

DESIGN THINKING AS A TOOL TO IMPROVE DESIGN AND FABRICATION OF PNEUMATIC SCISSOR LIFTERS

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ABSTRACT: Pneumatics is a branch of engineering that makes use of gas or pressurized air. Pneumatic systems used in industry are commonly powered by compressed air or compressed inert gases. A centrally located and electrically powered compressor powers cylinders, air motors, and other pneumatic devices. The pneumatic scissor lifters help in various types of works which includes variation in heights. It can be used in construction works and mechanic shops in which the works takes place at different height levels. It reduces the difficulty in the work thereby providing the height required for the process. To design a machine that can achieve high accuracy in lifting using smooth and efficient fluid power. To eliminate the use of hydraulic pump in hydraulic systems. Controlled lifting of load.

To minimize initial cost, operating cost and maintenance cost. Pneumatic Scissor lifters employ a lifting mechanism which incorporates a hollow cylinder and piston. An external motor or pump moves the piston within the cylinder, increasing the internal air pressure and causing the cylinder to move along the axis of the piston. The cylinder's motion along the axis creates a linear force which is then used to extend the lift components, raising or lowering the object.

Design thinking is a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases Empathize, Define, Ideate, Prototype and Test it is most useful to tackle problems that are ill-defined or unknown.

INTRODUCTION

Design thinking utilizes elements from the designer's toolkit like empathy and experimentation to arrive at innovative solutions. By using design thinking, you make decisions based on what future customers really want instead of relying only on historical data or making risky bets based on instinct instead of evidence. "Design thinking is a human centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success." Thinking like a designer can transform the way organizations develop products, services, processes, and strategy. This approach, which IDEO calls design thinking, brings together what is

desirable from a human point of view with what is technologically feasible and economically viable. It also allows people who aren't trained as designers to use creative tools to address a vast range of challenges.

Pneumatics is an engineering division that utilizes gas or pressurized air. Compressed air or compressed inert gases are usually operated by pneumatic systems used in industry. Cylinders, air engines, and other pneumatic machines control a centrally located and electrically driven compressor.

The pneumatic scissor lifters assist in different forms of operation, including height variation. It can be used in building works and mechanical shops where the work takes place at various location

To design a system that can use smooth and effective fluid power to achieve high precision in lifting. The use of hydraulic pumps in hydraulic systems should be abolished. Regulated load lifting. Operating expenditures and operating expenses to reduce initial costs.

A lifting mechanism containing a hollow cylinder and piston is used for Pneumatic Scissor lifters. The piston is pushed inside the cylinder by an external motor or pump, raising the internal air pressure and causing the cylinder to shift along the piston's axis. The motion of the cylinder along the axis produces a linear force that is then used to expand the components of the lift, raising or lowering the object.

Its mutual flexibility is the value of using pneumatic lifts. Many types of pneumatic lift need no energy and can be used in a range of applications, including high temperatures and areas vulnerable to explosion. In comparison, relative to electric and hydraulic, pneumatic systems are cheap, reliable to within (lbf +/-0.1) in and can produce lifting forces on the order of tens of thousands of pounds of force.

Despite these benefits, both their actuator scale and compressor requirements restrict pneumatic lifts. Operating pressure must be controlled during the lifting process, making pneumatic lifts less effective than other forms of lifts. This constant pressure includes the constant flow of compressed air, which also increases the total

running costs. In addition, for a given application, pneumatic actuators are usually sized, reducing the flexibility of a particular

1.1 OBJECTIVES

- ✓ It reduces the need of different ladder of different height.
- ✓ Compact size.
- ✓ Easy to carry.
- ✓ Low cost.
- ✓ Rigid construction
- ✓ High accuracy
- ✓ Generates large lifting forces
- ✓ Overall operating environment versatility
- ✓ No environment risks (from leaks)
- ✓ Lowest initial cost
- ✓ Instead of using hydraulic lift we have used mechanically operated pneumatic lift which is more cost efficient and portable. We have designed scissor lift in such a way that it has reduced design complexities. All the design calculations are

2. LITERATURE SURVEY

1) Brown (2008) Says in the paper "Review On Design Thinking"

Design thinking involves empathy, inclusive thinking, optimism, and collaboration to change the development of products, processes and companies strategies. Design thinking uses designer's sensitivity and methods to align people's needs with factors that can transform technologically feasible and viable business strategies into customer value and market opportunities. Design thinking can change how companies design products, processes, and strategies.

