A MINI-PROJECT REPORT ON

# BOOTHROYD DEWHURST METHOD

Submitted by

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## i. ABSTRACT

The Boothroyd Dewhurst method involves by systematically looking at the part geometry and how they are fastened to estimate a time to put the different parts together. Then, adding it up and comparing it to a theoretical minimum part count (the fewer number of components we can have to build the product). From this we will get the ratio of the two to get an overall design efficiency. The actual number does not matter as it is intended as a benchmarking tool; as we have to improve the design you have some benchmarks or some comparison points so you know this design is better or worse than your previous design.

The Boothroyd Dewhurst method lets you pop up the level and think specifically about the assembly and makes to ask questions to yourself such as: **Do I really need two parts? Can I put them together with simple fit? It is those key insights that are important?** and so on. In our project, we have selected skating board as our product and have applied Boothroyd Dewhurst method. The skating board was dismantled for the mini project. Keeping the essential parts, re-designing of the component is done using Creo, 3-D designing is done. Non-essential part is minimized, and the assembly time is taken for both original and modified model. Assembly efficiency is found for the models and compared for showing the improvement in the modified model. As there is an increment in the assembly efficiency, it improves productivity, profit margin and other aspects of a manufacturing industry. With respect to the results found, graphs are represented. The original product had an assembly efficiency of 9% which through applying Boothroyd method, the modified model has an assembly efficiency of 13.6%. Thus, the increment is of 4.6%. This report consists of graph that represents the difference between the original and modified model of the skating board. Hence, satisfying the conditions of Boothroyd Dewhurst method and DFMA conditions

