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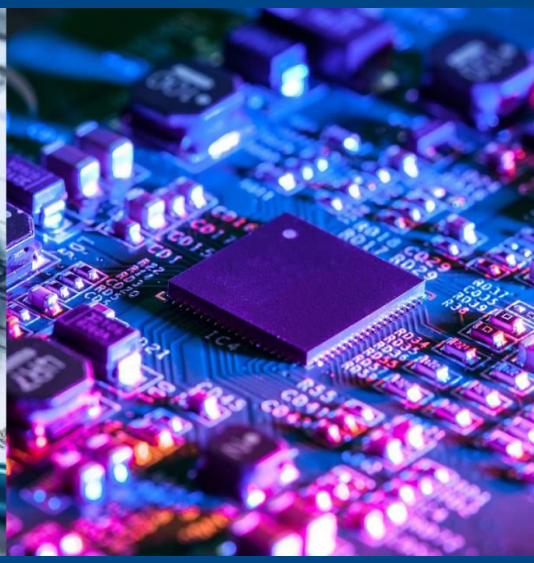

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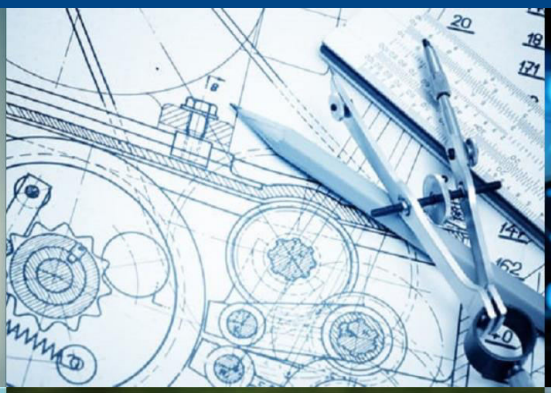

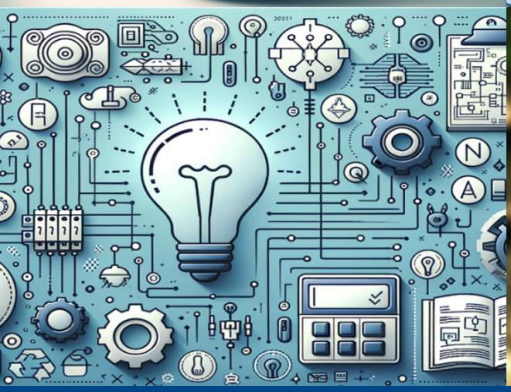

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Development of a Multifunctional Stand for an Impact Air Trench Trolley

M. Vigneshprabhu, T. Varunkumar, P. Jeevanandam, G. Maruthamuthu,

R.Vishnukumar, S. Rubinkumar

Department of Mechanical Engineering, P.A. College of Engineering and Technology, Pollachi,

Tamil Nadu, India

ABSTRACT: In this project, an air impact wrench trolley's multipurpose stand is designed and built with the goal of improving productivity and adaptability for use in industrial and automotive settings. The adjustable elements of the stand ensure maximum ergonomics and convenience of use by accommodating a range of wrench sizes and user preferences. Made of sturdy materials, it provides stability while in use and facilitates simple mobility thanks to its built-in wheels. The design process produced a novel strategy that puts functionality and safety first by involving a thorough investigation of user requirements and current solutions. Workflows in garages and workshops are streamlined by the multipurpose platform, which holds the air impact wrench and stores tools and supplies. Initial testing confirms the stand's efficacy in real- world circumstances by showing increased productivity and user comfort. This project promotes the integration of customizable features to satisfy a range of industrial needs, and it acts as a platform for future improvements and adaptations.