2) Martin (2009) Meinel and Leifer (2011) Says in the paper <https://www.ukessays.com/essays/design/literature-review-on-design-thinking.php?vref=1>

Design thinking uses abductive thinking to actively search for new data points, descriptions of issues, and create new world opportunities. To be successful, creative thinking of the company is required. Companies like apple, or IBM have focused on what happens before and after the design incident. Examples of popular business processes and routes, but there is no clear direction for changing the business. Design thinking brings people, business, and technology together to identify design problems and

processes. Design thinking combines a human-centered methodology that combines knowledge in design, social sciences, engineering and economics. Combine end-user attention with interdisciplinary collaboration and interactive enhancements to create intuitive products, systems, and services. Explore thought processes by explaining the development and application of design thinking.

3) Gaffer G Momin, Says in the paper "Design, manufacturing and analysis of hydraulic scissor lift," International Journal Of Engineering Research And General Science.

Design as well as analysis of a scissor lift. Conventionally a scissor lift or jack is employed for lifting a vehicle to change a tire, to gain access to travel to the underside of the vehicle, to lift the body of the vehicle to appropriate height, and lots of other applications also such lifts can be used for various purposes like maintenance and many material handling operations. The lift can be of mechanical, pneumatic, or hydraulic type. The design of the lift described within the paper is developed in such a way that the lift is operated by mechanically means by using a pantograph such that the overall cost of the scissor lift is reduced to some extent. In our case, we required the lift importable and also works without consuming any electric power source so they decided to use hydraulic hand pump to power the hydraulic cylinder Also such design can make the lift more compact and much suitable for medium scale work. Finally, the analysis of the scissor lift was done in ANSYS and also all responsible parameters were analyzed to check the design of the lift

4) Georgy Olein, Says in the paper "Design of hydraulic scissors lifting platform," Journal of Information, Knowledge and Research in Mechanical Engineering

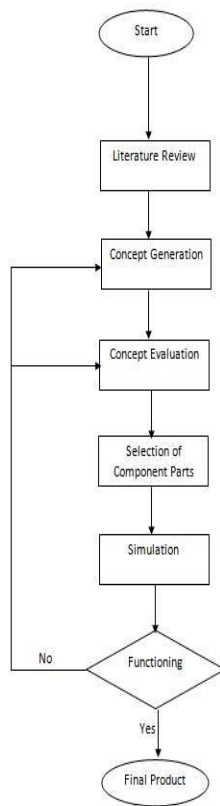
Design and analysis of scissor lifting platform for both for the highest and lowest position. Also, the working principle of scissor lift and types are discussed in this paper. Along with design the faults occurring during the operation of the scissor lift and their methods of elimination are provided to improve productivity. Design calculations are carried out by using concept of free body diagram and slandered formulae. In this paper numbers of cases are given for cylinder mountings which depended on the angle of inclination of the cylinder

5) Sandeep G. Thorat, Says in the paper "Design and construction of hydraulic scissor lift," International Journal of Current Engineering and Technology"

Hydraulic scissor lift is designed for high load resistance. Scissor lift is easy to use and daily maintenance is not required. Mild steel is selected for the manufacturing of scissor lift because it has greater durability, strength, easy and cheap availability. For the given dimensions of the scissor lift, it can lift a load in the range between 3000 to 4000 kg up to the height of 7ft. The lift provides plenty of

scope for modification for further improvements and operational efficiency

3. METHODOLOGY



4. DESIGN THINKING:

Design Thinking is an iterative method in which we try to consider the individual, test conclusions, and redefine challenges in order to find possible ideas and answers that aren't immediately obvious based on our current level of understanding. Simultaneously, Design Thinking offers a problem-solving strategy built on solutions. It is also a way of living and working.

