REVERSE ENGINEERING OF GEOMETRIC COMPASS

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Abstract - *Mathematicians have used a variety of methods to draw several different shapes of geometrical figures since the beginning of time. A ruler, a compass, and a protractor are the instruments used. These three methods haven't changed much in terms of features over the years. Even though the world has changed dramatically as a result of technological advancements, the resources do not receive much attention. In geometry drawing and drafting, a compass is used to draw arcs, circles, and other geometrical patterns that can be calculated by measuring intersecting line segments. Equal lengths are also marked with a compass. Geometric compass is widely used everywhere such as in schools, colleges etc. By using Reverse Engineering technique, the problem in the compass is identified as the usage of scale, which is needed for measuring of radius every time. In absence of scale, it is difficult to draw arcs. So, in our invention, scale is attached along with the compass, so its requirement is not needed every time. So, time consumption is less and also drawings can be drawn with dimension even in the absence of scale effectively.*

Key Words: Geometric Compass, Reverse Engineering, Slot mechanism, String Mechanism.

1. INTRODUCTION

Manufacturers are in a tight fight due to the dynamic nature of today's industry. To win the race, products need a shorter lead time and more functionality. In such an inconsistent domain, the loss must be minimized by reducing waste. Manufacturers should adapt lean manufacturing to achieve this. Traditional production methods are inefficient in this case because they result in work-in-process inventory and are unsuitable for producing small orders. Reverse engineering and rapid prototyping are two processes that can help us overcome some of these issues. In this paper, a geometric drawing compass is reverse engineered and new design is obtained.

Compasses [5] are drawing devices that have been used to calculate distances, switch lengths between drawings, and draw circles since antiquity. In Elements of Geometry [1], the Greek mathematician Euclid [2] restricted the constructions to those that could be achieved with an unmarked straightedge and a rudimentary compass. Unlike ordinary rulers, the straightedge is infinitely long but has no markings and only one straight edge. It's only good for drawing a line segment between two points or extending an existing one. The compass can be opened to any size, but it lacks markings (unlike some real compasses). Just two points can be used to draw a circle: The Centre and a point. The pencil is inserted and clamped in a way that the point of the pencil is in contact with the compass sharp edge in the other arm [7]. If the compass is not drawing a circle, it may or may not collapse. Actual compasses do not fall, and this aspect is often used in modern geometric constructions. Before the eighteenth century, every drawing compass had a needle instead of an ink, which scratched the paper. Drawing compasses [6] were commonly used in the world by the twentieth century.

Though the use of drawing compasses has decreased as a result of the advent of computer assisted design software, or CAD, it continues to be used in schools and colleges to teach technical drawing and geometry [8]. The drawback is that compass cannot be used as an independent component as it always depends on scale (measuring instruments) to obtain dimensions so that its accuracy can be obtained. To overcome the dependency on scale, a customized scale is attached along the left arm of the compass and so we get the dimensions every time effectively.

2. METHODOLOGY

The Reverse Engineering method [4] gets its name from the fact that it involves going backwards through the design process. However, you may have little understanding of the engineering methods used to create the product. As a consequence, the task involves disassembling the product piece by piece in order to gain a working understanding of the original design. Reverse engineering aids in acquiring the geometry of a component or substance that would otherwise be unavailable. When the original blueprints have been lost or destroyed, reverse engineering may be the only option for bringing those items back to life. If you can get a working model of an existing model, you can typically trace the design steps and use that knowledge to build a new model, fix a component, or develop future products. CAD and CAM play a vital role in reverse engineering concepts in order to check the feasibility of the optimized component. The reverse-engineering method involves taking measurements of an entity and then reconstructing it as a three-dimensional model.

Reverse engineering [9] is the method of dismantling a man-made structure in order to discover its designs, architecture, or derive information from it. The reverse engineering process concludes with the introduction of a new product into the marketplace. These new products are frequently improvements on the original product, with new designs, functionality, or capabilities. These products may also be variations of the original product for use with other embedded systems, such as various operating system platforms.