## ii. TABLE OF CONTENTS

## iii. LIST OF ILLUSTRATIONS

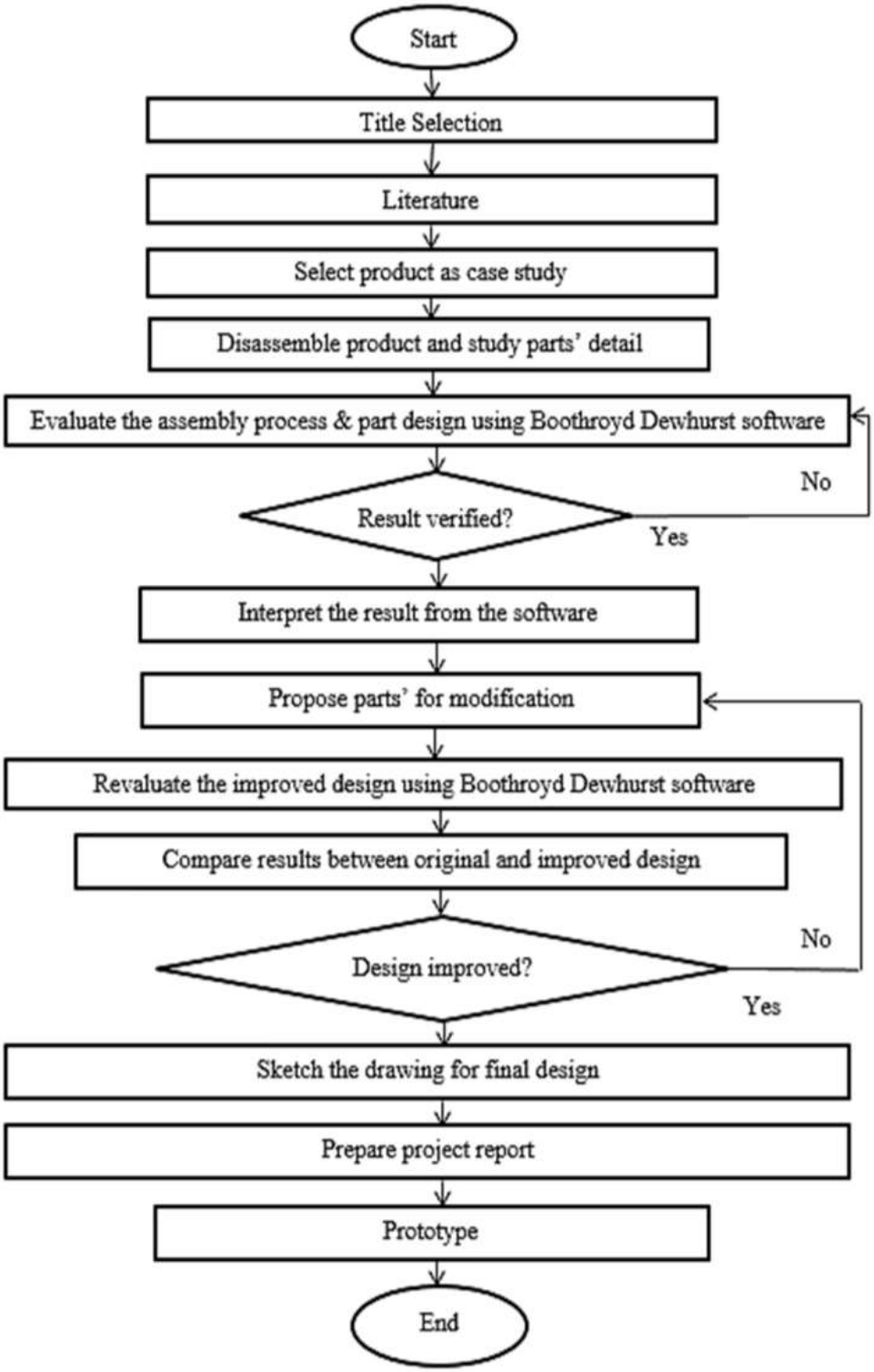
## 1.INTRODUCTION

The goal of this is to ease the assembly of products to reduce the assembly time. The comparison of the original and revised design of the products will help us with inputs and the revised edition or the new design will contain less parts, this leads to reduce the cost and assembly time as well as operations. The Boothroyd Dewhurst method benefits in this reducing the parts. This method is integrated into the product development and design team, as this involves a team that includes all the concurrent engineering disciplines and the stakeholders in the product designing phase. This method evaluates the product based on the design efficiency. The higher the efficiency, better the product.

## 2.EVALUATION

The number of parts of the product has significant effects to the design efficiency value. If the product has many parts, the assembly time will be higher. Higher the assembly time means lower design of efficiency. Moreover, assembly time is directly proportional to assembly cost.

**Fig.1. Flowchart**



## 3. STEPS TO APPROACH BOOTHROYD METHOD:

1. To determine the assembly sequence.
2. To segregate the essential and non-essential parts.
3. To create a tabular column containing all values.
4. To calculate assembly efficiency by using the formula.
5. Re-create a design keeping all essential parts in it and replacing non-essential parts with an effective part.
6. Tabulate and calculate assembly efficiency.
7. Compare both the efficiency.

### FORMULA INVOLVED

Assembly Efficiency (E) = $N_{min} \times \frac{t_a}{t_{tot}}$

Where,

$N_{min}$ = Minimum Number of essential parts

$t_a$ = Average assembly time = 3 seconds for manual process

$t_{tot}$ = Total assembly for component

### ALPHA AND BETA:

Alpha and Beta values tells how much degree a component should be rotated in order to reach the same insertion position. The sum of these two values helps to find the handling time of a component.

What is alpha?

It is the angle through which a component should be rotated in a axis perpendicular to the axis of insertion.

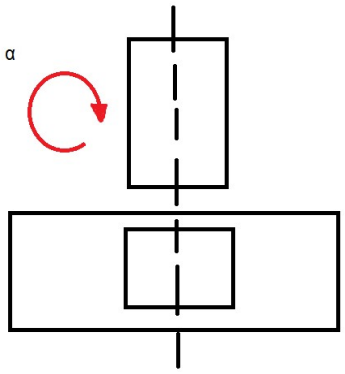



**Fig.2. Alpha Diagram**

What is beta?

It is the angle through which a part should be rotated about the axis of insertion.

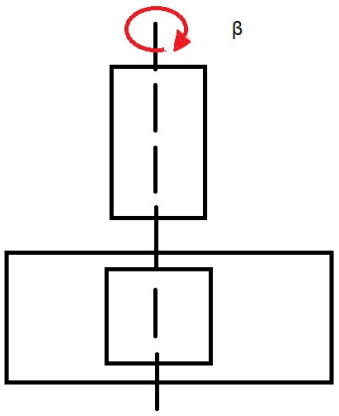



**Fig.3. Beta diagram**

**HANDLING TIME:**

This time is used to find the theoretical time while handling a part. With respect to the sum of the alpha and beta values and other parameters taking into consideration the time is chosen from the chart and every parameter have a code which is used to represent them and then this time taken accordingly and tabulated.