KEYWORDS: Ergonomic design, 360 Degree Rotatable, Height Adjustment, Easily Movable, Compact Design

I. INTRODUCTION

The development of a multipurpose stand for an impact air wrench trolley addresses critical needs within automotive repair and maintenance environments, streamlining workflows and enhancing operational efficiency by providing a dedicated, mobile platform for essential tools and equipment. Current automotive jacks are designed to lift heavy loads while maintaining a light and portable form factor (Haidon et al., 2020). Existing trolley jacks can be redesigned to enhance their capacity, lifting height, and stability through modifications such as incorporating a larger piston, a detachable extension rod, and a six-legged base, thereby improving their overall functionality and safety for automotive workers (Haidon et al., 2020). The design of such a stand should allow for both automated and manual workpiece exchange, accommodating various clamping systems, while maintaining a minimal overall height to reduce workspace constraints (Císar et al., 2017). The construction should be as simple as possible, and the pallet system must withstand maximal possible loads with minimal deformation (Císar et al., 2017). Hydraulic jacks offer greater efficiency compared to screw jack types, alleviating the stressful and vigorous spinning required by the latter. The integration of computer-aided design systems is essential for automating the jack design process, particularly for small enterprises that may lack the resources for extensive manual design and documentation (Аверченков et al., 2016).

The proposed multipurpose stand aims to consolidate the functionalities of tool storage, mobility, and accessibility, thereby reducing the time spent searching for tools and improving the overall organization of the workspace. It can accommodate various clamping systems (Císar et al., 2017). The design will incorporate features that enhance usability and safety, such as a stable base with locking casters, adjustable shelves and compartments for different tool sizes, and ergonomic considerations to minimize physical strain on the user.

The stand's structure will be designed to withstand substantial loads, ensuring durability and longevity in demanding workshop conditions. The primary aim is to create a system that is both automatable and compatible with other parts of a planned flexible manufacturing system, or as a manually operated system that can enhance the usability of machine tools for educational purposes, even if the FMS project is not fully realized (Císar et al., 2017).

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The development of such systems necessitates a deep understanding of hydraulic equipment design and production, along with the cooperative effort of a team of engineers, which can be challenging for smaller businesses (Аверченков et al., 2016). The redesigned workstation, featuring an adjustable chair, proper work height, strategically placed tools, and comprehensive operator training, significantly improves operator productivity and satisfaction (Das et al., 2007).

Increases in quantity and quality output can reach 22% and 50%, respectively, through improved jig and fixture designs, alongside comprehensive operator training that emphasizes quality (Das et al., 2007).

The high improvement in quality output could be attributed to the improved design of the jig and fixture and the comprehensive operator training method, which emphasizes the quality aspect of production output (Císar et al., 2017; Das et al., 2007).

To improve manufacturing and reduce costs, design for manufacture and assembly principles are employed, with simulation software used to analyze the integrity of the redesigned workstation (Sreerag et al., 2020)

II. EXISTING SYSTEM

An Impact Air Wrench Trolley is a mobile tool cart specifically designed for the storage, organization, and transportation of impact air wrenches and their related accessories, commonly used in automotive and industrial settings. Constructed from durable materials such as mild steel or aluminum, the trolley provides a stable yet lightweight platform for easy mobility. It typically features swivel castor wheels for smooth movement, with brakes for added stability during use. The trolley includes dedicated holders for the air wrench, tool trays, and compartments for accessories like sockets and bolts. To enhance functionality, some trolleys are equipped with integrated air hose management systems, allowing users to neatly store air hoses and prevent tripping hazards. Ergonomically designed handles and non-slip surfaces improve user comfort and safety during operation, while protective coatings, like powder coatings, guard against corrosion and wear

III. EXISTING SYSTEM DRAWBACKS

- It takes time to alter the working position because it can't be rotated in a full circle
- In this trolley, the height cannot be adjusted, so it can't be used for another vehicle.
- Additionally, the material weight is high, making it difficult to move from one location to another
- Limited Manoeuvrability the inability to rotate fully restricts the trolley's manoeuvrability, making it challenging to navigate tight space

IV. METHODOLOGY

- Conceptual Design
- Detailed Design
- Fabrication planning
- Fabrication and Assembly
- Testing Evolution
- Final Adjustment
- Deployment

V. DESIGN CONSIDERATION

Conceptual Design

This is the initial stage where the idea of the trolley is developed, and the basic concept of the solution is defined. It includes:

- **Problem Identification:** The need for a trolley to efficiently handle and transport an air impact wrench in a workshop setting.
- **Design Goals:** Establishing the primary goals such as mobility, durability, ergonomics, and stability.