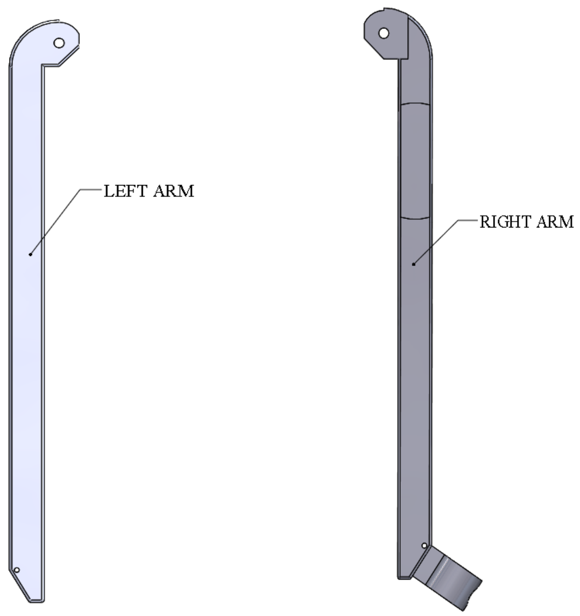
3. CONCEPT OF REVERSE ENGINEERING

Reverse engineering methodology [9] is used in the project for the following reasons:

1. Existing compass is deconstructed.
2. Parts are separated.
3. Dimensions of individual parts are measured.
4. The CAD model of the compass(with measured dimensions) is done by using Solidworks modelling software.
5. At last, the needed modifications are done on the compass model using Solidworks.
6. Several designs are attempted and discussed.
7. Finally, the suitable design is adopted and modelled.
8. Existing compass is deconstructed.

3.1. PRODUCT DISSECTION AND DRAWING

The compass which is globally used is disassembled piece by piece to obtain a working knowledge of the original design and parts are separated. The dimensions of those components are measured separately using measuring components. By using CAD software, the design of each component is done and it is assembled to understand the working principle of compass effectively.



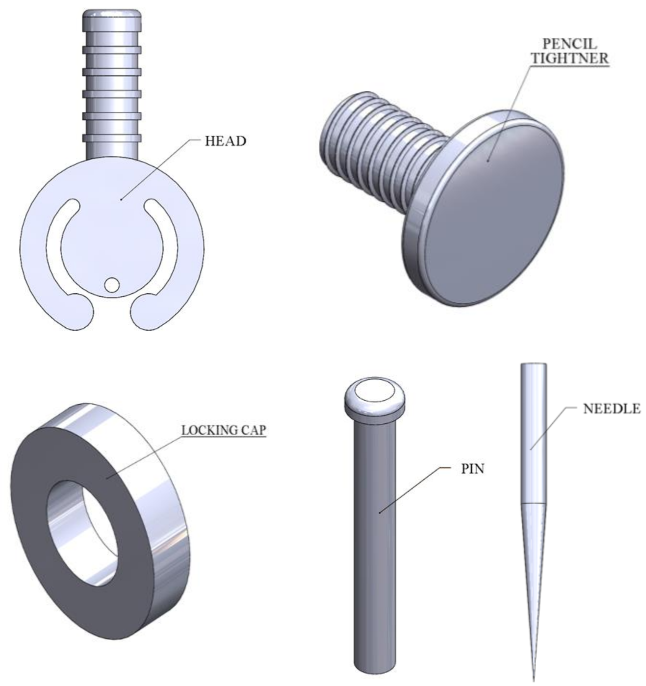


fig. 3.1.1 Parts of Geometric Compass (General)