**INSERTING TIME:**

This time is used to find the theoretical insertion time of a component. This is taken with respect to the parameters in the chart and then the time is tabulated. This also have code for the representation.

## 4.EXPERIMENTAL WORK

**PRODUCT: Skating board**

PHOTO OF PRODUCT

**Fig.4. Skating board**

### STEP 1: TO DETERMINE ASSEMBLY SEQUENCES

The below numbers are based on the assembly sequence,

1. Board(x1)
2. Body connector(x2)
3. Small bolts(x8)
4. Small nuts(x8)
5. Truck (x2)
6. Spacer(x2)
7. Washer(x2)
8. Big bolts(x6)
9. Big nuts(x6)
10. Wheels(x4)

**STEP 2: TO SEGREGATE ESSENTIAL AND NON-ESSENTIAL PARTS:**

**ESSENTIAL PARTS:**

1. Board(x1)
2. Trunk(x2)
3. Body connector(x2)
4. Wheels(x4)

Total number of essential parts are **8**.

**NON-ESSENTIAL PARTS:**

1. Small bolts(x8)
2. Small nuts(x8)
3. Spacer(x2)
4. Washer(x2)
5. Big bolts(x6)
6. Big nuts(x6)

Total number of non-essential parts are **32.**

The above essential and non-essential parts are segregated based on the criteria to be followed as per the Boothroyd conditions.

**PHOTOS OF THE PARTS (Current Design):**

**Fig.5. Parts of the skating board-1**

**Fig.6. Parts of skating board-2**

The above parts are the taken from actual skating board and all these are current parts before modifying the design.

**STEP 3: To create a tabular column: (Fig.7. Table of original model)**

| Part | Usage | Alpha | Beta | α+β | Handling Code | Handling Time | Insertion Code | Insertion Time | Essential(Y/N) | Total Time | Essential Part |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Truck | 2 | 360 | 360 | 720 | 30 | 1.95 | 18 | 9.00 | Y | 21.90 | 2 |
| Wheels | 4 | 180 | 0 | 180 | 00 | 1.13 | 01 | 2.50 | Y | 14.52 | 4 |
| Small nuts | 8 | 180 | 0 | 180 | 04 | 2.18 | 38 | 6.00 | N | 65.44 | 0 |
| Small bolts | 8 | 360 | 0 | 360 | 14 | 2.55 | 38 | 6.00 | N | 68.40 | 0 |
| Bigger Bolts | 2 | 360 | 0 | 360 | 11 | 1.80 | 38 | 6.00 | N | 15.60 | 0 |
| Spacer | 2 | 180 | 0 | 180 | 0 0 | 1.13 | 07 | 6.50 | N | 15.26 | 0 |
| Bigger nut | 6 | 180 | 0 | 180 | 01 | 1.43 | 38 | 6.00 | N | 44.58 | 0 |
| body connector | 2 | 360 | 180 | 540 | 20 | 1.80 | 92 | 5.00 | Y | 13.60 | 2 |
| washer | 2 | 180 | 0 | 180 | 03 | 1.69 | 0 0 | 1.50 | N | 6.38 | 0 |
| | | | | | | | | | **Total=** | **296.88** | **8** |

Total time taken is **296.88 seconds.**

- Here, in the above table, first the alpha and beta values for each part are found with respect to the procedure to be followed for it. Then these two values are added in such a way we will get to know a value of degrees.
- With respect to the added value of alpha and beta, the handling code and respective time is taken from the chart (that contains handling time).
- Based on the type of insertion type method and ease of insertion types, the insertion code and respective time is taken.
- The components are segregated are essential and non-essential and listed down.
- For total time, handling and insertion time is added and multiplied with the number of same parts used in that product.
- Total number of essential parts is calculated.