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- **Sketches and Rough Designs:** Creating basic sketches or diagrams of the trolley concept, outlining the main features like the frame, handle, wheels, and mounting arm.
- **Brainstorming:** Considering various design alternatives, identifying key constraints (e.g., weight capacity, workshop conditions), and selecting the best solution

Detailed Design

Once the concept is finalized, the detailed design phase begins, focusing on precision and exact specifications. This stage includes:

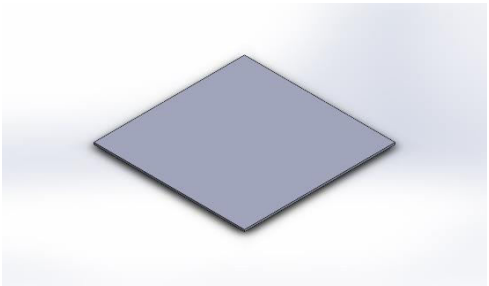
- **3D CAD Modelling:** Using software like SolidWorks or AutoCAD to create a detailed 3D model of the trolley assembly as shown in the Fig 7.2.
- **Material Selection:** Choosing the appropriate materials for each component based on strength, durability, and cost.
- **Engineering Analysis:** Conducting calculations such as load capacity, stress analysis, and stability assessments to ensure the design will perform as required.
- **Technical Drawings:** Creating technical drawings of each component, specifying dimensions, tolerances, and assembly instructions.

Detailed Design

VI. SELECTION OF COMPONENTS:

Base plate

The Base Plate is used to withstand the load and transferring that load into wheel gradually. The Robot chassis is made up of mild steel and withstands all the loads like Solid Shaft, Hollow Shaft, Hydraulic Stick, and Fixture for Pneumatic gun.



Base Plate

Rotating Wheel

When selecting a wheel, key factors include dimensions like diameter and width, which ensure compatibility. The material—rubber, polyurethane, plastic, or metal—affects durability, while bearing materials like steel or ceramic enhance smooth rotation. Load capacity, often up to 500 lbs, is crucial for performance. The rotation mechanism should allow for full 360-degree movement, supported by appropriate bearing types. Mounting options and plate sizes determine installation ease. Environmental resistance features, such as water resistance and temperature range, are vital

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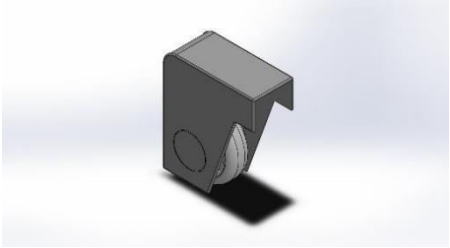
for specific conditions. Additional features like braking systems and tread patterns improve functionality. Lastly, certifications like ISO or ASTM ensure quality and safety standards are met.



Rotating Wheel

Solid Shaft

When fixed in a bearing, the mild steel shaft, with a diameter of 30 millimetres and a height of 300 millimetres, provides robust support and stability for transmitting power or motion. The solid design enhances strength, allowing it to handle significant loads without deformation. The bearing facilitates smooth rotation, reducing friction and wear, which is essential for efficient operation in machinery. Additionally, the ductility and weld ability of mild steel ensure that any necessary modifications or attachments can be easily made. Overall, this configuration optimizes performance in various industrial applications while maintaining reliability and durability.

Solid Shaft

Hollow Shaft

A 32 mm hollow shaft secured inside a larger solid shaft with a lock pin ensures robust connection and prevents relative movement, crucial for torque and axial load transmission. This design maintains rotational stability and alignment, making it ideal for applications like driven shafts and coupling mechanisms. The lock pin enhances structural integrity and reliability, ensuring consistent performance under operational stresses. Overall, this configuration is essential for durability in mechanical systems.

Hollow Shaft

Bearing F206

These bearings are used in various applications, including machinery and equipment, where support for rotating shafts is required. Always refer to specific manufacturer documentation for precise specifications and variations.