Design Thinking is based on a strong desire to learn more about the people about whom we are creating goods or services. It enables one to observe and empathize with the intended customer. Design Thinking aids in the process of questioning: the challenge, the conclusions, and the consequences. When it comes to dealing with problems, Design Thinking is incredibly helpful.

Through re-framing the issue in human-centric terms, generating multiple solutions in brainstorming workshops, and taking a hands-on approach to prototyping and experimenting, Design Thinking is particularly helpful in solving challenges that are ill-defined or undefined. Sketching, prototyping, researching, and trying out designs and proposals are all part of the Design Thinking process.

PHASES OF DESIGN THINKING :

1. **Empathise** – with your users
2. **Define** – your users' needs, their problem, and your insights
3. **Ideate** – by challenging assumptions and creating ideas for innovation.
4. **Prototype** – to start creating solutions
5. **Test** – solutions

1. EMPATHISE

This project is mainly Empathise the Man Workers such as Painters, Industry workers etc.. need for rise in certain height from the floor level to work as well as maintenance etc.. Provision of lifting equipment to handle materials efficiently and with minimum physical effort must be one of the most important considerations in industry today. On the one hand there is the growing pressure on management from workers, their trade unions and safety representatives, to provide lifting equipment to ease their daily tasks; on the other an increasing awareness of the greater efficiency and reduced costs that can be obtained by employing modern mechanical handling equipment of all capacities.

Labour Journey Map

Interview based sticky note technique for mapping the process that someone is going through

1. Who we are to help through this project

Maintenance Workers like Painters, Plumbers, Electricians

2. What they are doing ?

The are doing the maintenance workers in civil as well as industries.

Usage of conventional methods of lifting mechanism by maintenance workers

Costlier lifting mechanism and

Usage of hydraulic and other costlier mechanism

After

ladders and stool equipments are replaced by a pneumatic scissor lifter which is safe as well as cost efficient

2. DEFINE :

We made a Definition in this paper that the design and fabrication of a portable work platform Of the lift which is elevated by one Pneumatic cylinder were carried out effectively and meeting the necessary design criteria. The double type of scissors lift is elevated by one Pneumatic cylinder and it is operated manually. This scissor lift is design for average load purposes, because the higher the load more the effort required for raising the load from ground level. The hydraulic scissor lift is easy to use and does not require continuous repairs and maintenance. It can also lift heavier loads. For the given dimensions of the scissor lift can raise a load up to 280 kg up to the height of 1000mm (For Working model). Hence, its extensive application in industries, hydraulic pressure system, for the lifting of a vehicle in garages, maintenance of huge machines, and for staking purpose

We concluded that force is also acting on the Pneumatic scissor lift when it is extended and contracted. Generally, a pneumatic scissor lift is used for lifting and also holding heavyweight components. Material selection plays a very important role in designing a machine and also influence on several factors such as durability, reliability, strength, resistance which finally helps to increase the life of scissor lift. The Pneumatic lift design such a way that it must be portable, compact, and more suitable for the medium type of load handling application. Drafting and drawing of the hydraulic system of a scissor lift are done using solid works software with suitable modeling and imported to Ansys workbench software for meshing and analysis of lift. Hence, the analysis of this scissor lift includes Total deformation load, and Equivalent stresses were done in Ansys software and all other responsible parameters of the lift were analyzed to check the compatibility of the design value. The computational values of two different materials such as aluminum and mild steel are also compared for the best results

