

ME-637: Manufacturing Automation

Project Report

on

Automated cutting and bending for Kitchen Equipment Manufacturer

By Group No. 10

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ACKNOWLEDGEMENT

We sincerely thank Prof. K. P. Karunakaran for his constant motivation, guidance and support. The project has helped us get a detailed insight into the vast field of manufacturing automation and special purpose machines and understand their working. It has also helped us understand the difficulty of implementing what we learnt in theory in practical, since there are a lot of factors to be kept in mind before purchasing new equipment or implementing a new technology. Especially being the technology of future, the project helped us a lot in understanding the varied applications of this technology. We would also like to thank WSS Kitchen Craft Enterprises, Hari Om Grinding Works and Siddhesh Engineers for allowing us to explore their machinery and suggesting changes. They were very receptive to our suggestions and discussed the pros and cons of it as well.

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ABSTRACT

The Industrial visit to the **WSS Kitchen Crafts Enterprises** situated in Vikhroli West involved study of 3 different types of manufacturing (machining) apparatus. The report primarily focuses on the use of steel cutting machine and hydraulic press, along with improvement in efficiency of floor space to increase overall productivity. The apparatus that was studied in details to understanding its working and its relevance to the course content of ME637.

We also visited **Hari Om Grinding Works**, a grinding machines gala where we observed the working of different imported grinding machines.

In the same vicinity we had **Siddhesh Engineers**, a manufacturer that made machines that are used to do the secondary packaging of the pharmaceutical products.

We have included in the report everything we learnt at the three place, and we chose to focus on WSS Kitchen Craft and it's production line since it seems to be the one in dire need for automation to improve the working and production.

WSS Kitchen Craft

A small-scale manufacturer and designer of kitchen equipments and exhaust systems for restaurants. The following machines are used:

- 1) Argon machine for welding
- 2) Cutting machine for cutting stainless steel sheets
- 3) Hydraulic Press for drilling
- 4) Grinding machine

Raw materials used:

- 1) Stainless steel 202 – Has 0% Nickel. Does not rust if water falls on it and is wiped off but rusts if the water remains there for 3-4 days or more.
- 2) Stainless steel 304 – Has 8% Nickel. Most commonly used. Is not affected by water
- 3) Stainless steel 316 – Has a higher percentage of Nickel. Used in pharmaceutical and chemical industries where hazardous gases are there and can eat up steel as well. Rarely used since not required in the kitchen.

As the nickel percentage increases, the cost of the steel also increases.

- 1) SS202 - ₹140/kg
- 2) SS304 - ₹190-200/kg
- 3) SS316 - ₹300/kg onwards

They feel no need for automation since they manufacture up to 200-250 different kitchen equipments, and they cannot have a standardized automation for all since each equipment is different. There is no batch production.

A lot of requirements must be taken care of when designing the kitchen. Space constrains, chef should have easy access to everything be it refrigerator or sink. For the sample design we were shown they had to design a separate dishwash area as well, complete with the dish landing table, double sink, watercooler and rack for keeping the cleaned cutlery and dishes.

For the exhaust they see each individual items' CFM (cubic feet per minute) value, for example a burner has CFM of 500, and then they combine the values of deep fryer, gridle plate, dosa plate, etc, to arrive on the size, blower suction and other features of the exhaust fan needed. They also need to calculate the static pressure inside the room, if on a terrace its more difficult since the inside and outside temperatures roughly same or maybe inside even lesser so suction won't be possible.

They work in coordination with the electrical and plumbing(drainage) department for the entire set up of the kitchen of restaurants, including exhaust systems. The three teams work in parallel, you cannot have them work one after the other as that would increase the time of the project by 3 times. The project manager is the coordinator in this case.

They make roughly 15 lakhs per project they undertake, of which 20% is their profit margin after employee payments and everything. They get approximately 10-12 such projects a year.

Procedure:

- 1) Hand layout of required equipment with dimensions is made
- 2) Hand layout is given to the laborer
- 3) The laborer makes the marking on the sheets keeping in account amount that would be wasted, since the raw material is expensive



You cannot obviously get the same finish as Godrej or other branded and high-end manufacturers since they have state of the art machines at their disposal. Also, the job will be made slower compared to them as there is no automation, while we have the same laborers doing cutting and welding, while in Godrej you would have each laborer mastering at one task.

