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# Design of fixture for gear cover component machining on VMC

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**Abstract**
Gear cover is very important part of the gear transmission system, where the gear gets fixed inside firmly. It should be accurately machined with the acceptable tolerance. Also the fluctuations of dimensions in work-piece to work piece should be minimum so That it will be easier to assemble the gears inside the gear cover perfectly.
This casted gear cover component requires machining (Facing, Drilling, Tapping, Boring, Counter Boring operations as per the requirement at each faces) on four sides. At present the industry is utilizing 3 separate fixtures for machining of all four sides of the die casted Aluminium gear cover component. Due to this, the maintenance of accuracy of the machining becomes the burden on the operator to adjust the fixtures each time. This increase the setting time, handling time, tool change time. Also the cost per component increases.
The aim of this project is to design and development of a single new fixture connected to turret which replaces the old three fixtures for machining operation using designing software's i.e. Pro ENGINEERING, AutoCAD and analysis using ANSYS, which can eliminate the said problems. Also costing analysis is carried out by comparing old and newly designed fixture. The production rate will also increase up to 50% and cost per component machining decreases, which is quite objective.
Thus, we are designing the fixture for such gear cover component machining for 2-wheeler excel TVS vehicle.

**Keywords:** fixture, clamping, holder, turret, AutoCAD, pro e, ANSY**S**

## 1. Introduction
Fixture [1] – A fixture is a work piece holding device which is rigidly fixed using fasteners on to the machine bed. It has no special arrangements to guide the tool as in jigs. In a setup using a fixture, the responsibility of accuracy is dependent on the operator and the construction of machine tool. In fixtures, the method of clamping and locating should be such that it reduces the idle time to a minimum. Fixtures vary in design from relatively simple tools to expensive, complicated devices. In order to decide upon the location method, one has to consider the work piece shape, size, surface and features that are likely to affect obstruct the tool movement.
The correct position of the work piece essentially require restricting of all Degree Of Freedom of the work piece positively. Once a work piece is located, it is necessary to press it against the locating surface and hold it there against the forces acting upon it.

### 1.1 Elements of Fixture [2]
- Fixture Body – This is the main structural element of the fixture. This body is designed as per the dimensions of the required component that is to be machined. In our Design, we have provided the profile cut, that fits the gear cover component on to it. And the size of the fixture body must not be heavy so that it is easy to place it on to the machining bed.
- Clamps - It is necessary hold the work piece firmly against the forces acting upon it. This action refers to as Clamping and the mechanism used for this action is called Clamp.
- Locators - Fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part. For work-pieces of greater variability in shapes and surface conditions, a locator can also be adjustable.
- Supports – These are the elements that are provided on the fixture body to provide the required force against the deformation which are caused due to the action of clamping.

## 2. Fixture Design Steps
- Dimensional analysis of the Casted Gear Cover Component.
- Modelling of the component in 2D and 3D.
- Analysis of the time and cost of old 3 Fixtures that were used for machining earlier.
- Concept designing of the new fixture considering Design specification, Factory requirements, economy, ease of use and safety.
- Stress and deformation analysis using ASYSIS R16.2 Version.
- Final design and production.

### 2.1 Casted Gear Cover Component Design

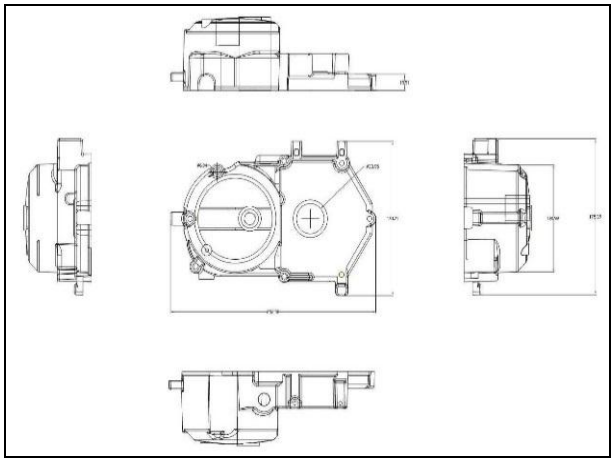

**Fig 1a:** Actual picture. **Fig 1b:** 3D model. **Fig 1c:** 2D AutoCAD Drawing.

### 2.2 Old Fixture Design

We have used Pro E and AutoCAD software to generate the old fixtures design.