We found that design as well as analysis of a Pneumatic scissor lift. Conventionally a scissor lift or jack is employed for lifting a vehicle to change a tire, to gain access to travel to the underside of the vehicle, to lift the body of the vehicle to appropriate height, and lots of other applications also such lifts can be used for various purposes like maintenance and many material handling operations. The lift can be of mechanical, pneumatic, or hydraulic type. The design of the lift described within the paper is developed in such a way that the lift is operated by mechanically means by using a pantograph such that the overall cost of the scissor lift is reduced to some extent. In our case, we required the lift is portable and also works without consuming any electric power source so they decided to use a hydraulic hand pump to power the hydraulic cylinder Also a such design can make the lift more compact and much suitable for medium scale work

- **From the User's perspective:**

This is especially made for the physical workers such as painters, Electricians, Plumbers and the workers needed to reach a certain height from the floor space to do their work. This will be a alternative for convention methods of lifting.

- **From a user research perspective:**

Pneumatic Scissor Lift may be a very simple device used to raise elements or objects or load from ground level to a specific height to perform a particular work with maximum load capacity and minimum efforts of a worker. To achieve this we required the higher strength material, Pneumatic components such as hydraulic cylinder, wheels, etc. all the researchers attempt to optimize these parameters according to the concerned requirement. it had been tried to think about different research papers containing the research and analysis made on scissor lift evaluated the design and analysis of hydraulic Scissor Lift. It gives a brief description of its types, working, system requirements and design methodologies. This review paper also focused on the analysis of some research papers containing the entire study of components (pneumatic cylinder, spacing shaft, and platform and scissor arm), selection of material, and analyzes the dimension of components. After the analysis of the research papers, the longer-term scope of the research was also suggested.

- **Based on the four Ws - who, what, where, and why:**

WHO - for the physical workers such as painters, Electricians, Plumbers and the workers needed to reach a certain height from the floor space to do their work.

WHAT - A scissor lift is a sort of platform which will move only vertically. With Today's development of science and technology, more and more new technologies were applied to material handling. The main aim of the scissor lift was material handling and providing comfort to the operator while performing the operation. The scissor lift was convenient to operate or use and it will be used frequently in industries and other common places. A scissor lift table is used to hold, stack, raise or lower, convey or transfer materials or loads between two or more height. The mechanism used in a scissor lift to achieve this function was nothing but the utilization of linked, folding arms during a criss-cross 'X' pattern, referred to as a pantograph. A scissor lift provides the most economically dependable and versatile methods of lifting heavy loads in the industry.

WHY - The portable work platform is operated by a hydraulic cylinder which is also operated by a hand pump by of a person or an operator working in the company premises is the responsibility of an organization so it is an important thing to give some amount of comfort to the operator. Hence by making this hydraulic lifter we

improved the comfort level of the operated working on the machine. The natural frequency of lift should not be equal to the external excitation frequency hence no vibration in the lift. A portable work platform hydraulic scissor lift is designed for high load resistance. The hydraulic scissor lift is simple in use and does not require routine maintenance. The scissor lift reduces the complexities in a design and fabrication time was reduced. But the limitation of this lift is the initial cost. The design and fabrication of a portable work platform raised by a hydraulic cylinder were carried out meeting the required design standards. The portable work platform of a scissor lift is operated by a hydraulic cylinder which is operated by a motor. The scissor lift can be design for high load also if a suitable high capacity hydraulic cylinder is used. It can also lift heavier loads. The main objective of this device is its high initial cost but has a low operating cost.

3. IDEATE :

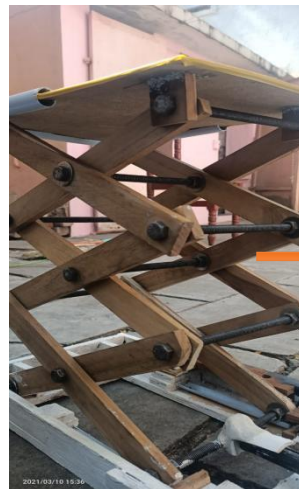
During the Define stage, we put together the information we have created and gathered during the Empathise stage. we will analyse the observations and synthesise them in order to define the core problems that our team have identified up to this point. We seek to define the problem as a problem

Possible Problem	Action we took
Pressure too low	Checked pressure at cylinder to make sure it meets circuit requirements.
Piston seal leak	Operated valve to cycle cylinder. Observe air flow at valve exhaust ports at end of cylinder stroke. Replace piston seals if flow is excessive.

statement in a human-centred manner.