The space is only 10ft X 40ft, proving major space constraints as storage also has to be done.



Cutting machine



Argon welding machine



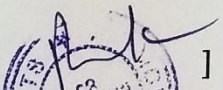
To whomsoever it may concern

This is to certify that the following people have visited our manufacturing facility and performed surveying for the purpose of ME637 Manufacturing Automation Project, IIT Bombay

1. Aditya Kalra (14D100014)
2. Tanya Gupta (150040010)

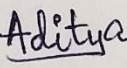
Name and Address of the facility: WSS KITCHEN CRAFT
Unit No-25, Hariyali Industrial Estate, Surya Nagar,
Vikhroli West - Mumbai - 400083.

Signature of the concerned authority Signature of the students

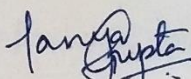
[] 22/4/18



ADITYA KALRA

[]

TANYA GUPTA

[]

Date and Time: 31/03/18
11am

SIDDESH ENGINEERS

They are responsible for making machines that aid in the secondary packing of the materials made by the pharmaceutical companies.

Machines used by them include:

- 1) Vertical Milling Machine
- 2) Lathe machine
- 3) CNC Machine
- 4) Grinding machine

The requirements change as the bottle size changes for 50, 100, 200 ml doses. The problem we discussed was if the client feels the need to put an information leaflet in the carton of the bottle/tablet, how to modify the existing machine or do we have to make a new one.

Machines designed:

- 1) Booklet Feeding machine (cost ₹25 lakhs)
- 2) Pick and place system for leaflet (cost ₹8 lakhs)
- 3) Pick and place system for bottle (cost ₹10-12 lakhs)

It takes 4 months to make a single machine. Orders vary with as when demand varies.

Procedure:

- 1) They first do a survey of the area – Area layout
- 2) They check the requirements of the client – Machine layout
- 3) Check for human interference – ease of operation, safety, operational, lifetime, etc.

The raw design is made in AutoCAD. But there is a new software called ProE which they are going to start using to check fitting of different machined parts before assembly so that they can modify the design in case of misfit.

Costing:

- 1) Employee salaries
- 2) Electricity costs
- 3) Development costs
- 4) Exhibition and installation costs
- 5) Reworking and overhead costs

Their products cost 50% lesser than their competitors since they do not use imported machines, for which they would have to pay high customs and excise duty. This also helps since they can directly aid their clients on site in case of issues and do not have to wait for international contact or help. They also showed us a bottle rejection system layout and explained how it worked. There is a sensor which rejects empty bottles. Will include its working in the final project submission.

While most of the work is automated, we felt the need for designing better machines for the packaging of the products of the pharmaceutical company to help them do the boxing faster. Also, if they worked in synchronization with another gala, preferably a grinding one then they could overcome the space constraints and well and both the galas would benefit.



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SIDDHESH ENGINEERS

Packaging Machineries Parts Manufacturer

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To whomsoever it may concern

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2. Tanya Gupta (150040010)

Name and Address of the facility: SIDDHESH ENGINEERS

Ajanta, CHS MMRD BLD No.K-2,
Kanjurmargwest Mumbai - 400078

Signature of the concerned authority Signature of the students

ADITYA KALRA

[
For SIDDHESH ENGINEERS

Authorised Signatory

[Aditya]

TANYA GUPTA

[Tanya Gupta]