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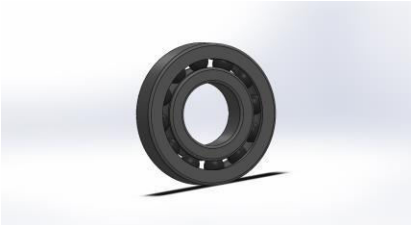
- **Inner Diameter**: 30 mm
- **Outer Diameter**: 62 mm
- **Width**: 16 mm
- **Material**: Generally made of steel, often with a zinc plating for corrosion resistance.
- **Seal Type**: Usually equipped with rubber seals on both sides to protect against contaminants.
- **Mounting**: Designed for easy mounting on a surface or a shaft, often with set screws or bolts.



Bearing F206

Hydraulic Stick

A hydraulic stick, or hydraulic actuator, is a device that converts hydraulic energy into linear mechanical motion, typically consisting of a cylinder, piston, hydraulic fluid, and ports. When hydraulic fluid is pumped into the cylinder, it exerts pressure on the piston, causing it to move in the opposite direction. This movement creates powerful and precise linear motion, making hydraulic sticks essential in applications such as construction machinery, automotive systems, and industrial equipment. Their ability to generate significant force with compact design and efficient control makes them invaluable in various engineering fields.

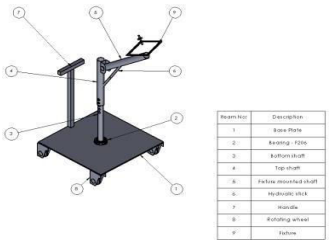
Hydraulic stick

Handle

A mild steel handle offers ergonomic positioning for easy pushing and pulling, ensuring operator comfort during use.

Handle

Design for Manufacture and Assembly:



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Detailed Design

Base and Wheel Assembly

1. **Identify the base plate** – This is the flat structure at the bottom of the trolley. It has pre-drilled holes where the wheels or casters will be attached.
2. **Prepare the wheels** – If the wheels or casters come disassembled, they will need to be attached to the corners of the base plate.
3. **Install the wheels:**
   - Place each wheel into the corner of the base where the holes are pre-drilled.
   - Insert the bolts through the holes in the base plate and the corresponding holes in the wheels.
   - Tighten each bolt securely using a wrench or Allen key. Ensure the wheels rotate smoothly and are properly attached.
   - Double-check the stability of each wheel by giving the base a slight push.
4. **Check mobility** – Once the wheels are attached, place the base plate on the floor and make sure it rolls smoothly without wobbling. The base should now be mobile.

Installing the Vertical Post

1. **Position the post** – The vertical post (the main pillar) should be positioned at the centre of the base plate. There is likely a mounting point or pre-drilled hole for the post to be inserted or attached.
2. **Attach the post:**
   - Slide the bottom of the post into the base's mounting point or hole.
   - Align the pre-drilled holes on the base and the post to make sure everything lines up.
   - Insert bolts through these holes and tighten them securely using a wrench or Allen key. This step ensures that the post is firmly attached to the base.
   - Ensure the post is upright and stable before proceeding. If the post wobbles, tighten the bolts further.

Attaching the Handle

1. **Identify the handle** – The handle is likely the U-shaped structure seen at the back of the trolley. This part is essential for pushing or manoeuvring the trolley around.
2. **Position the handle** – The handle will either attach to the vertical post or the base itself. Based on the image, it appears the handle is connected directly to the base near the back.
3. **Attach the handle:**
   - Align the bottom of the handle with the pre-drilled holes on the base or sides of the trolley. Make sure the handle is centered and straight.
   - Insert bolts through the handle and into the base or post. Tighten these bolts with a wrench or Allen key until the handle is securely fixed in place.
   - Ensure the handle doesn't wobble or move after tightening.

