| DIE SET | JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY  DEPARTMENT OF MECHATRONIC ENGINEERING  EMG2440  MANUFACTURING TECHNOLOGY  PROJECT PROPOSAL  JUMA JOEL MWIMALI  ENM221-0060/2017  KIPNG’ENO ERICK KOECH  ENM221-0068/2017 |
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# Abstract

# Introduction

Among the significant advances in civil engineering, developing construction parts in pieces and sliding them together is being widely adopted especially when construction is on a busy site, and sometimes due to extreme urgency for the completion of the project. This approach allows for modularization and distribution of the project modules. However, it also introduces complexity to the project as such parts weigh hundreds of tonnes. Sliding such constructions into place requires a standard piece of engineering. This project proposes a viable solution to this problem. It proposes a slight modification of a caster wheel by setting the caster angle to zero, eliminating bearings, and using high-strength materials with a yield strength of at least 241MPa.

## Design

Fig 1.1 Design assembly

# Design selection process

## Caster angle

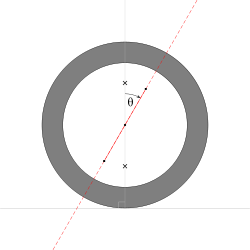


Fig 2.1 Caster angle

Caster angle is the slope of the imaginary line that intersects the upper and lower steering pivot points, viewed from the side. A conventional caster wheel e.g on shopping carts, hospital beds has a positive caster angle of about 150. This provides align torque which improves the straight-line stability of the object. However, it also introduces a limit to the amount of weight the wheel can support.

Setting the caster angle to zero in a die set allows the die set to support up to hundreds of tonnes of load since the load is directly transferred to the patch area.



Fig 2.2 Neutral caster angle

## Material

Heavy-duty caster wheel uses polyurethane(PU) with a yield strength of 0.01-0.07 MPa, and some, cast iron with a yield strength of less than 100 MPa. This can only be used to carry loads whose weight is a fraction of the weight of a single construction piece.

The following materials were chosen for the respective parts as shown in the table below:

| Part number | Part | Material | Yield strength |
| --- | --- | --- | --- |
| 1 | Top plate | Malleable iron | 245MPa |
| 2 | Axle | Carbon Steel | 525MPa |
| 3 | Axle support | Malleable iron | 245Mpa |
| 4 | Wheel | Malleable iron | 245Mpa |

This selection provides enough strength and capable of supporting up to hundreds of tonnes of load.

## Bearings

A conventional caster wheel uses bearings between the axle and the wheel. This ensures smooth motion and increases the life span of the wheel and the axle. The choice of the bearing depends on the external diameter of the axle and the internal diameter of the through-hole in the wheel. This also limits the crush strength of the bearing since the smaller the bearing, the lower the crush strength. A 1 ½ inch bearing has a crush strength of 122400 pounds (848MPa) but cannot fit into the design.

A temporary solution to this was to use a carbon steel axle, and a malleable iron wheel. There is also clearance of 2mm between the two. This ensures the die set can support loads of up to hundreds of tonnes.

# Assembly

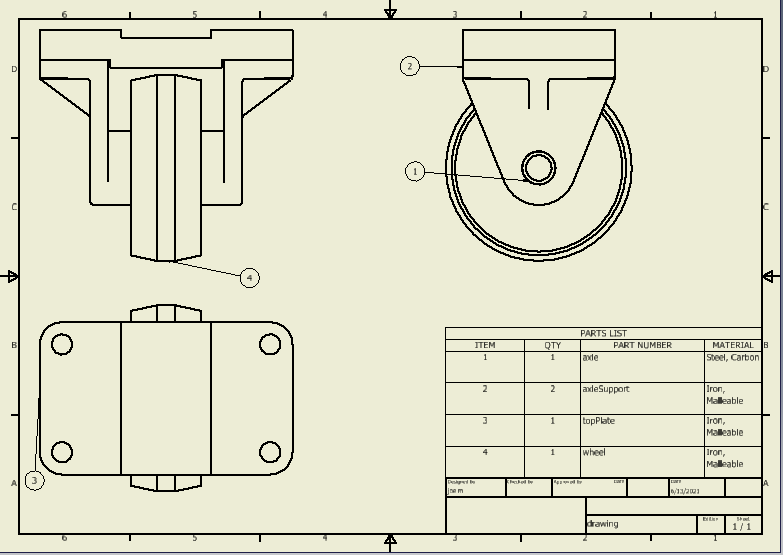


Fig 3.1 Assembly drawing

The above illustrates the final die sets assembly presented in projected views, showing how the parts fit together. Individual components (axle, axle support, wheel, and the top plate) have also been identified with balloons and the leader lines. The parts list on the bottom edge relates to the balloon numbers on the drawings.