Date and Time: 31/03/18
1:00

HARI OM GRINDERS

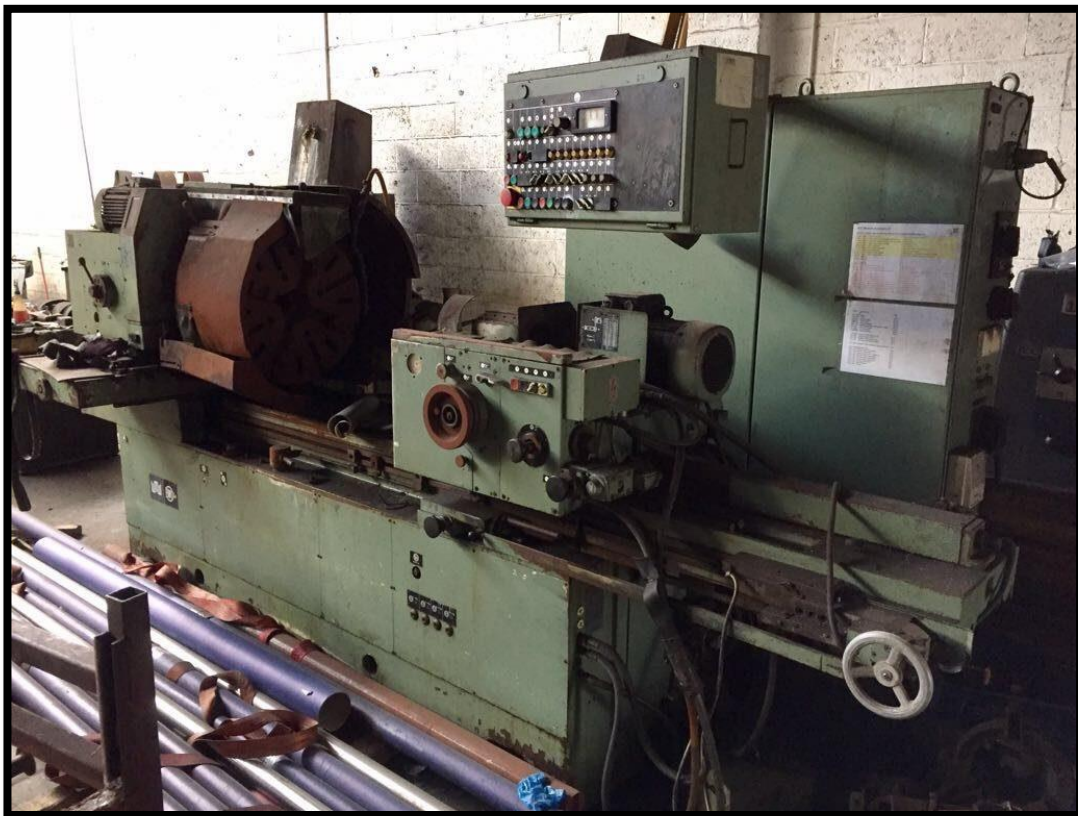
It is not a manufacturer but does external and internal grinding of machine parts that come from its clients. It has 5 different grinding machines imported from different parts of the world and having different specification, operating at different power and different frequencies and job heights, to cater to jobs of different diameters.

Except for one, all are used for internal as well as external grinding

- 1) Churchill (From England) – only internal grinding – job center height is 250mm
- 2) Amba (Made in India) – job center height is 100mm

And three others, one made in Germany, one in Czechoslovakia and one made in India. The manager claimed that these days good labor is difficult to get as no one is interested to do manual work when there are other companies where there is automation and they pay as much to just operate the machine. Also, the laborers is not educated, so lot of time is invested in explaining the machine working to them and even then to get accuracy of 2-3 micron you cannot trust them.

We also enquired if they felt the need for an automation or assembly line, but they refuted the idea since there work was labor and job oriented and they did not get large batch sizes of the same work. Each task was different from the previous one, so there was no point in the automation.



Internal grinding machine



To whomsoever it may concern

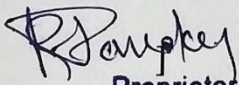
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2. Tanya Gupta (150040010)

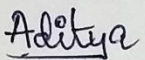
Name and Address of the facility: **HARIOM GRINDING WORKS.**
G-17, Ajanta, CHB MMRD BLD No. K-2
Kangurmag West - Mumbai - 400078

Signature of the concerned authority Signature of the students

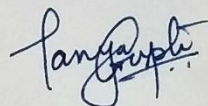
For HARIOM GRINDING WORKS

[]
Proprietor

ADITYA KALRA

[]

TANYA GUPTA

[]

Date and Time: 31/03/18
3pm

NEED FOR AUTOMATION

We found scope for automation in WSS Kitchen Craft's cutting process of the stainless-steel sheets due to following limitations.