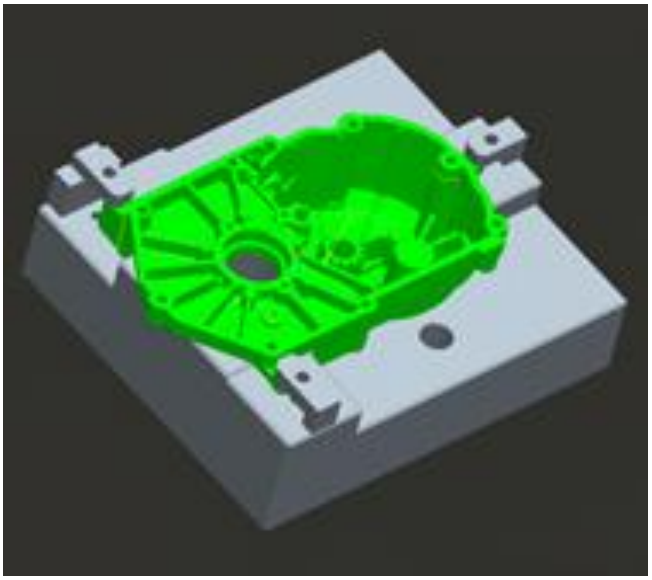

**Fig 2a:** First Fixture

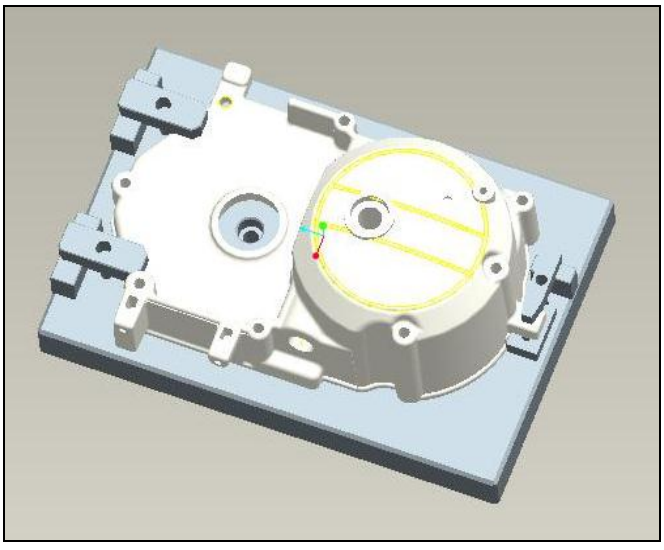

**Fig 2b:** Second Fixture

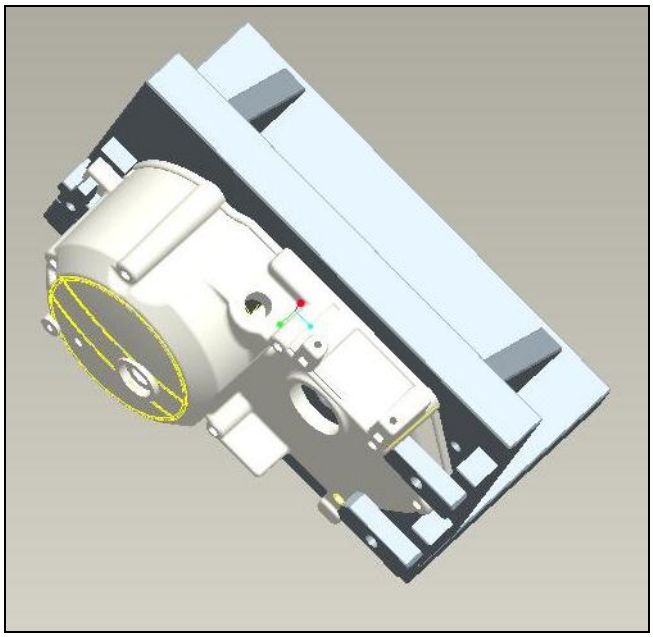

**Fig 2c:** Third Fixture

### 2.3 Disadvantages

- It consumes more machining cycle time.
- Since it use 3 separate fixtures the total fixture cost is high.
- Requires man power for changing the fixtures continuously which becomes a tedious job for a single component machining.
- If the machining is carried out only for one face of the component utilizing single fixture, then the inventory is required for the storage which adds the inventory cost.
- Idle time is high.