Problems we have faced during ideating phase :

4. PROTOTYPE



Scissors lifter



Cylinder piston



Pneumatic Cylinder

Prototypes are often used in the final, testing phase in a Design Thinking process in order to determine how users behave with the prototype, to reveal new solutions to problems, or to find out whether or not the implemented solutions have been successful. The results generated from these tests are then used to redefine one or more of the

problems established in the earlier phases of the project, and to build a more robust understanding of the problems users may face when interacting with the product in the intended environment.

5. TEST :

Testing can be undertaken throughout the progress of a Design Thinking project, although it is most commonly undertaken concurrently with the Prototyping stage. Testing, in Design Thinking, involves generating user feedback as related to the prototypes you have developed, as well as gaining a deeper understanding of users. When undertaken correctly, the Testing stage of the project can often feed into most stages of the Design Thinking process: it allows to Empathise and gain a better understanding of your users; it may lead to insights that change the way to Define problem statement.



4. DESIGN CALCULATION :

(Working model)

Mass to be put on lift = 500 Kg

Taking Factor of safety = 1.5

The safety factor for bending strength for visually graded dimension lumber is 1.3; by contrast, the safety factor for structural steel, which has much less variability from piece to piece, is as much as 2.

Factors of Safety - FOS - are a part of engineering design and can for structural engineering typically be expressed as

$$FOS = F_{fail} / F_{allow} \quad (1)$$

where

FOS = Factor of Safety

F_{fail} = failure load (N, lbf)

F_{allow} = allowable load (N, lbf)

Mass of the top frame = 22.5 Kg

Mass of each link = 40 Kg

Mass of cylinder = 8.150 Kg

Total mass = 814 .65 Kg

Total Load = 8580.316 N

For a scissor lift force required to lift the load is dependent on Angle of link with horizontal Mounting of cylinder

Length of entire link (L) = 720mm

Length of the link considered as beam = 360mm

The load position on the top platform is considered to U.D.L hence the load

Pattern on the link is uniformly varying load U.D.L due to inclination

The calculation is done for link shut height position. When the angle made by the links with horizontal is 20 degree

Bulking of link with one end fixed and other hinged

$$P = \pi^2 EL / L^2 e$$

$$As I = h^4/3$$

$$B = 4h$$

$$E = 2 \times 10^5 I = 0.72$$

$$So b = 1.2m, b = 30m$$

Taking moment about point A

$$V_b \times 360 - (2015.714 \times 360 \times 2/3)$$

$$V_b = 1343.089 N$$

$$R_a = 715.026N$$

$$R_a \cos(20^\circ) = 671.90$$

$$R_a \sin(20^\circ) = 244.55 N$$

$$M/I = \delta b/$$

$$\Delta b = 62.5$$

It has safe bending.

$$\tau = 0.5 \times 505 / FOS$$

$$= 126.25 Mpa$$

Hence Standard Value.

Force acting on Intermediate link

$$X_{mi} = \frac{H_{yo} \cot\theta (2i^2 - 2i \times \text{by} \times \cot\theta)}{8}$$