- 1) Cutting machine being used is out of date and not fully automated
- 2) Rate of operation is poor and product damage rate is high.

To solve this problem, it is necessary to use design automatic cutting machine. By practice, the product equipment of this task can significantly reduce the number of labor and the production cost of enterprise. It brings intuitive economy benefits. It would also fit in the space of the gala after getting rid of the previous cutting machine.



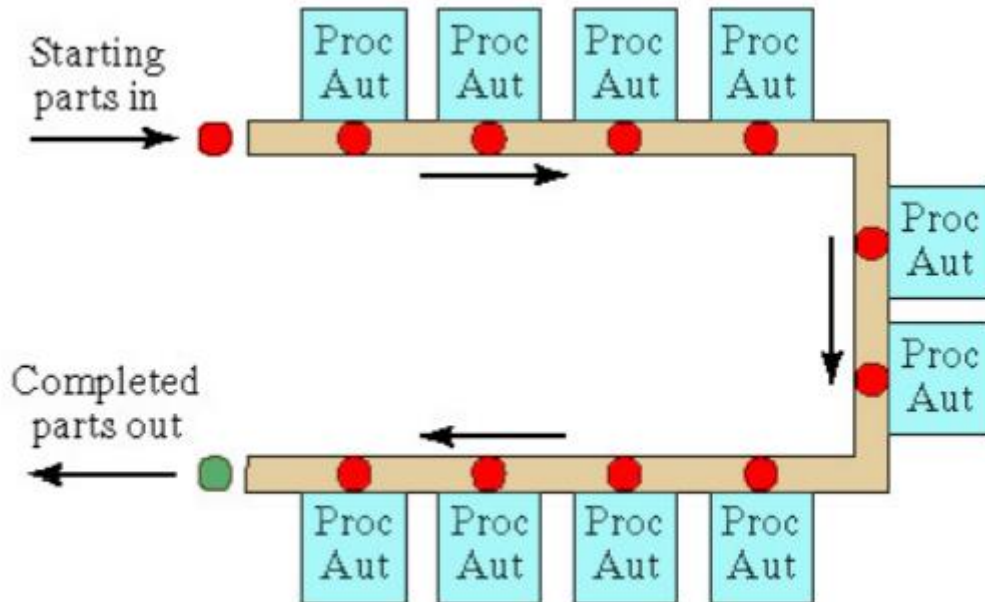
We also spoke about putting up an designated production line to utilize the space effectively. Mr. Abdul claimed this could be useful if the machine equipments was placed at strategic locations and designing was done properly. Though there is no mass production it would help if the laborers would be good at one task instead of trying to be good at every task.

Advantages of automated production line:

- 1) Low direct labor content
- 2) Low product cost
- 3) High production rates
- 4) Production lead time and work-in-process are minimized
- 5) Factory floor space is minimized

Definition of product line - “Fixed-routing manufacturing system that consists of multiple workstations linked together by a material handling system to transfer parts from one station to the next.” The slowest workstation sets the pace of the line (bottleneck). In this case, it would be the cutting operation.

We would use the segmented in line operation with the U-shaped layout.



On one side, we would have the cutting operation. The second side would be the hydraulic press for bending and drilling. And the third side would be the welding and buffing side of the automation line.

PROJECT WORK

INTRODUCTION:

We have chosen working on WSS Kitchen Craft Industries as our project topic because of the scope of improvement in space usage efficiency and automation that can be implemented using what we learnt in the course.

OBJECTIVE:

To use automation to increase efficiency, productivity and finish. To achieve this objective, we have tried to visualize the overall challenge by dividing it into 4 problem statements:

- 1) Need for Cutting machine
- 2) Better Bending machine
- 3) Effective Space utilization
- 4) Proper use of metal polishing machine

PROBLEM STATEMENT 1:

How to bring changes to the existing cutting method considering it is the most time consuming of all the processes.

SOLUTION WE DERIVED:

Using a cutting machine with the given specifications instead of the previous one. It required more manual labor and hence was less accurate and unsafe for the laborers. We suggested the use of the **SS Sheet Cutting Machine**, which was better in all the above qualities and reduced the time required for the cutting to $\frac{3}{5}$ th of the original.