### 2.4 New Fixture Design

We have used Pro E and AutoCAD software to generate the new fixture design.

The fixture is placed on the fixture base profile cut portion. The force of facing, drilling, tapping and boring operations is withstood by the fixture base itself. When the turret is rotated by 90°, the 2nd phase operations i.e. drilling, tapping, spot facing is carried out. For this, the support on the opposite facing is provided to withstand this force. Again at the back

side i.e. at 180° from 1st face that is one counter boring operation is carried out. For this the clamping force of the clamps is enough to withstand the counter boring force.
This new fixture design utilizes the Turret connection for VMC. The turret is the element that is programmed to rotate the component by rotating fixture.

**2.5 Components of new design**

- Fixture Base – The fixture base provides base for building the other components and has the groves as per the component design.

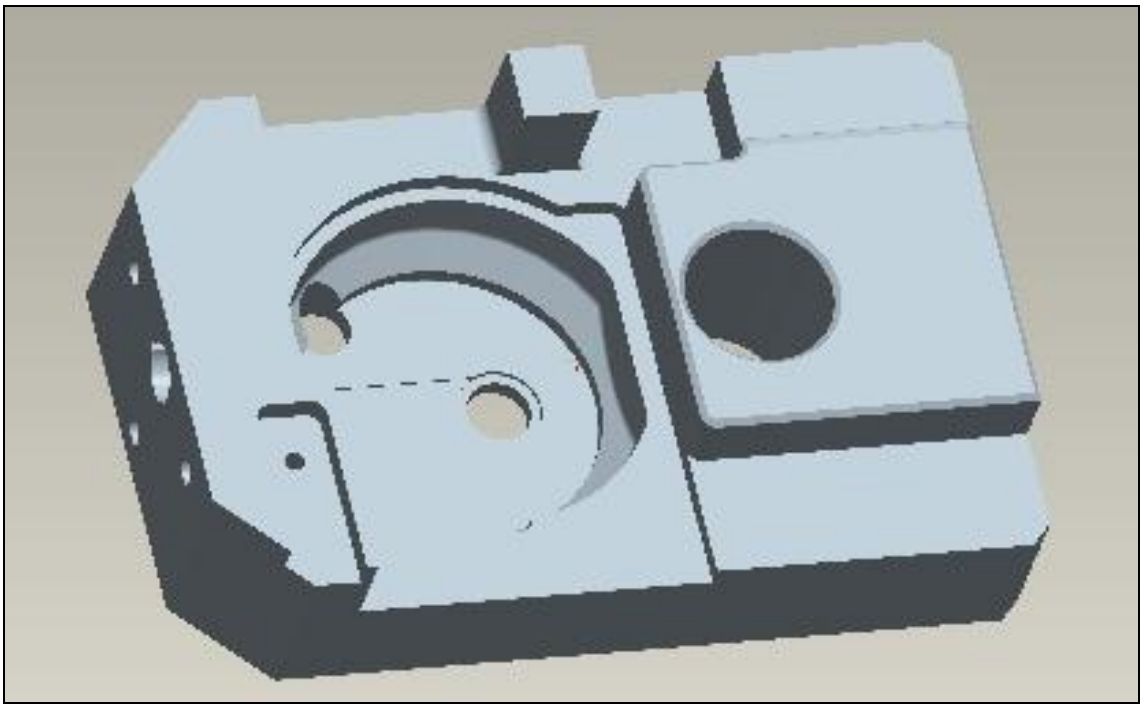

**Fig. 3a:** Fixture Base

- Clamps – The new fixture consist of 3 clamps which are mechanically clamped with the aid of spring force provided for the screw.