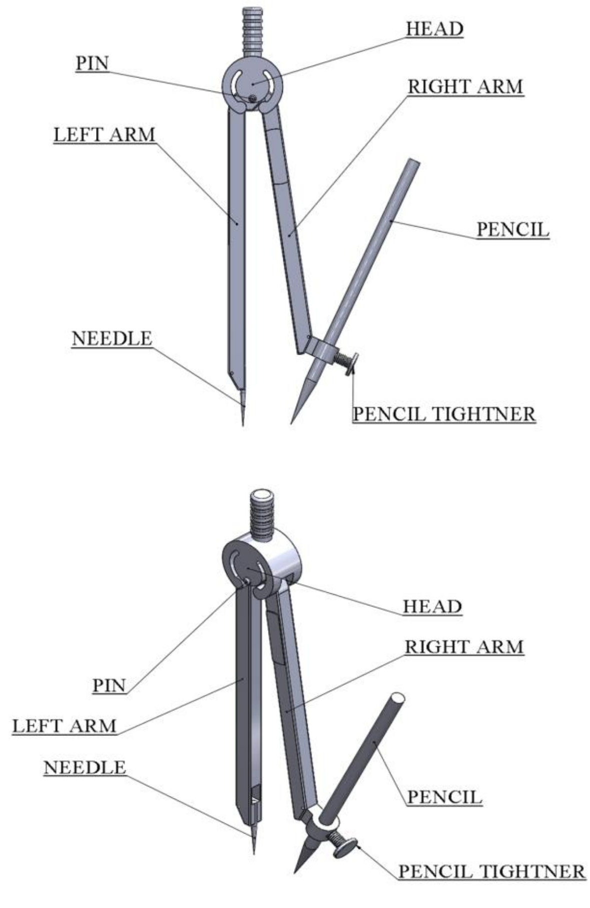


fig. 3.1.2 Assembled View of Geometric Compass (General)

3.2. Addiction of New Mechanisms

As the compass is reversed engineered, a new mechanism is added and so the compass doesn't need to depend on the ruler to measure the dimensions every time. Two mechanisms are taken into consideration is as follows:

1. Slot Mechanism
2. String Mechanism

3.2.1. SLOT MECHANISM

In this mechanism, a new component(follower) is introduced and one end of the follower is fixed in one arm and the other is moved along the slot in the other arm whenever it is elongated. Hence more dimension can be added and so this mechanism is used.

In this design the length of the compass is increased and so we get more length in the slot and so more distance can be achieved. Two new components are added namely:

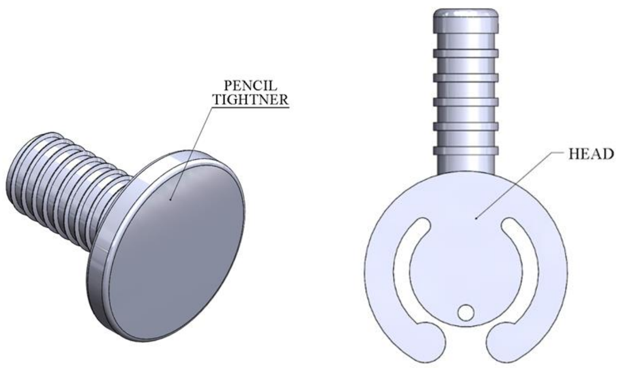
1. Follower
2. Indicator

FOLLOWER

Follower is attached and Slot mechanism is applied and so whenever the compass is stretched the follower moves downwards and the required dimensions can be achieved.

INDICATOR

Indicator is attached to the one end of the follower which is present in the slot. When the compass is elongated, the indicator which is present in the slot moves down and it indicates the output dimension which is marked as scale in that end.