Product Image-



Product details-

- Voltage - 380 V
- Cutting Length - 2650 mm
- Dimension - 1500 x 860 x 1530 mm
- Power - 7.5 kW
- Material - Cast Iron

Product description:

- “ACCURATE” Brand Under Crank Shearing Machine is suited for cutting to size general purpose unalloyed steel. Structural steel sheets up to 4 mm thickness, with high productivity. Each machine, designed to the most accurate of efficiency, offers outstanding operational performance dimensional accuracy telling on high output and dependability.
- FRAME CONSTRUCTION: All “ACCURATE” Brand guillotine shears fabricated from Is-226 grade. Rolled steel plates. Table and cutting beam are deeply reinforced and fines machine after stress reliving. The interlocked design put the direct support to frame. Thus, frames are strain free and eliminate welds at load supports. Thus, the accuracy of machine is never disturbed.
- BED: Super strong bed of closed box type construction. Stress relived in a furnace. Forms a rigid backbone for the shear and a solid backing for the lower knife. Dovetail slots in front of the bed are provided for front gauge. Slots on top of bed are also provided for machined pad across the bed for convenient setting of front gauge brackets at any desired spacing, Depressions in the top of the bed provide ample clearance for fingers in handling sheets narrower than the bed.
- UPPER BEAM: Ram is also of solid steel plate, carrying the upper knife. Their minimum weights ensure lesser load on the bearings. The upper beam moves in flat heat-treated steel guide plates to avoid deflection, for smooth running and maintain the accurate straightness of the upper knife.

- **HOLD-DOWN MECHANISM:** Solid clamping by powerful spring-loaded hold down is one of the reasons for accuracy in our shears. Heavy uniform pressure is applied along the full length of the work piece, preventing slippage regardless of variations in thickness. Hold down pressure is easily adjustable for clamping soft material. Different thickness of material can be cut without further adjustment with consistently accurate and burr free results.
- **ROLLING KEY CLUTCH:** Made of alloy steel for positive engagement and continuous operation having three key ways. Single rolling key system is incorporated in the machine ensuring easy and efficient working of the machine.
- **SHEAR KNIVES:** Knives are manufactured strictly as per standard material of HCHCR/OHNS. Every step from designing metallurgical specifications, heat treatment, grinding and inspection is carefully controlled. The blades are standardized and are easily replaced.
- **ACCURATE GAUGING:** The rigid and accurate construction of the back gauge provided with the machine allows consistency in the width of sheets being cut.
- **LUBRICATION:** Single shot lubrication provides oil to all lubrication points, where necessary.
- **DRIVE:** Drive is through V-belts on flywheel and a reduction gears are made of steel, hob cut for smooth running and longer life.

PROBLEM STATEMENT 2:

The equipments are placed in a haphazard manner leading to inefficient space utilization.

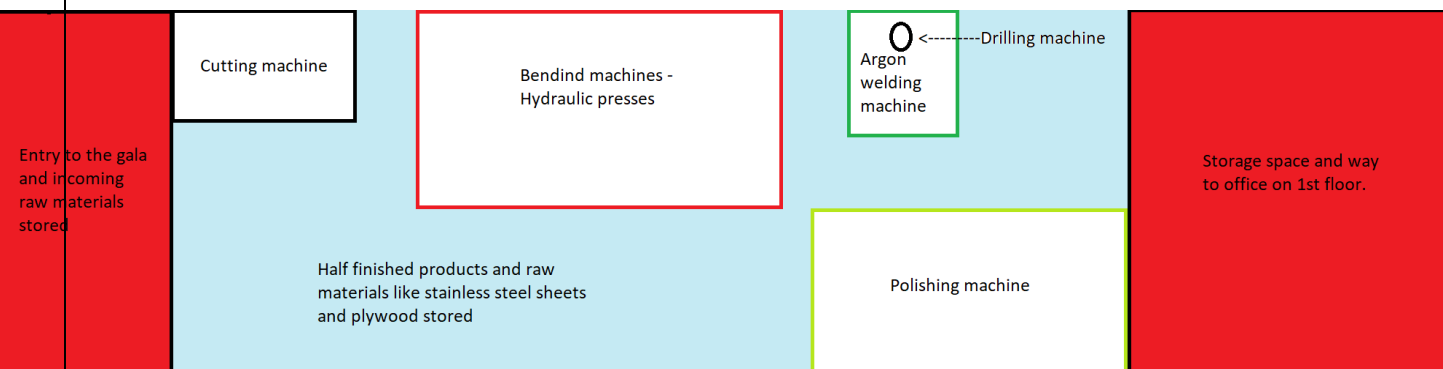
SOLUTION WE DERIVED:

Ensuring a proper sequence of execution of the processes by changing the existing spacial orientations and locations of the machines to warrant maximum and efficient utilization of space. The order is as follows:

- 1) Cutting
- 2) Bending
- 3) Drilling
- 4) Argon welding
- 5) Buffing
- 6) Storage
- 7) Transport

We tried to make a scaled layout of the shop floor and reposition the various equipments. We hope to achieve higher efficiency and reduce danger to the workers' lives.

We apologize for the layout not drawing a CAD model as AutoCAD kept giving an error, the laptop probably couldn't deal with such a heavy software. The model has been drawn to scale.



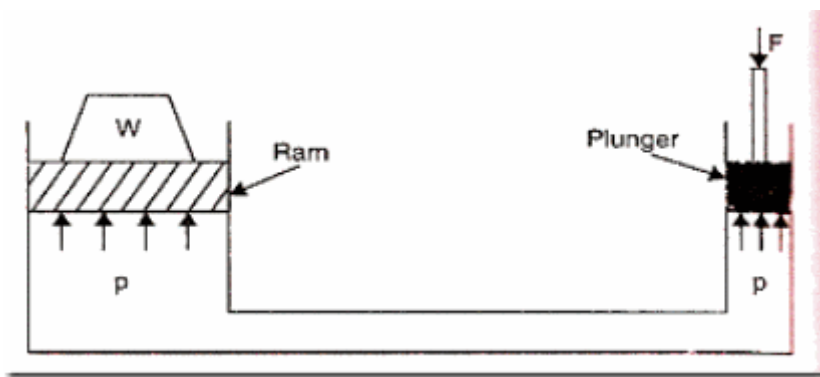
PROBLEM STATEMENT 3:

Lack of use of good bending machines and not having labor who is skilled enough to use the existing one.

SOLUTION WE DERIVED:

Working of a hydraulic press:

The hydraulic jack is a device used for lifting heavy loads by the application of much smaller force. It is based on Pascal's law, which states that intensity of pressure is transmitted equally in all directions through a mass of fluid at rest.



WORKING PRINCIPLE: The working principle of a hydraulic jack may be explained with the help of Fig. 23. Consider a ram and plunger, operating in two cylinders of different diameters, which are interconnected at the bottom, through a chamber, which is filled with some liquid.

Let

W = Weight to be lifted,

F = Force applied on the plunger,

A = Area of ram, and

a = Area of plunger.

Pressure intensity produced by the force F , $p = F/\text{Area of plunger} = F/a$

As per Pascal's law, the above intensity p will be equally transmitted in all directions.

Therefore, The pressure intensity on ram $= p = F/a = W/A$ or $W = F(A/a)$

Above Equation indicates that by applying a small force F on the plunger, a large force W may be developed by the ram.

Mechanical advantage of press $= A/a$

If the force in the plunger is applied by a lever which has a mechanical advantage (L/l) then total mechanical advantage of machine $= (L/l) \cdot (A/a)$

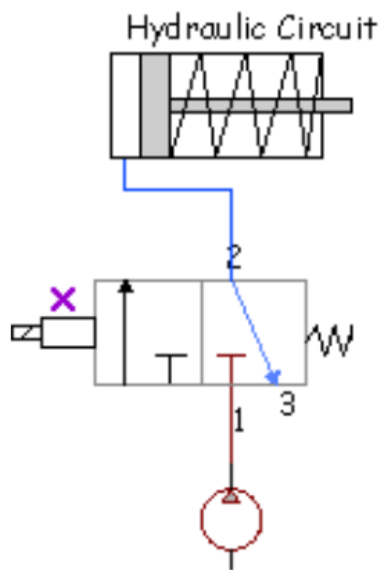
The ratio (L/l) is known as leverage of press.