**STEP 4: To calculate assembly efficiency by using the formula:**

The formula for assembly efficiency is,

Assembly Efficiency (E) = $N_{min} \times \frac{t_a}{t_{tot}}$

$N_{min}$ = 8+1(Skating board) = 9 parts

$t_a$ = 3 Seconds; $t_{tot}$ = 296.88 seconds.

$$E= 9 \times \frac{3}{296.88}$$

Assembly efficiency, **E= 9%**

**STEP 5: Re-create a design keeping all essential parts in it and replacing non-essential parts with an effective part:**

The essential and non-essential parts are analyzed and based on the possibility of changes that could be made in practical is designed for the skateboard.

**SOFTWARE USED: CREO (PARAMETRIC 5.0)**

**PRODUCT RE-DESIGN:**

a. **Wheel + One touch button lock:**

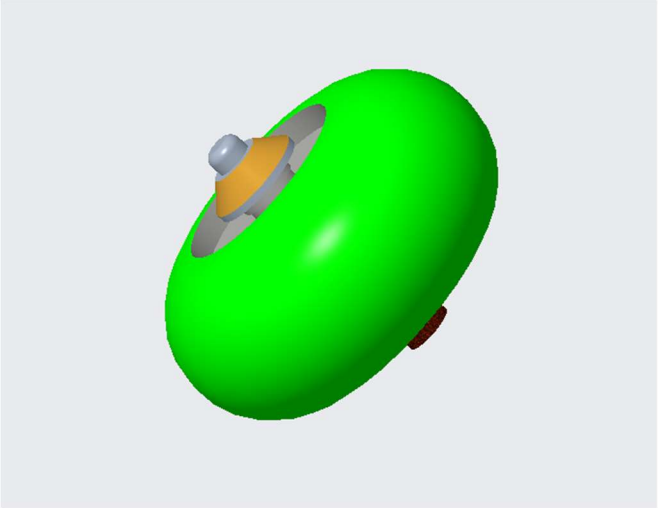


**Fig.8.Modified design of wheel**

Here, in the above image, it is noticed that the wheel and one touch button lock are together. The wheel, during the manufacturing process, the button lock is attached and manufactured in such a way it makes the assembly easy and saves time.

