# "Design, Manufacturing & Analysis of Human Powered Forklift"

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## ABSTRACT

*In today's life, there is a wide variety of forklifts, from the large heavy loading truck to the one that works among narrow aisles. Forklifts have become one of the basic transportation tools we use in our lives. With all the forklifts in existence, we find that there are some improvements that can be made to bring the forklift to a better performance. The main aim of our project is to design and develop fork lift which will lift the load and then it will transfer the load from one place to another place. The 3D model was drawn with the help of CATIA model. The experimental testing was carried out. The result & conclusion was drawn after making the experimental testing.*

**Keywords:** *forklifts, CAD model, design and development of forklift*

## 1. INTRODUCTION

A forklift (also called lift truck, jitney, fork truck, fork hoist, and forklift truck) is a powered industrial truck used to lift and move materials over short distances. The forklift was developed in the early 20th century by various companies, including Clark, which made transmissions, and Yale & Towne Manufacturing, which made hoists. Since World War II, the use and development of the forklift truck have greatly expanded worldwide. Forklifts have become an indispensable piece of equipment in manufacturing and warehousing. In 2013, the top 20 manufacturers worldwide posted sales of $30.4 billion, with 944,405 machines sold.

The middle nineteenth century through the early 20th century saw the developments that led to today's modern forklifts. The forerunners of the modern forklift were manually powered hoists that were used to lift loads. In 1906, the Pennsylvania Railroad introduced battery powered platform trucks for moving luggage at their Altoona, Pennsylvania train station. World War I saw the development of different types of material handling equipment in the United Kingdom by Ransomes, Sims & Jefferies of Ipswich. This was in part due to the labor shortages caused by the war. In 1917, Clark in the United States began developing and using powered tractor and powered lift tractors in their factories. In 1919, the Towmotor Company, and Yale & Towne Manufacturing in 1920, entered the lift truck market in the United States. Continuing development and expanded use of the forklift continued through the 1920s and 1930s. The introduction of hydraulic power and the development of the first electric power forklifts, along with the use of standardized pallets in the late 1930s, helped to increase the popularity of forklift trucks.

The start of World War II, like World War I before, spurred the use of forklift trucks in the war effort. Following the war, more efficient methods for storing products in warehouses were being implemented. Warehouses needed more manoeuvrable forklift trucks that could reach greater heights and new forklift models were made that filled this need. For example, in 1954, a British company named Lansing Bagnall, now part of KION Group, developed what was claimed to be the first narrow aisle electric reach truck. The development changed the design of warehouses leading to narrower aisles and higher load stacking that increased storage capability. During the 1950s and 1960s, operator safety became a concern due to the increasing lifting heights and capacities. Safety features such as load backrests and operator cages, called overhead guards, began to be added to forklifts produced in this era. In the late

1980s, ergonomic design began to be incorporated in new forklift designs to improve operator comfort, reduce injuries and increase productivity. During the 1990s, exhaust emissions from forklift operations began to be addressed which led to emission standards being implemented for forklift manufacturers in various countries. The introduction of AC power forklifts, along with fuel cell technology, are also refinements in continuing forklift development.

Forklifts are rated for loads at a specified maximum weight and a specified forward centre of gravity. This information is located on a nameplate provided by the manufacturer, and loads must not exceed these specifications. In many jurisdictions, it is illegal to alter or remove the nameplate without the permission of the forklift manufacturer.

An important aspect of forklift operation is that it must have rear-wheel steering. While this increases manoeuvrability in tight cornering situations, it differs from a driver's traditional experience with other wheeled vehicles. While steering, as there is no caster action, it is unnecessary to apply steering force to maintain a constant rate of turn.

Another critical characteristic of the forklift is its instability. The forklift and load must be considered a unit with a continually varying centre of gravity with every movement of the load. A forklift must never negotiate a turn at speed with a raised load, where centrifugal and gravitational forces may combine to cause a disastrous tip-over accident. The forklift is designed with a load limit for the forks which is decreased with fork elevation and undercutting of the load (i.e., when a load does not butt against the fork "L"). A loading plate for loading reference is usually located on the forklift. A forklift should not be used as a personnel lift without the fitting of specific safety equipment, such as a "cherry picker" or "cage".