Thus 11512.48 Nmm

$$M/I = \delta b/Y$$

$$D = 12 \text{ cm}$$

Bulking Formula

$$F = \frac{\pi^2 EI}{l^2 e}$$

Diameter of Cylinder

$$d = 17.4 D = 2d = 34.8 \text{ mm}$$

Area of cylinder Side will be 951.14 mm²

Area on rod side will be = 237.78mm²

$$P = F / A$$

$$P = 12 \text{ N/mm}^2$$

$$= 120 \text{ bar}$$

Taking

$$S_{ut} = 440 \text{ Mpa}$$

Considering Factor of Safety =3

$$\delta = 146.66 \text{ Mpa}$$

Now,

$$t = \frac{P_i D_i}{2\delta t}$$

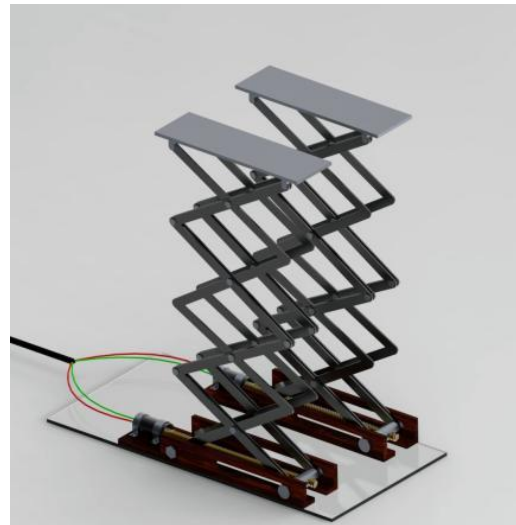
$$t = 1.42 \text{ mm}$$

Cylinder Part

5. MODEL

Solid works offers a range of tools to enable the generation of a complete digital representation of the product being designed. A number of concept design tools that provide up-front Industrial design concepts can then be used in the downstream process of engineering the product. These range from conceptual Industrial design sketches, reverse engineering with point cloud data and comprehensive free-form surface tools.

We created 3D model of this project frame by using Solid Works software. The models are shown below,



Designed in solid works version 2018

5.1 SELECTION OF MATERIAL (PROTOTYPE)

We selected a basic material as M.S for working model, but for this prototype we took wood because of some of its basic factors like easily availability, easily processing , But for connecting we used MS screw nuts,for cylinder we took PVC pipes, worings are given rubber material to prevent leakage.

5.2 MACHINING PROCESS (ACCORDING TO DESIGN AND CALCULATION)

Several machining processes were done like cutting of wood as per the dimensions.and drilling is done by drilling machine in the workshop, the cutting of PVC pipes are done manually by hacksaw blades and pasted with the help of PVC solution.

5.3 DIMENSIONS OF THE PROTOTYPE

The dimensions of the model is determined by the field parameters and it can be fixed according to the field circumstances. This project's parameters are basically fixed by the standard order.

6. PNEUMATIC SCISSORS LIFTERS

The main Principle of the pneumatic scissor lifter is that the air pressure is converted into mechanical energy by expansion in the engine cylinder. The gas is compressed in the cylinder by the compressor to increase the pressure. Pneumatic cylinder is consisting of cylinder, end cover, piston, piston rod and seal. Air from a single stage air compressor enters the push button direction control valve and is directed to the pneumatic actuator. The pneumatic actuator is a double acting cylinder and the compressed air extends the piston. The piston rod acts as piston in the pneumatic line and increase the pressure inside the cylinder. Thus, the lifter rises using the

pneumatic pressure. Pneumatic lifts employ a lifting mechanism which incorporates a hollow cylinder and piston. An external motor or pump moves the piston within the cylinder, increasing the internal air pressure and causing the cylinder to move along the axis of the piston. The cylinder's motion along the axis creates a linear force which is then used to extend the lift components, raising or lowering the object. The advantage of employing pneumatic lifts is their collective versatility. Many pneumatic lift models do not require electricity and can be used in a variety of applications, including extreme temperatures and explosion-prone a