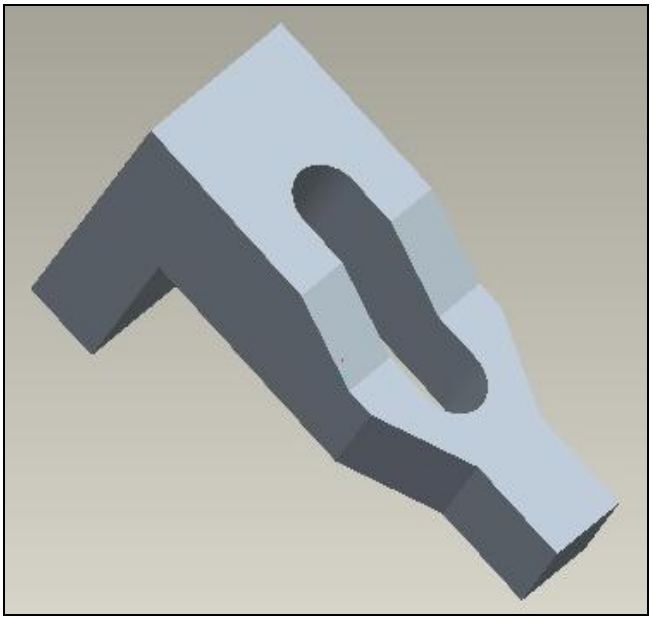

**Fig 3b:** Clamp

- Holder – This part is provided to attach the fixture body to the turret on one side and bearing on the other side. This part is provided with a flat surface on one side which helps to locate the fixture at the axis.

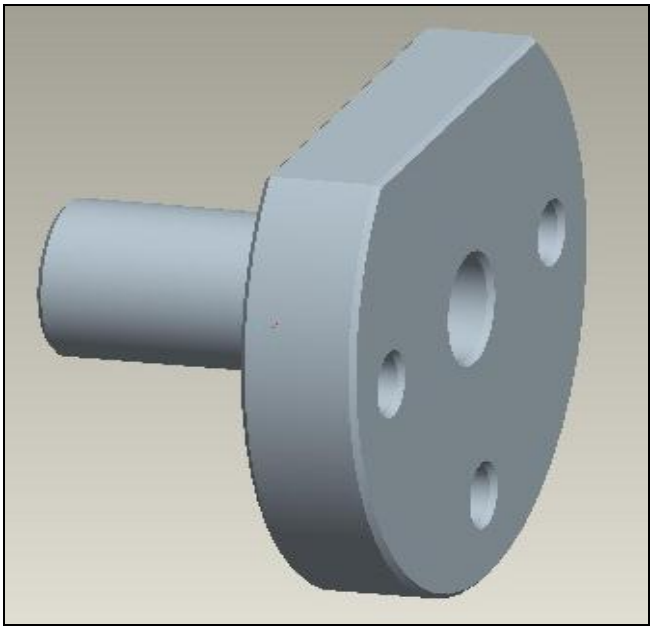

**Fig 3c:** Bearing side holder

- Locator – This element is used to locate the fixture part on to the bearing.