Forklifts are a critical element of warehouses and distribution centres. It's imperative that these structures be designed to accommodate their efficient and safe movement. In the case of Drive-In/Drive-Thru Racking, a forklift needs to travel inside a storage bay that is multiple pallet positions deep to place or retrieve a pallet. Often, forklift drivers are guided into the bay through guide rails on the floor and the pallet is placed on cantilevered arms or rails. These maneuvers require well-trained operators. Since every pallet requires the truck to enter the storage structure, damage is more common than with other types of storage. In designing a drive-in system, dimensions of the fork truck, including overall width and mast width, must be carefully considered.

**1.1 Forklift control and capabilities:**

Forklift hydraulics are controlled either with levers directly manipulating the hydraulic valves or by electrically controlled actuators, using smaller "finger" levers for control. The latter allows forklift designers more freedom in ergonomic design.

Forklift trucks are available in many variations and load capacities. In a typical warehouse setting most forklifts have load capacities between one and five tons. Larger machines, up to 50 tons lift capacity, are used for lifting heavier loads, including loaded shipping containers.

In addition to a control to raise and lower the forks (also known as blades or tines), the operator can tilt the mast to compensate for a load's tendency to angle the blades toward the ground and risk slipping off the forks. Tilt also provides a limited ability to operate on non-level ground. Skilled forklift operators annually compete in obstacle and timed challenges at regional forklift rodeos.

**1.2 Forklift Safety:**

1.2.1 Standards

Forklift safety is subject to a variety of standards worldwide. The most important standard is the ANSI B56—of which stewardship has now been passed from the American National Standards Institute (ANSI) to the Industrial Truck Standards Development Foundation (ITSDF) after multi-year negotiations. ITSDF is a non-profit organization whose only purpose is the promulgation and modernization of the B56 standard.

Other forklift safety standards have been implemented in the United States by the Occupational Safety and Health Administration (OSHA) and in the United Kingdom by the Health and Safety Executive.

1.2.2Driver safety

In many countries, forklift truck operators must be trained and certified to operate forklift trucks. Certification may be required for each individual class of lift that an operator would use.

Forklift training has many names, such as forklift licensing or forklift certification. Whichever term is used, training must adhere to federal or national standards.

Health care providers should not recommend that workers who drive or use heavy equipment such as forklifts treat chronic or acute pain with opioids. Workplaces which manage workers who perform safety-sensitive operations should assign workers to fewer sensitive duties for so long as those workers are treated by their physician with opioids.

**1.3 Problem Statement:**

A small scale industry (SAI ENTERPRISES) having major problem related to cost of material handling system, they does not use automated device so that they use manually machines. The material handling like lifting of raw materials, transfer the finished product to final stage, transfer the one product from one department to other department so that overall cost required for material handling is increase. This cost affected on profit of company so that we avoid this problem we find solution to overcome above problem with the help of human powered forklift.

**1.4. Objective**

1. Fork lifter reduces the efforts.
2. Reduces the time.
3. Compact in size.
4. Flexible material handling.

**1.5. Methodology**

a) Literature survey for related heat design, manufacturing and analysis of human powered forklift.
b) Selection of the optimized designed for the forklift.
c) Selection of the optimum material
d) manufacturing of all the components required.
e) assembly of all the parts.
e) experimental validation

## 2. LITERATURE REVIEW

**A. Ehlanda, M.S. Williams, A. Blakeborough** commented Long-span warehouse floors can suffer problematic vibrations due to dynamic interaction with moving fork-lift trucks. However, the dynamic loads caused by trucks are poorly understood and no mathematical model of these loads suitable for use in a dynamic analysis has previously been proposed. This paper presents a two-degree-of-freedom dynamic load model of a fork-lift truck suitable for use in an analytical floor vibration assessment. The load model comprises two time-varying vertical forces that are a fixed distance apart. Each force is the product of a mass matrix and a vertical acceleration vector, which is in turn a function of the horizontal velocity of the truck. The model derivation is partly analytical and partly experimental, with some key parameters derived from field tests on four fork-lift trucks in a total of twelve configurations. Data for general models are presented for a range of truck capacities from 1000 kg to 6000 kg. The model fills a significant gap in the current state of the art of vibration analysis, enabling a realistic assessment of fork-lift truck-induced floor vibrations to be performed using a finite-element program.