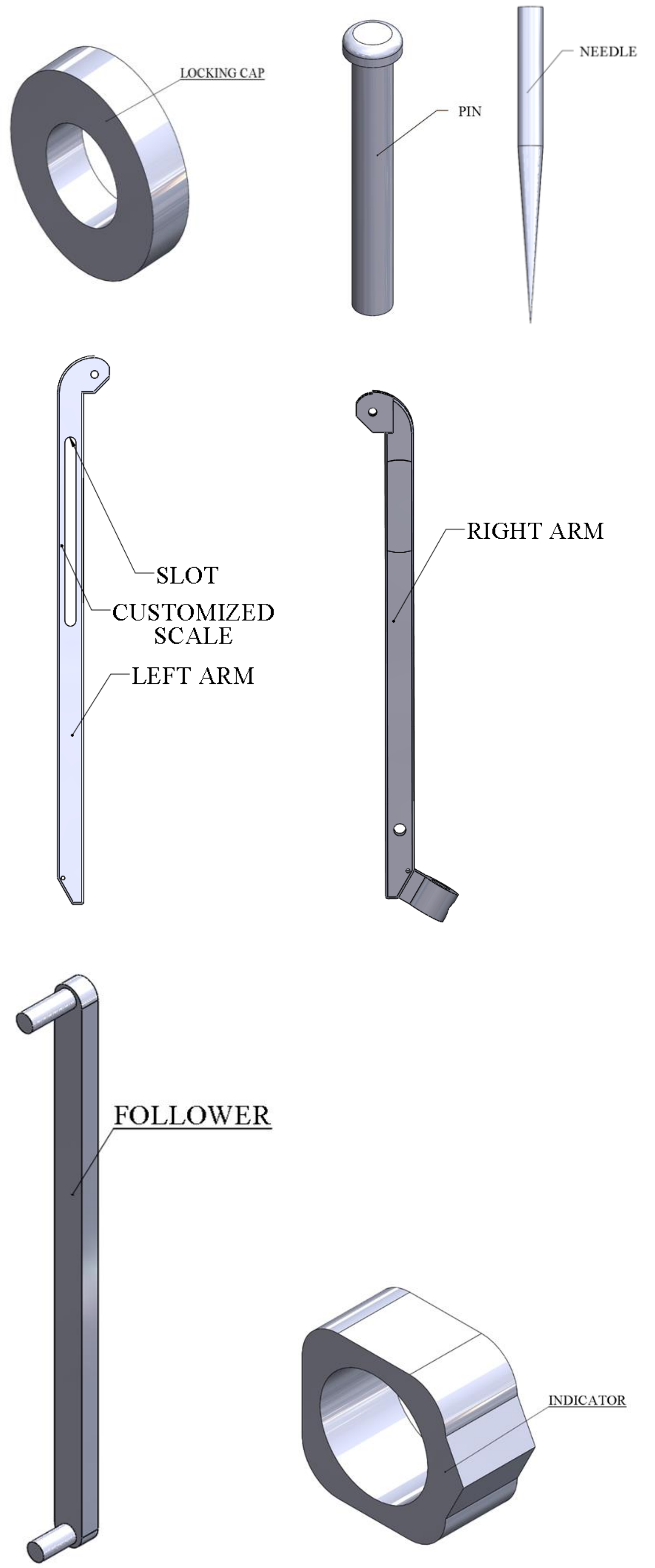


fig. 3.2.1.1 Parts of Modified Geometric Compass with added Slot Mechanism

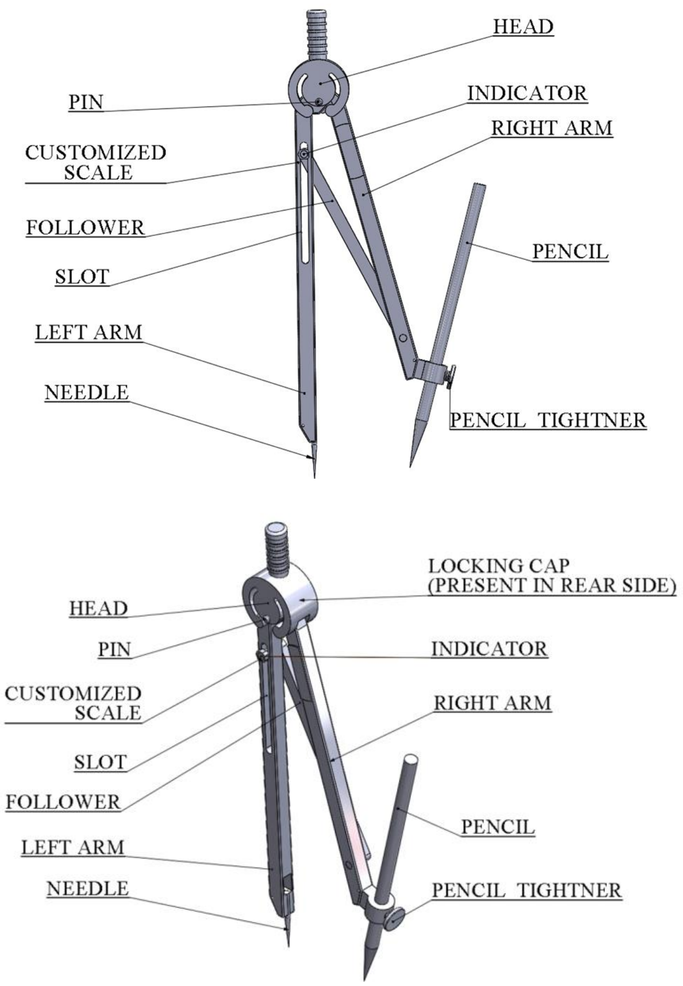


fig. 3.2.1.2 Assembled View of Modified Geometric Compass with added Slot Mechanism