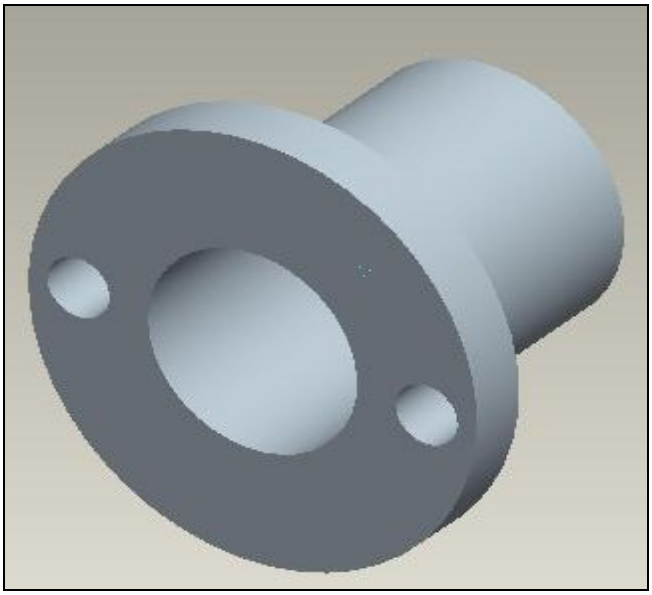

**Fig 3d:** Bearing Locator

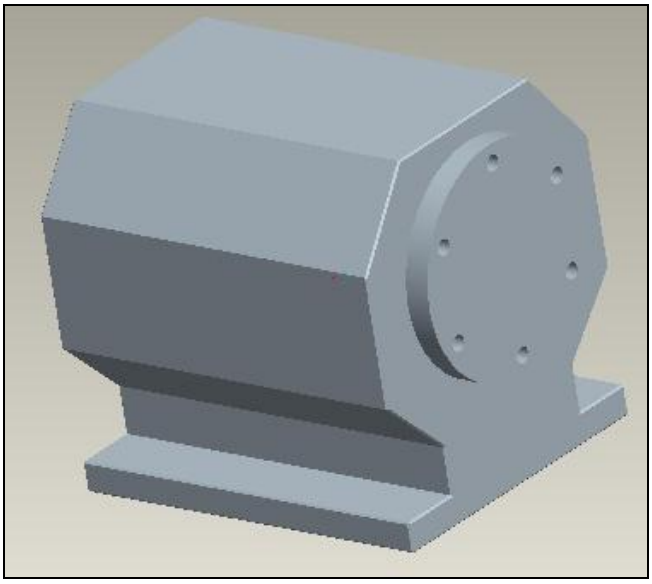

**Fig 3e:** Turret

- Turret – This is the programmable rotary part that provides required angular rotation of the fixture.
- Bearing – This is the fixture holding part. This is connected to the fixture and thus supporting the side opposite to the turret.

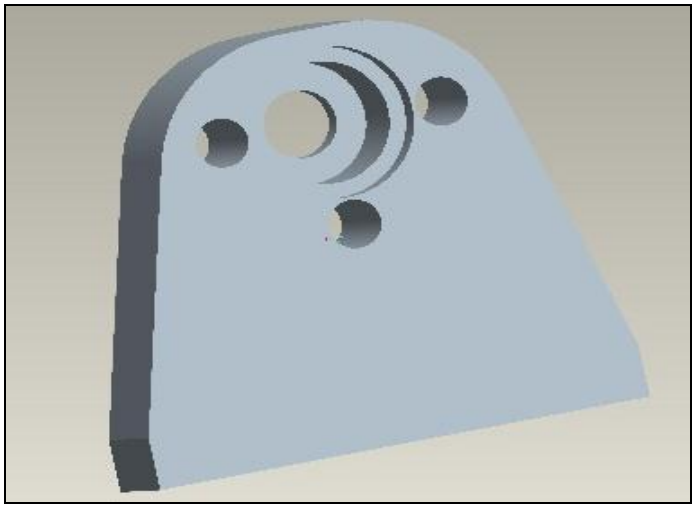

**Fig. 3f –** Bearing Bracket

### 2.6 Assembly

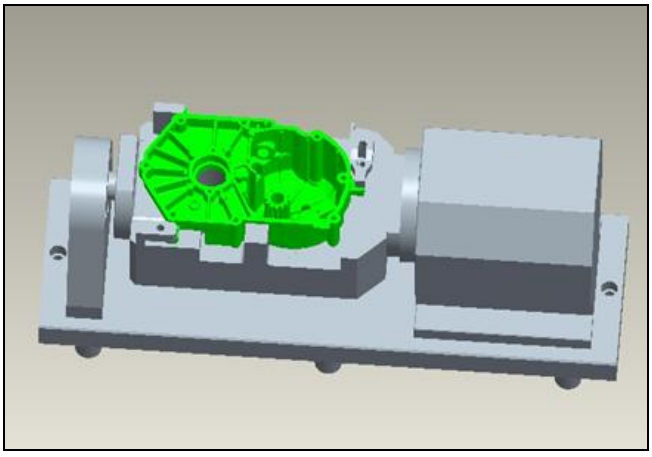

**Fig 4a:** Assembly without machine bed

### 2.7 Advantages

- Single fixture is used to carry out the complete all faces machining part.
- The cost of the fixture is reduced.
- The time requirement for clamping gets reduced to 1/3$^{rd}$ of the time which is being utilized at present.
- Completes all the machining process at single input of component.
- No idle time in between the machining operations.
- Cost per component manufacturing is less.
- The production rate is increased up to 50 %.

### 2.8 Final Design

The final design is included the new design and machine table. The final design eliminates all disadvantages in the old design and will enhance the production because the time is reduced. Also the cost per component manufactured decreases.