Attaching the Adjustable Arm

1. **Identify the adjustable arm** – This is the arm that extends outward from the vertical post. It is designed to hold a tool or air impact wrench.
2. **Position the arm** – The adjustable arm should be attached to the vertical post at your preferred height. Depending on the design, the arm can likely be mounted higher or lower on the post.
3. **Attach the arm:**
   - Align the holes on the arm with the corresponding holes on the vertical post.
   - Insert bolts through these holes and tighten them using the necessary tool. If the arm is adjustable, you may only want to lightly tighten the bolts until you set the exact height.
   - Once you have positioned the arm at your preferred height, fully tighten the bolts to secure the arm.
   - The arm may also have additional mechanisms (like a pivot or locking mechanism) to help it adjust up or down. Ensure that these parts are working smoothly.

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Attaching the Tool Holder

1. **Identify the tool holder** – This part is likely located at the end of the adjustable arm. It is meant to hold the air impact wrench or other tools.
2. **Attach the holder:**
   - Slide the tool holder onto the end of the adjustable arm.
   - Secure it with screws or bolts, making sure the holder is tightly fixed.
   - If the holder is designed to rotate or adjust, make sure the mechanism is working smoothly and that the tool can be easily placed and removed.

VII. WORKING PRINCIPLE

The Air Impact Wrench Trolley is designed to enhance mobility, support, and ease of use for air impact wrenches in industrial and automotive settings. Its base features wheels that allow effortless movement across the workspace, eliminating the need to carry heavy tools.

The adjustable arm securely holds the wrench at a customizable height, ensuring ergonomic comfort and reducing strain during operation. A tool holder at the end of the arm keeps the wrench easily accessible, while the trolley's sturdy construction provides stability and balance. When in use, the technician can easily manoeuvre the trolley to their desired location thanks to its wheeled base. Once positioned, they can adjust the height of the arm using the hydraulic stick, ensuring optimal ergonomics. The air impact wrench is then securely held in place by the fixture, allowing for efficient operation without unnecessary physical effort.

Overall, this combination of features allows for a streamlined workflow, enhancing productivity while minimizing physical strain on users in industrial and automotive environments.

VIII. RESULTS AND DISCUSSION

The Air Impact Wrench Trolley consists of several key components that enhance its functionality and efficiency. The base plate provides stability, while the Bearing - F206 ensures smooth movement of the shafts. The bottom shaft supports the adjustable arm, and the top shaft allows for height adjustments. The fixture mounted shaft securely holds the air impact wrench, and the hydraulic stick facilitates easy height changes. A handle aids in manoeuvring, and rotating wheels ensure mobility across surfaces. Finally, the fixture keeps the wrench secure and accessible, promoting safety and efficiency in industrial and automotive settings.

In existing trolleys, the overall efficiency is around 65%. However, the output in our developed trolley is around 85%, which is 5% higher than our expected output of 80%. This increase was determined after fieldwork, where we calculated the trolley's moving time and speed over a full day's working hours in the field.

X. CONCLUSION AND FUTURE SCOPE

The project focused on developing a portable and mobile solution for managing tools marks a significant advancement in workplace efficiency, safety, and ergonomics, particularly in industrial and automotive settings. The developed trolley achieved 85% efficiency, surpassing the expected 80%. This 5% improvement was determined through field testing, by measuring moving time and speed over a full day's work. One of the primary goals of this design is to enhance ergonomics by allowing workers to easily move heavy tools. This feature is crucial in environments where manual handling is prevalent, as it helps reduce physical strain and fatigue. By minimizing these common issues, the design not only lowers the risk of injury but also contributes to a more comfortable and productive work experience.

In addition to ergonomic benefits, the solution significantly improves efficiency by enabling tools to be transported directly to the work site. This eliminates the need for manual carrying, which can be time-consuming and cumbersome. By streamlining the process of tool transportation, workers can save valuable time and focus more on their tasks at hand. This direct approach not only enhances productivity but also fosters a more organized work environment, as tools are readily available when needed.

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Safety is another critical aspect of this innovative design. The solution ensures that tools are securely held during transport, significantly reducing the risk of dropping or mishandling them. In industrial settings where accidents can have serious consequences, this feature is essential for maintaining a safe working environment.

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