**J. Malchaire, A. Piette and I. Mullier** investigates the effects of the main characteristics of the working condition on the vibration exposure on fork-lift trucks. Four hundred and eighty recordings were made on five trucks equipped with four different types of tyres and a 'normal' or an 'anti-vibration' seat, driven while empty or loaded, on a smooth or a rough track by three workers. An analysis of variance was performed to study the main effects and the significant interactions between these factors. A mathematical model is proposed for the weighted acceleration on the floor and on the seat in the vertical axis. This shows quantitatively that the vibration exposure is mainly influenced by the roughness of the track, the speed and the quality of the seat. Inflated tyres are preferable when an anti-vibration seat with a very low resonance frequency is used. In other cases, cushion tyres are more indicated.

**Matthias Hentschel, Daniel Lecking, Bernardo Wagner**This paper introduces a novel trajectory planner for flexible material handling with an autonomous fork lift truck. Based on a set of predefined waypoints, a continuous curvature path is computed by a concatenation of line and polar spline segments. Regarding the nonholonomic constraints of the vehicle, the trajectory as well as an associated speed profile is generated. As flexible path planning is required for this kind of application, trajectory generation is not only limited to the base points of a single route. From a list of multiple predefined routes, the proper set of waypoints is chosen for guiding the vehicle to a desired destination. Furthermore, a graph-based routing algorithm enables the combination of different routes for trajectory generation. Following the description of the trajectory planner for single and multiple paths, experimental results with speeds up to 1.7 m/s demonstrate the effectiveness of this approach.

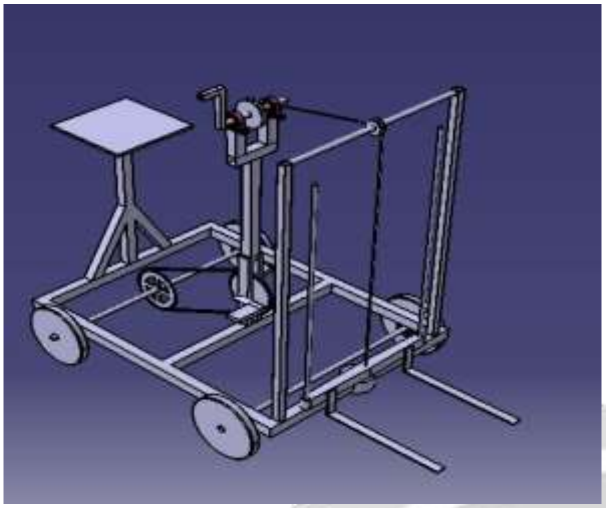
**Juan M. Massone et al.** Researchers has reported various internal finned tube by experimental validation, by Numerical modeling to achieve high heat transfer rate with minimum pressure drop and also for minimizing flow resistance increase when developing novel heat augmentation technique. Different heat transfer enhancers are reviewed. They are (a) fins and micro fins, (b) porous media, (c) large particles suspensions, (d) nano fluids, (e) phase-change devices, (f) flexible seals, (g) flexible complex seals, (h) vortex generators, (i) protrusions, and (j) ultra high thermal conductivity composite materials[13]. Most of heat transfer augmentation methods presented in the literature that assists fins and micro fins in enhancing heat transfer are reviewed. It is found that not much agreement exists between works of the different authors regarding single phase heat transfer augmented with micro fins. However, too many works having sufficient agreements have been done in the case of two phase heat transfer augmented with micro fins; there are still many conflicts among the published works about both heat transfer enhancement levels and the corresponding mechanisms of augmentations. In addition, this paper describes a well-modeled passive enhancement method. Many recent works related to passive augmentations of heat transfer using vortex generators, protrusions, and ultra high thermal conductivity composite material are reviewed. Finally, theoretical enhancement factors along with many heat transfer correlations are presented**.**