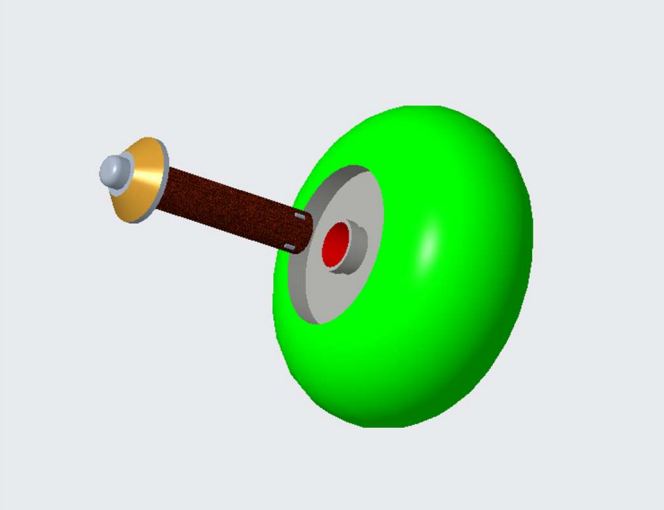


**Fig.9. Exploded view of modified wheel**

b. **TRUCK:**

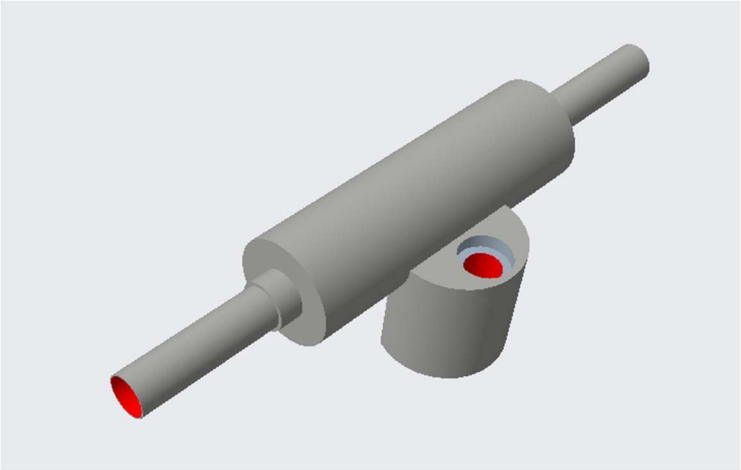


**Fig.10. Modified Truck**

In this image, the truck part is totally re-designed. The two bigger bolt present at both the sides has been removed and a permanent hollow shaft is manufactured along with the truck. Not only this, the spacer has been removed and a permanent joint which replaces the spacer is shown. The bigger bolt will fix into it without any spacer. The hollow shaft has an internal groove in such a way it provides room for the button lock to fit into it. This makes the wheel to fit into it easily and quickly.

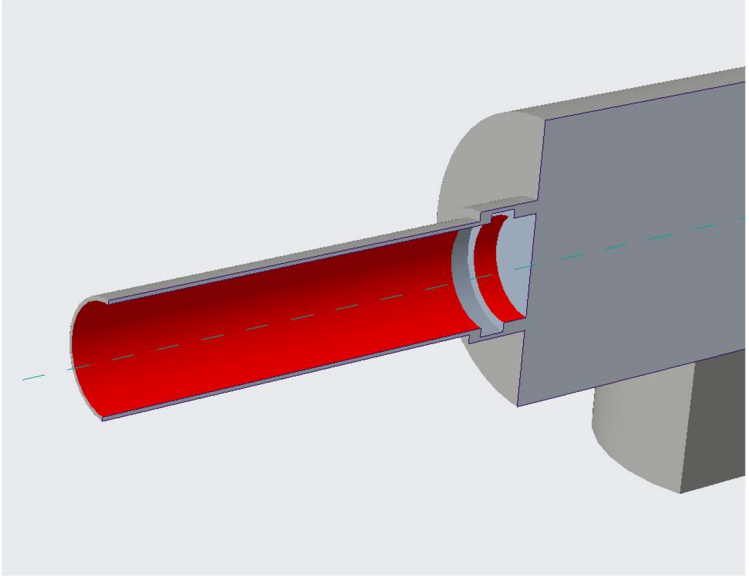


**Fig.11. Internal groove for the button lock**

### c. MODIFIED ASSEMBLY:

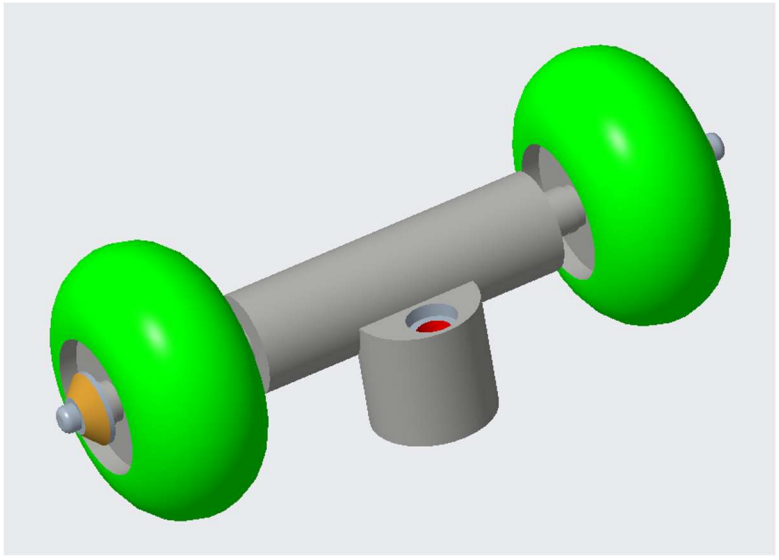


**Fig.12. Modified design of a part in Skating Board**

Hence, most of the non-essential part is eliminated and replaced by efficient changes in the essential parts which will improve the assembly efficiency by some percentage of value.