Hydraulic jack may be employed for the following jobs:

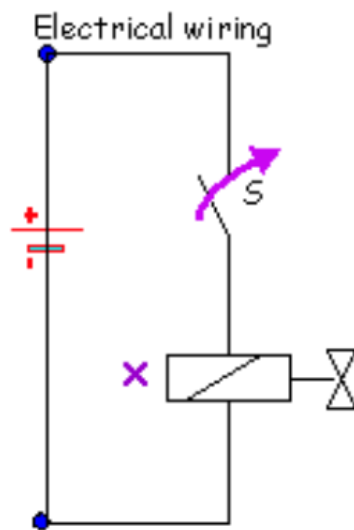
- Metal press work (to press sheet metal to any required shape).
- Drawing and pushing rods.
- Bending and straightening any metal piece.
- Packing press.

The hydraulic workshop press is semiautomatic and costs 1.1 lakh rupees.

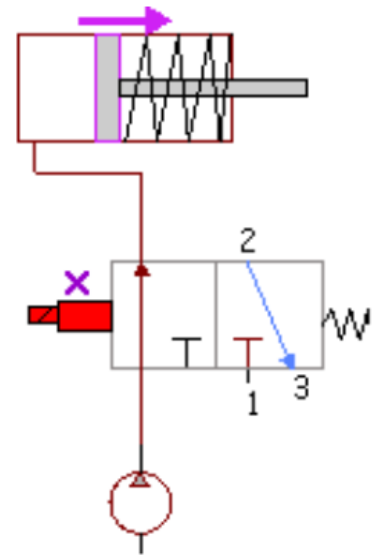
Draw the hydraulic circuit and the electrical diagram for a hydraulic ram. The piston is to be extended when a manual switch is closed. The piston should return back when the switch is released. Use a single-acting cylinder and a 3/2 valve



The valve is normally closed



Close switch S



Solenoid is energised;
the actuator starts moving

PROBLEM STATEMENT 4:

Inappropriate use of polishing/buffing machine

SOLUTION WE DERIVED:



The polishing machine they use is good and inexpensive, but the workers do not know how to use them. Also, after wear and tear, extended use of the same brush leads to rough polishing, which is bad. So, we have suggested more frequent replacement of this brush so that the product looks better, brighter and more desirable.

Investments:

- 1) Cutting machine – 5lakhs
- 2) Skilled development of the workers – enroll them in a weeklong workshop and keep under supervision in the initial days.
- 3) They can lay off some workers, since now the cutting machine is more automated, so they do not require as many laborers as they used before

Advantages:

- 1) 40% of the time of manufacturing any kitchen equipment goes into cutting. So, by changing the existing cutting machinery we save 16% of the total time per equipment. Seeing that we get 10-12 projects a year, averaging 1 project per month, we will save 5 days per month. Meaning we save 2 months in a year, which we can use to do 2 more projects. We get 3 lakhs profit turnover per project, so the investment done in buying the steel cutting machine will be recovered within the first year itself.
- 2) Safety and accuracy: By reducing the human element we reduce the risk faced by unskilled workers, wither during cutting or welding, etc.
- 3) Replacing the brush of the metal polishing machines more frequently to give better finish which will help the overall appeal and sales, so they will have an increased demand and repeated customers.

By improving the overall production on these three scales we hope to achieve better customer satisfaction and safer work environment.

REFERENCES:

- 1) Working hydraulic press – <https://www.youtube.com/watch?v=YqTYTHdsFao>
- 2) <http://engineering.myindialist.com/2009/working-principle-of-hydraulic-jack-or-hydraulic-press/#.WtEsKYhuZRY>
- 3) <https://grabcad.com/library/hydraulic-press>
- 4) <https://www.indiamart.com/proddetail/ss-sheet-cutting-machine-8598007488.html>
- 5)