**Lili Wanga et al.** In recent years, the forklift is facing two challenges energy saving and environmental. However, the hydraulic forklift has low transmission efficiency and energy efficiency. To solve the problem, this paper proposes an approach for the lifting hydraulic cylinder replaced by ball screw device. The lifting system is controlled directly with an electric motor drive instead of pump. First, we analyzed the working condition and energy flows of the forklift and proposed an energy recovery system for forklift. Second, we built the system model including super capacitor model, vehicle model and the simulation model in AMESIM. Due to the markedly changing loads, super capacitor with high specific power and high durability seems the best choice for energy storage system. In addition, the study of rule-based energy management control strategies on forklift with electric lifting device is discussed, which is validated and evaluated by simulation. The results show that the fuel consumption of the forklift with electric lifting device can be reduced by about 46.72% compared with the hydraulic forklift and its transmission efficiency is improved 82.3% when the loads is 3t. The energy saving effect of electric system is very significant.

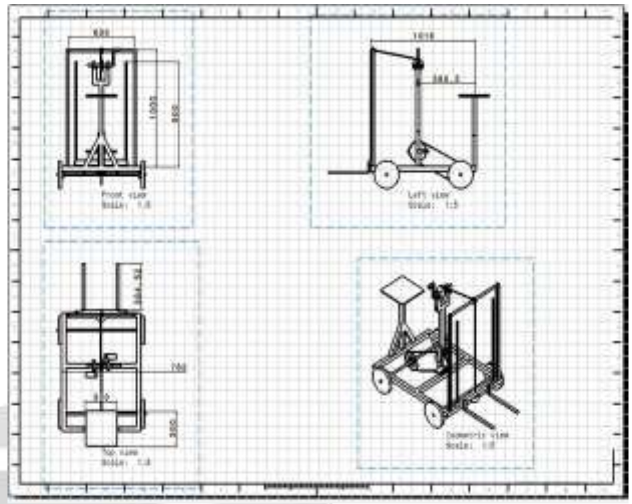
## 3. PROPOSED WORK:

### 3.1 Construction And Working

Human powered forklift consist of frame which made of steel square bars which are welded together to form structure. The wheels are provided for turning purpose the wheel is mounted on front axle. The rod is connected to front axle, with the help of this rod we turned front wheels. The chain and sprocket mechanism are provided to provided forward and backward moment of forklift which is place at back side. The handle is provided at middle side of forklift and rope and pulley are provided for lifting purpose. When operator operates a handle a rope are wounded on pulley and load which are place which can be move upward at specific level. In this way by using various mechanical components like chain, sprocket, pulley, rope, We operate a forklift. Main special thing in our forklift is fully mechanical without supplying electricity or any battery source. Fog(1) shows CAD model of human powered forklift drown using CATIA V5 R21



(a) CAD model of human powered forklift



(b) Drafting of forklift

Fig. (1): CAD model & Drafting of human powered forklift

**3.2 Process sheet:**

Following operations were while fabricate the project

**Cutting:**

This operation is used to cut the material as our required size. The machine used for this operation is power chop saw. A power chop saw, also known as a drop saw, is a power tool used to make a quick, accurate crosscut in a workpiece at a selected angle. Common uses include framing operations and the cutting of moulding. Most chop saws are relatively small and portable, with common blade sizes ranging from eight to twelve inches. The chop saw makes cuts by pulling a spinning circular saw blade down onto a workpiece in a short, controlled motion. The workpiece is typically held against a fence, which provides a precise cutting angle between the plane of the blade and the plane of the longest workpiece edge. In standard position, this angle is fixed at 90°. A primary distinguishing feature of the mitre saw is the mitre index that allows the angle of the blade to be changed relative to the fence. While most mitre saws enable precise one-degree incremental changes to the mitre index, many also provide "stops" that allow the mitre index to be quickly set to common angles (such as 15°, 22.5°, 30°, and 45°). The time required for this operation is 50 minutes.