3.2.2. STRING MECHANISM

In this string mechanism one end is attached to an indicator which is on the left and the other end is attached to the right arm. As like in the pulley when the right arm is stretched the string pulls the indicator and hence it moves in the left arm the dimensions can be measured and can be obtained. In this mechanism 2 components are added namely:

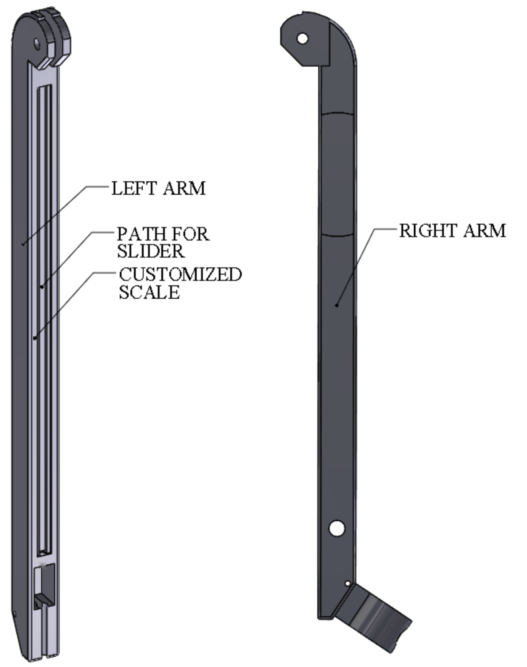
1. String
2. Indicator

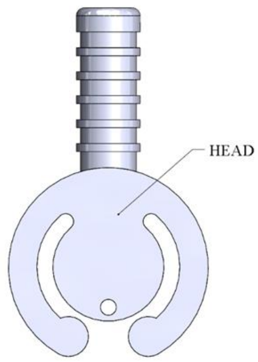
STRING

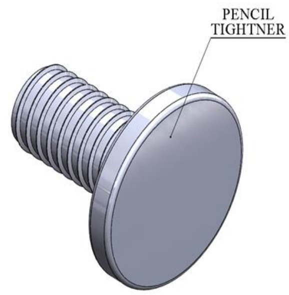
One end of the string is connected to the indicator which is present in the left arm. In the left arm, a cut is made and so the string may pass through that and join the other end in the right arm. When the right arm is stretched, the string pulls down the indicator as it is connected below. The indicator points the dimension and so it can be determined.

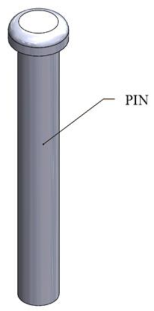
INDICATOR

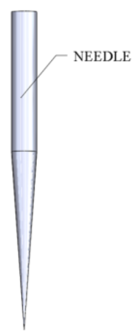
Indicator is fitted in the slot which is created in the left arm. The lower end is attached to the one end of the string. A customized scale* added on the left side to indicator. When the string is pulled, the indicator moves down and indicates the value in scale.