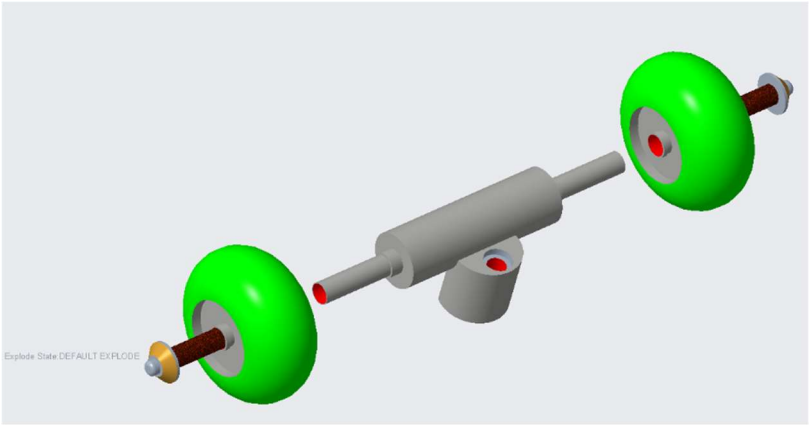



**Fig.13. Exploded view of modified design assembly**

The total number of parts eliminated – **12 non – essential parts.**

Total number of parts before re-designing – **40 parts**

Total number of parts after re-designing – **28 parts**

**STEP 6: Tabulate and calculate assembly efficiency:(Fig.14.Table of modified model)**

| Part | Usage | Alpha | Beta | α+β | Handling Code | Handling Time | Insertion Code | Insertion Time | Essential(Y/N) | Total Time | Essential Part |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Truck | 2 | 360 | 360 | 720 | 30 | 1.95 | 18 | 9.00 | Y | 21.90 | 2 |
| Wheels | 4 | 360 | 0 | 180 | 10 | 1.5 | 30 | 2.00 | Y | 14.00 | 4 |
| Small nuts | 8 | 180 | 0 | 180 | 04 | 2.18 | 38 | 6.00 | N | 65.44 | 0 |
| Small bolts | 8 | 360 | 0 | 360 | 14 | 2.55 | 38 | 6.00 | N | 68.40 | 0 |
| Bigger Bolts | 2 | 360 | 0 | 360 | 11 | 1.80 | 38 | 6.00 | N | 15.60 | 0 |
| Bigger nuts | 2 | 180 | 0 | 180 | 01 | 1.43 | 38 | 6.00 | N | 14.86 | |
| body connector | 2 | 360 | 180 | 540 | 20 | 1.80 | 92 | 5.00 | Y | 13.60 | 2 |
| | | | | | | | | | **Total=** | **197.90** | **8** |

$N_{min}$ = 8+1(Skating board) = 9 parts

$t_a$ = 3 Seconds; $t_{tot}$ = 198.04 seconds.

Assembly Efficiency (E) = $N_{min} \times \frac{t_a}{t_{tot}}$

$$E = 9 \times \frac{3}{197.90}$$

Assembly efficiency, **E= 13.6%**

**STEP 7: To Compare both the efficiencies:**

Assembly efficiency of the model before re-designing = **9%**

Assembly efficiency of the model before re-designing = **13.6%**

**Increase in the assembly efficiency is by 4.6%,** hence, by increasing the assembly efficiency, the time to assemble is reduced as there are minimum number of parts which will increase the production rate, which will simultaneously increase the profit margin.

## 5.RESULT:

Hence, for the selected product (Skating board), the non-essential parts is minimized keeping the essential parts and designing an efficient model in that essential part. The assembly has been increased from 9% to 13.6%, a increment 4.6% has been got from the modifying the parts in the skating board. The graphical representation of each important aspects are presented below.