The die sets incorporate a wheel that is mounted on stationary axle support. The orientation of the axle support and the top plate which is fixed relative to the body that is attached to is determined when the whole die set is if fixed to the vehicle. The axle support firmly supports the wheel in its position to prevent wobbling which may be fixated to the top plate by riveting.

## Die set (parts and dimensions)

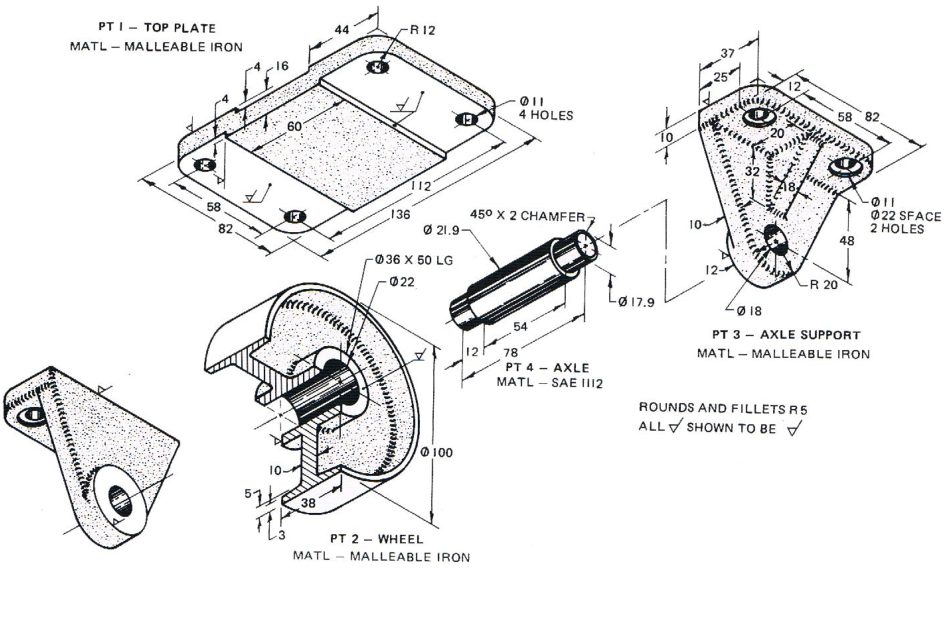


Fig 3.2 Exploded drawing

# Conceptual Design

## Wheel

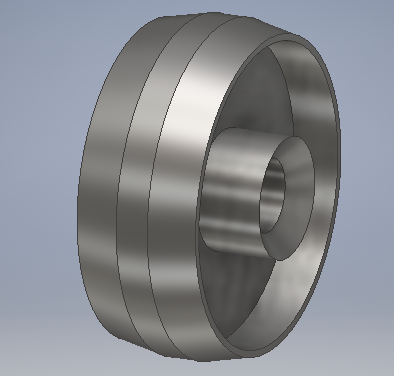


Fig 4.1 wheel

The machining of the 100mm diameter wheel will involve 2Dmilling operations, drilling, boring, chamfering, and finally on turning. Turning will be employed to reduce the originally rectangular stock into a cylindrical-shaped body and to the required dimensions (100mm). 2Dmilling operations specifically facing will be used to reduce the overall length of the wheel to its required size (38mm). Since we lack a 22mm drill bit, the drilling operations will first be done using a smaller diameter drill bit then boring afterward to come up with the required size.

## Top Plate

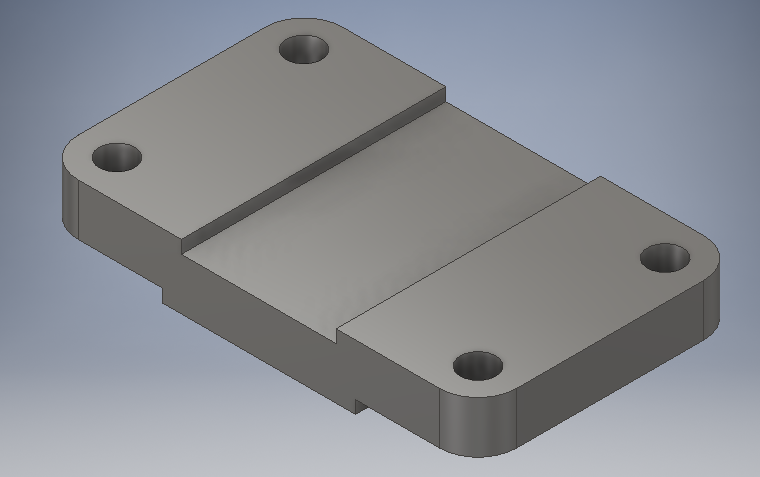


Fig 4.2 Top plate

It is a 136mm by 82mm rectangular block with four 11mm drilled holes. The machining process of the stock will involve milling operations on the surface, specifically 2D milling operations in this case facing operations to reduce it to the required standard size. Adaptive milling, which allows users to rough a volume of material by using an adaptive cut pattern, is also applicable in drilling the four 11mm diameter holes and both the middle and the bottom section. A 10mm diameter flat mill can be used to perform the adaptive milling operations and the drilling of holes while a 50mm diameter face mill to do the facing operations.

