button 2. It is equal to Binary - 0010
    {

```

```

        if(oldCon!=2){
            digitalWrite(D1, LOW);
        }
        oldCon=2;
    }
    else if(SoQ4==LOW && SoQ3==LOW &&
SoQ2==HIGH && SoQ1==HIGH ) // Condition for
Button 3. It is equal to Binary - 0011
    {
        if(oldCon!=3){
            digitalWrite(D2, HIGH);
        }
        oldCon=3;
    }
    Else if (SoQ4==LOW && SoQ3==HIGH &&
SoQ2==LOW && SoQ1==LOW ) // Condition for
Button 4. It is equal to Binary - 0100
    {
        if(oldCon!=4){
            digitalWrite(D2, LOW);
        }
        oldCon=4;
    }
    else if(SoQ4==LOW && SoQ3==HIGH &&
SoQ2==LOW && SoQ1==HIGH ) // Condition for
Button 5. It is equal to Binary - 0101
    {
        if (oldCon!=5){
            digitalWrite(D3, HIGH);
        }
        OldCon =5;
    }
    else if(SoQ4==LOW && SoQ3==HIGH &&
SoQ2==HIGH && SoQ1==LOW ) // Condition for
Button 6. It is equal to Binary - 0110
    {
        if (oldCon!=6)
        {
            digitalWrite(D3, LOW);
        }
        oldCon=6;
    }
    else if(SoQ4==LOW && SoQ3==HIGH &&
SoQ2==HIGH && SoQ1==HIGH ) // Condition
for Button 7. It is equal to Binary - 0111
    {
        if (oldCon!=7){

```

```

    digitalWrite(D4, HIGH);
}
oldCon=7;
}
else if(SoQ4==HIGH && SoQ3==LOW &&
SoQ2==LOW && SoQ1==LOW ) // Condition for
Button 8. It is equal to Binary - 1000
{
    if (oldCon!=8){
        digitalWrite(D4, LOW);
    }
    oldCon=8;
}
else if(SoQ4==HIGH && SoQ3==LOW &&
SoQ2==LOW && SoQ1==HIGH ) // Condition for
Button 9. It is equal to Binary - 1001
{
    if (oldCon!=9){
        digitalWrite(D1, LOW);
        digitalWrite(D2, LOW);
        digitalWrite(D3, LOW);
        digitalWrite(D4, LOW);
    }
    oldCon=9;
}
Delay (50); // Debounce Delay.
}

```

## 7. CONCLUSION

Manpower is the basement of industry, so if we look after them we can be able to shine in this society. Material handling technique reduces the strain of the employee in loading and unloading the job onto and from the trolley. By this method, we can be able to eliminate the employee bending fatigue while wrenching and it also reduces the over-energy consumption of the employee during torque setting which makes them active in the workplace. This method does not affect the production time of component. Application of the automatic mould clamp allows everyone to change moulds by button operation, to prevent backache and sweat-caused slip and to improve work environment. Productivity can be improved because the work without any tool results in saving time for searching tool. In addition, mould change by one person is also possible. The application of the automatic mould clamp allows everyone to mount moulds by the same clamping force which leads to work standardization. Finally, this process of making a manual operation into a semi-automatic operation has been done considering the safety issues. Hence in this work Audrino

programming was carried out in order to simulate the movements of single arm robot for wrenching operation.

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