**GRAPHICAL REPRESENTATION:**

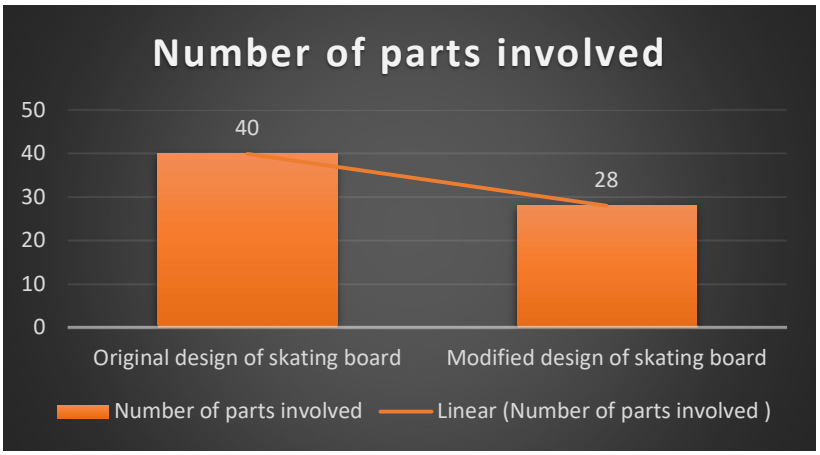



**Fig.15. Number of parts involved(graph)**

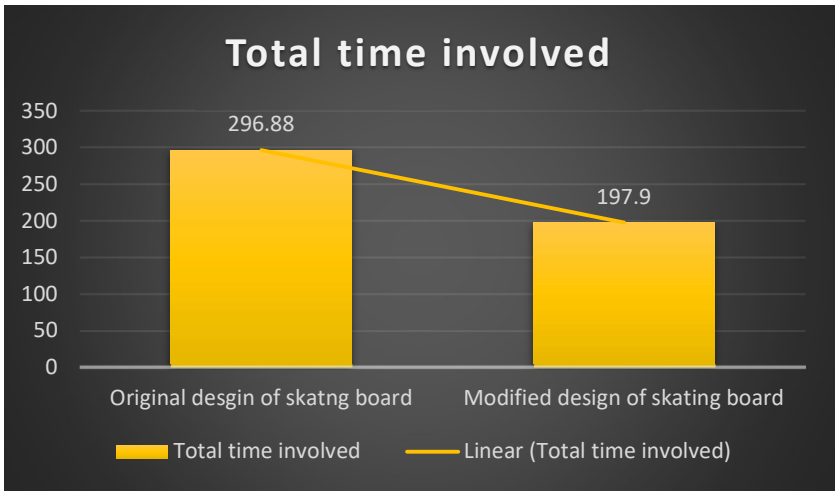



**Fig.16. Total time involved(graph)**

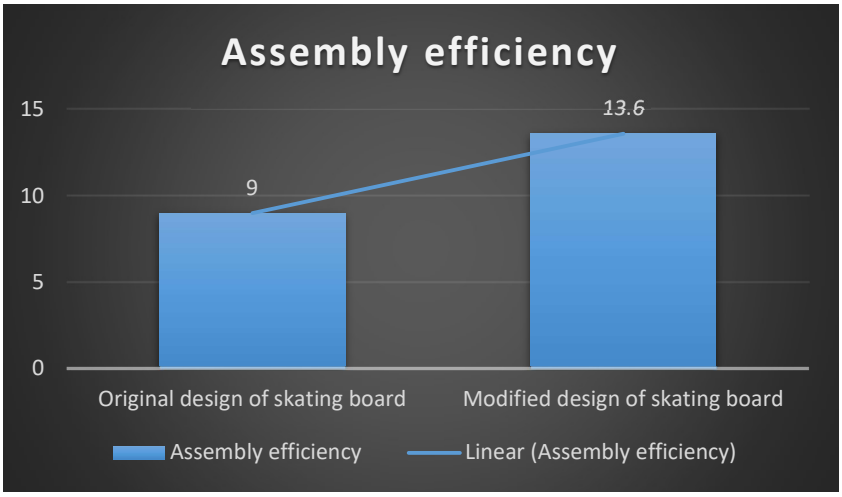



**Fig.17. Assembly efficiency(graph)**

## 8.CONCLUSION:

From this mini project, we as a team learned to know about have a number of parts and its assembly efficiency will have a greater impact on the time and because of time, how it affects an overall primary divisions industries such as productivity, laborer working hour and their cost, inventory etc. In our project, we have reduced the number of parts and have increased the assembly efficiency from 9% - 13.6% (an increment of 4.6%). Therefore, satisfies the condition of Boothroyd Dewhurst method and DFMA conditions.

## 9.REFERENCE:

1. https://www.imao.biz/catalog/en/imageindexlists2/?categorycode=$SMEOFS,$SME
2. https://www.youtube.com/watch?v=PcZRB0PpIPc

## 10.ACKNOWLEDGEMENT:

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