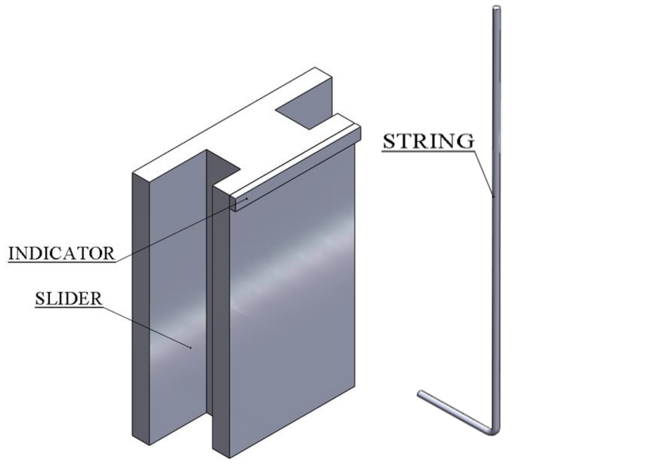


fig. 3.2.2.1 Parts of Modified Geometric Compass with added String Mechanism

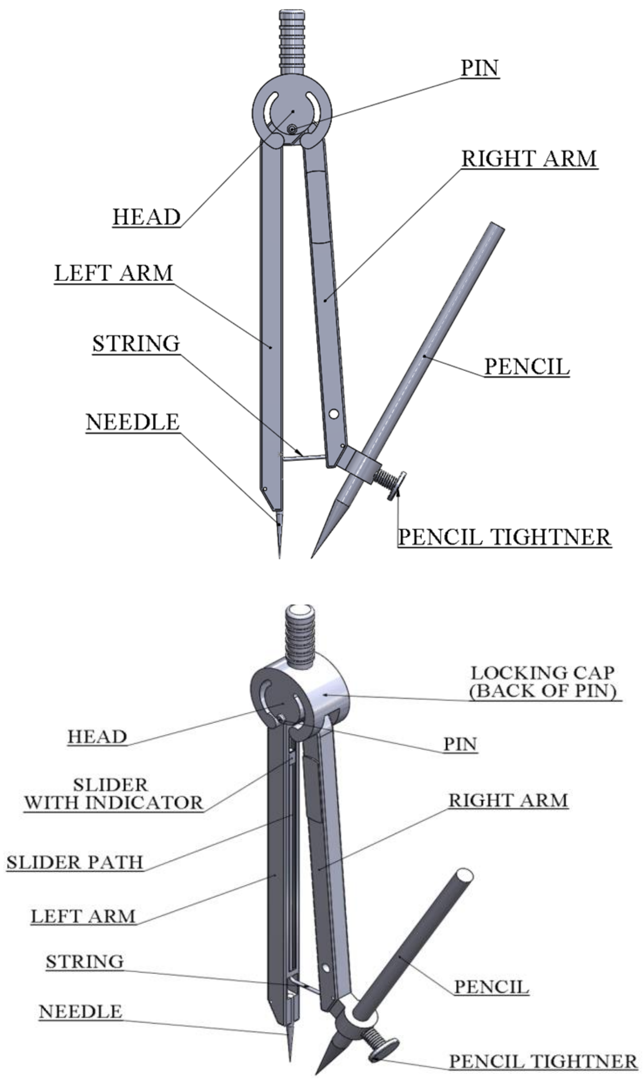


fig. 3.2.2.2 Assembled View of Modified Geometric Compass with added String Mechanism

4. CUSTOMIZED SCALE

In both the mechanisms, a customized scale is added. As the name indicates, a new scale is calibrated for these mechanisms and attached near the indicators. From our analysis and theory, when the right arm of the compass is stretched for 1cm apart, the string which is connected with the indicator pulls down and indicates the value greater or less than 1 depending upon the string material. thus, we need to calibrate the ruler which depends upon the material type of string to produce almost accurate results.

4.1. CALIBRATION OF CUSTOMIZED SCALE

From the below figure in string mechanism, when the distance between the tip of the needle and tip of the pencil is 1cm, the respective distance moved by the slider (i.e., A) should be marked as 1cm. By following this procedure all the values for the scale should be calibrated and markings must be attached as printed scale values near the indicator. The same procedure is followed for the slot mechanism also.

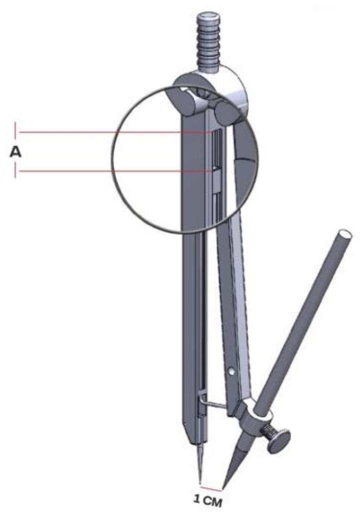


fig. 4.1.1 Indicates Method of Calibration

5. APPLICATIONS OF R.E. COMPASS

The need for a separate scale while using a compass is not required. This compass can reduce the time for measuring the dimensions in scale every time. The important properties of a compass include not just the ability to produce circles, but also the ability to indicate congruences [3]. Accuracy of dimensions can be obtained. Mainly it is useful in drawing machine components and engineering graphics efficiently.

6. CONCLUSIONS

Our project mainly focuses on optimization of compass to make a circular profile without the help of the Measuring scale. The aim is to reduce the time consumption while measuring the dimensions every time effectively. The concept of reverse engineering plays a vital role through which new mechanisms were added to the existing components and so it increases the application and advantages than the existing model. In this paper a new mechanism which was added is designed through CAD software which helps to visualize and develop the product. Reverse engineering can also be combined with rapid prototyping method to produce a model and helps in visualization and better interpretation of the final product.

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