6.1 DEVELOPMENT OF THE MODEL

A Picture of overall developed model is given below,



Fig 6.1: DEVELOPED MODEL

MERITS AND LIMITATIONS

6.2 MERITS

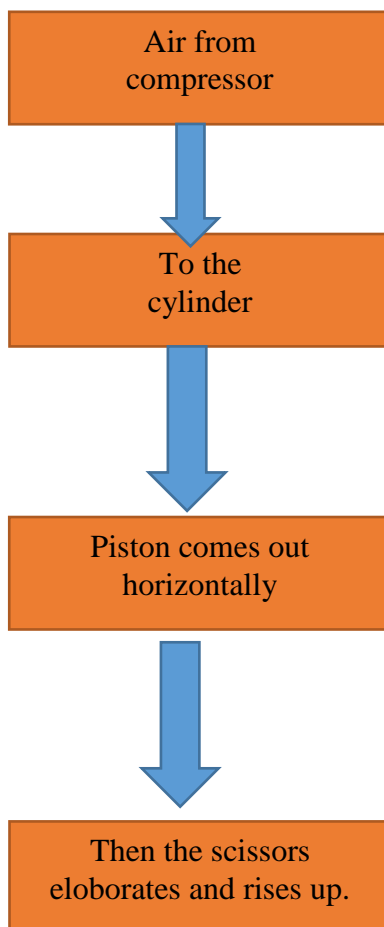
- Simple in construction.
- Maintenance cost is low.
- It does not create any type of pollution such as noise, air and so on.
- It does not require fuel to energize.
- It involves high initial expenses like installation and the complete system, but this cost is soon offset by savings on energy bills.
- This complete system can be manually operated but can be used as automatic machine.

6.3 LIMITATIONS

- Initially the cost required to purchase is a bit high.
- The efficiency of the system decreases during cloudy and rainy seasons
- Must be handles carefully because of more number of moving parts.
- Suitable only for particular crops.
- Large time required to remove the grass

7. FUTURE SCOPE

The upper base can be made with a sliding mechanism so it is easy for heavy jobs can easily slide over the base. The design can be made more compact and material made



lighter and low frictional contact. By providing the roller at the base support scissor lift is portable. By providing the foot pedal to the lift so we can avoid the hydraulic motor so it does not require the electric connection and the lift become more portable and move to any corner in the industry. By using the mild steel and aluminum alloy it makes a more durable. We can increase contact force between the shaft and pinion to prevent slipping and allow lifting of larger weights. The number of plates in the scissors can be increased to improve the height to the number of rotations ratio.

7.1 ACKNOWLEDGEMENT

First and foremost, I would like to thank the Almighty God for giving us the strength, knowledge, ability and opportunity to undertake this project study and to persevere and complete it with satisfaction.

We would like to express our gratitude towards our parents for their tremendous contribution in helping us reach this stage in our life. This would not have been possible without their unwavering and unselfish love, cooperation and encouragement given to us at all times.

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many

7.2 COST OF PROJECT

Raw materials (wood,screw rod, PVC Pipes)	1500/
Workshop charges	1800/-
Air Pump and Cylinder	1000/-
Carpentary charges	1200/-
Paint, Adhesives and valves	500/-
TOTAL	6000/-

8. CONCLUSION

The portable work platform is operated by a Pneumatic cylinder which is also operated by a hand pump by of a person or an operator working in the company premises is the responsibility of an organization so it is an important thing to give some amount of comfort to the operator. Hence by making this pneumatic lifter we improved the comfort level of the operated working on the machine. The natural frequency of lift should not be equal to the external excitation frequency hence no vibration in the lift. A

portable work platform pneumatic scissor lift is designed for high load resistance. The pneumatic scissor lift is simple in use and does not require routine maintenance. The scissor lift reduces the complexities in a design and fabrication time was reduced. But the limitation of this lift is the initial cost. The design and fabrication of a portable work platform raised by a hydraulic cylinder were carried out meeting the required design standards. The portable work platform of a scissor lift is operated by a hydraulic cylinder which is operated by a motor. The scissor lift can be design for high load also if a suitable high capacity hydraulic cylinder is used. It can also lift heavier loads. The main objective of this device is its high initial cost but has a low operating cost.

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