**Finishing:**

This technique is used to finish the edges with grinder using grinding wheel. The machine used for this operation is hand grinder. An angle grinder, also known as a side grinder or disc grinder, is a handheld power tool used for cutting, grinding and polishing. Angle grinders can be powered by an electric motor, petrol engine or compressed air. The motor drives a geared head at a right-angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically have an adjustable guard and a side-handle for two-handed operation. Certain angle grinders, depending on their speed range, can be use*d* as sanders, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired. The time required for this operation is 20 minutes

**Welding:**

This method is used to weld square pipes of different lengths to make frame. The machine used for this operation is electric arc welding. Electrical arc welding is the procedure used to join two metal parts, taking advantage of the heat developed by the electric arc that forms between an electrode (metal filler) and the material to be welded. The welding arc may be powered by an alternating current generator machine (welder). This welding machine is basically a single-phase static transformer Suitable for melting RUTILE (sliding) acid electrodes. Alkaline electrodes may also be melted by alternating current if the secondary open-circuit voltage is greater than 70 V. The welding current is continuously regulated (magnetic dispersion) by turning the hand wheel on the outside of the machine, which makes it possible to select the current value, indicated on a special graded scale, with the utmost precision. To prevent the service capacities from being exceeded, all of our machines are fitted with an automatic overload protection which cuts of the power supply (intermittent use) in the event of an overload. The operator must then wait for a few minutes before returning to work. This welding machine must be used only for the purpose described in this manual. Read the entire contents of this manual before installing, using or servicing the equipment, paying special attention to the chapter on safety precautions. Contact your distributor if you do not fully understand these instructions. The time required for this operation is 120 minutes.

**Polishing:**
This technique is used to polish the welded joints with hand grinder using grinding wheel. The machine used for this operation is hand grinder. With refinement, grinding becomes polishing, either in preparing metal surfaces for subsequent buffing or in the actual preparation of a surface finish, such as a No. 4 polish in which the grit lines are clearly visible. Generally speaking, those operations which serve mainly to remove metal rapidly are considered as grinding, while those in which the emphasis is centred on attaining smoothness are classified as polishing. Grinding employs the coarser grits as a rule while most polishing operations are conducted with grits of 80 and finer. If polishing is required, start with as fine a grit as possible to reduce finishing steps. There is a wide range of grinding and polishing tools on the market and advice is available from ASSDA members to assist in particular applications. Polishing operations are conducted with the abrasive mounted either on made-up shaped wheels or belts which provide a resilient backing. The base material may be in either a smooth rolled or a previously ground condition. If the former, the starting grit size may be selected in a range of 80 to 100. If the latter, the initial grit should be one of sufficient coarseness to remove or smooth out any residual cutting lines or other surface imperfections left over from grinding. In either case, the treatment with the initial grit should be continued until a good, clean, uniform, blemish-free surface texture is obtained. The initial grit size to use on a pre-ground surface may be set at about 20 numbers finer than the last grit used in grinding, and changed, if necessary, after inspection. Upon completion of the initial stage of polishing, wheels or belts are changed to provide finer grits. Polishing speeds are generally somewhat higher than those used in grinding. A typical speed for wheel operation is 2500 metres per minute. The time required for this operation is 20 minutes.

## 4. SAFETY PRECAUTIONS:

The following points should be considered for the safe operation of machine
and to avoid accidents:

- All the parts of the machine should be checked to be in perfect alignment.
- All the nuts and bolts should be perfectly tightened.
- The operating switch should be located at convenient distance from the operator so as to control the machine easily.
- The inspection and maintenance of the machine should be done from time to time.

## 5. CONCLUSION

The human operated fork lift is developed which is operated with the help of rope & pulley and chain & sprocket arrangement in the system. This model reduces the human efforts. So, design is completed.
The speciality of the existing design is that no need of providing the counter weight for balancing since the load being lifted is transferred to the rare part of the structure though chain block being mounted on the ISMB which rests on the pipe frame.

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