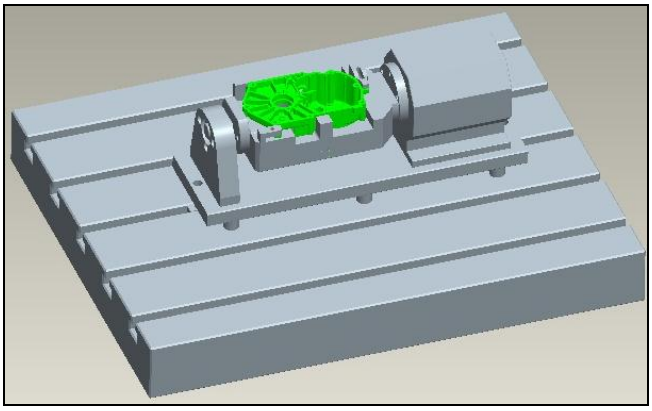

**Fig 4b:** Final design

## 3. Result and Conclusion

Thus we have designed a new single fixture which is to be replaced with the old 3 fixtures. The stress analysis is carried out for this design. And the factor of safety is 3.44.

We have analyzed the stress and deformation using ANSYS R16.2 Version. Including the body weight and machining load the maximum force acting on our fixture is considered to be 2000N.

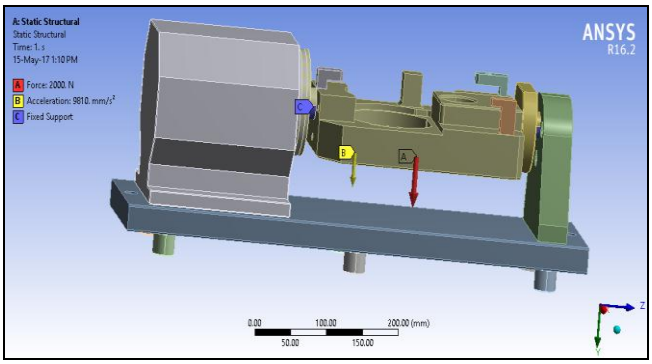


**Fig 5a:** Load condition

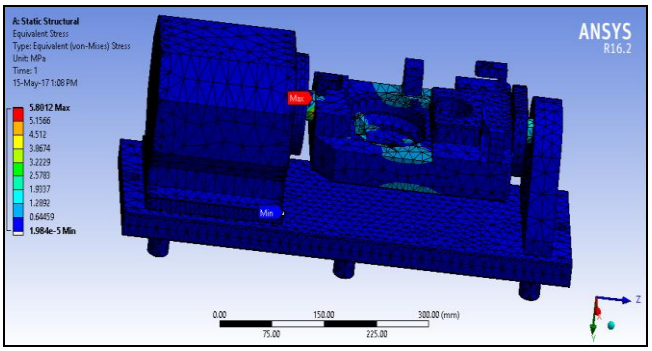


**Fig 5b:** Stress analysis

We are selecting the 20MnCr material for the manufacturing of this fixture. The yield stress is
200 GPa. From the ANSYS analysis we have obtained Von-Mises Stress/ Equivalent /Working stress as 58.012 GPa. Thus the factor of safety becomes:
Factor of Safety = Yield Stress / Working stress
FOS = 200 / 58.012 = 3.44

The maximum deformation with respect to the applied force is 0.048mm, which is very much less or negligible deformation.

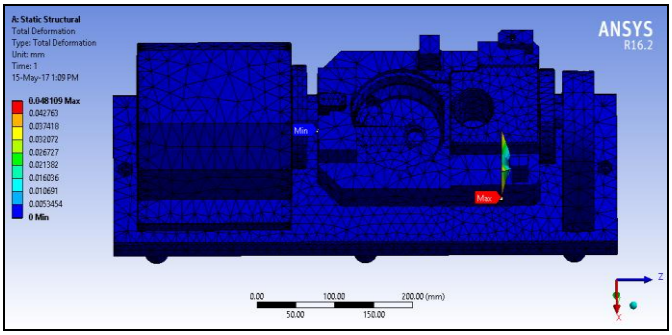


**Fig 5c:** Deformation of fixture

Thus our new fixture design is proved to be safe with factor of safety 3.44.

## 4. Acknowledgement

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