## Axle

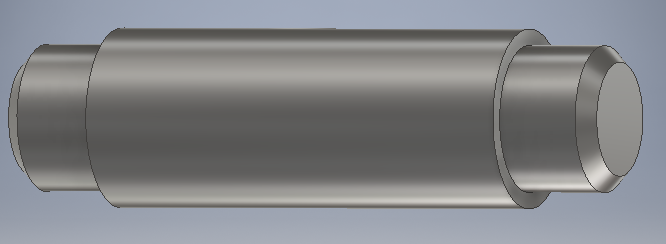


Fig 4.3 Axle

The axle is 78mm long with 21.9 mm outer diameter and 17.9 inner diameters. The chamfers on the side are 450\*2mm in dimensions. The machining of the stock which is originally rectangular will involve turning operations, facing, chamfering, and profiling. Facing at both ends will reduce the original block to the required size (78mm) while the turning operations are necessary to reduce the rectangular block into a cylindrical-shaped body with a 21.9 outer diameter. A 10mm diameter face mill may be used for the facing operations while a right hand, neutral or left hand turning tool may be used for the operations.

## Axle support

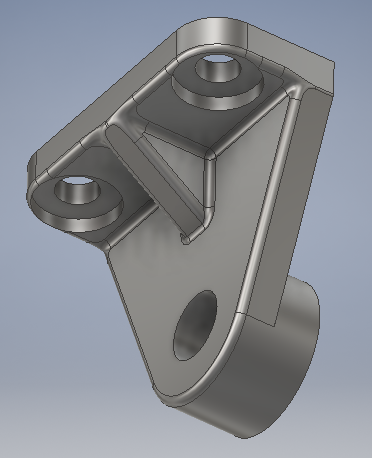
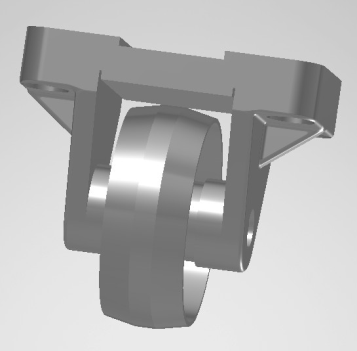
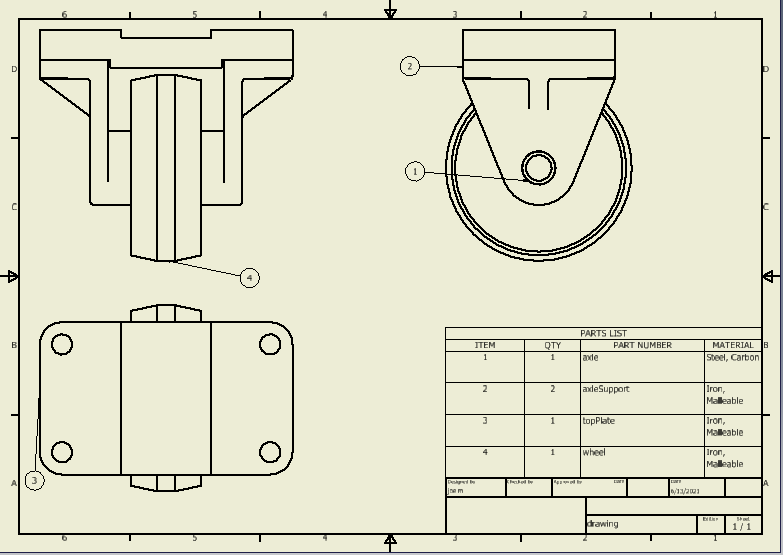


Fig 4.4 Axle support

The axle support supports the wheel in a fixed position. The stock is originally 78mm by 82mm by 37mm and will involve 2D milling operations, 3Dmilling operations in this case adaptive milling, profiling, and drilling operations, to bring the originally rectangular stock to the desired size and shape. Adaptive milling will be generally employed on the whole stock



Design Assembly



Assembly drawing

# CAD/CAM softwares

## CAD: Autodesk Inventor (version 2020)

* Enhanced user interface and work flows: streamlined part modelling, smart sketch profile detection, multi –monitor app frame and a modernized look and feel.
* Command UI and productivity enhancements: a fix on the hole command in inventor 2019
* Performance improvements: 3D section few is improved, for large assemblies, Open or Close performance is improved, Part files with improved DXF or DWG files open faster.

## CAM: Autodesk Inventor CAM plugin (version 2020)

* Up to 5-axis milling
* Probing – it automatically avoid collisions between the part and the tool holder during CNC calculations
* Adaptive 2D and 3D milling – Combines all the surfaces with the same milling operations, and defines the best tool entry and tool path for itself.

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