Design and Optimization of Hydraulic Lifting Platform

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Abstract— In this present work the complete design of Hydraulic lifting platform is done taking into consideration the various. The critical factor that may result in the failure is analyzed first theoretically and then analytically to make sure that the design is safe. Finally, we formulate the present re-engineering proposal based on the examination of the survey's results, and the re-design of the New Hydraulic lifting platform.

Key words: Hydraulic Lifting Platform, Hydraulic Cylinder, Stability Ratio, Intermediate Support, Frame Design

I. Introduction

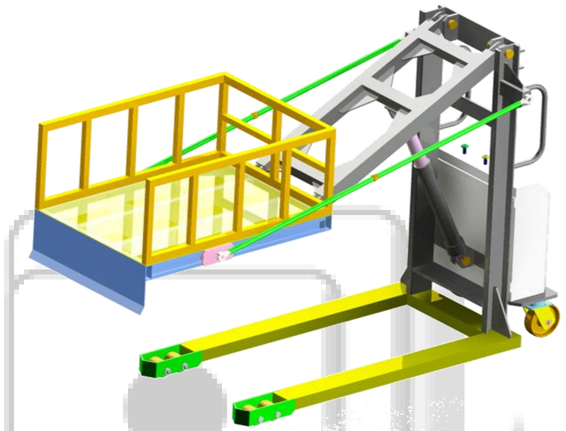


Fig. 1: Hydraulic lifting platform

Hydraulic lifting platform are mechanical devices that are used to give access to areas that would previously be out of reach, mostly on buildings or building sites. They are also known as aerial work platforms (AWPs). They usually consist of the work platform itself - often a small metal base surrounded by a cage or railings and a mechanical arm used to raise the platform. The user then stands on the platform and controls their ascent or descent via a control deck situated there. Some forms of aerial work platform also have separate controls at the bottom to move the actual AWP itself while others are controlled entirely on the platform or towed by other vehicles. Most are powered either pneumatically or hydraulically. This then allows workers to work on areas that don't include public walkways, such as top-story outdoor windows or gutters to provide maintenance. Other uses include use by fire brigade and emergency services to access people trapped inside buildings, or other dangerous heights. Some can be fitted with specialist equipment, for example allowing them to hold pieces of glass to install window planes. They are temporary measures and usually mobile, making them highly flexible as opposed to things such as lifts or elevators. However generally they are designed to lift fairly light loads and so cannot be used to elevate vehicles, generators or pieces of architecture for which a crane would more likely be used. In some cases however elevated work platforms can be designed to allow for heavier loads. Depending on the precise task there are various different types of aerial work platform which utilize separate mechanisms and fuel sources.

The most common type is the articulated elevated work platform, (EWP) or 'hydraulic platforms' (and also known as boom lifts or cherry picker). A hydraulic platform is hydraulically powered and is similar in appearance to arcane consisting of separate jointed sections which allow for 'up and over' applications. Although, a scissor lift can move only vertically due to different unfolding system of elevation whereby a crisscross structure elongates and compresses itself to alter the height.

II. Materials

Designed the product with Channel, flat and tubes

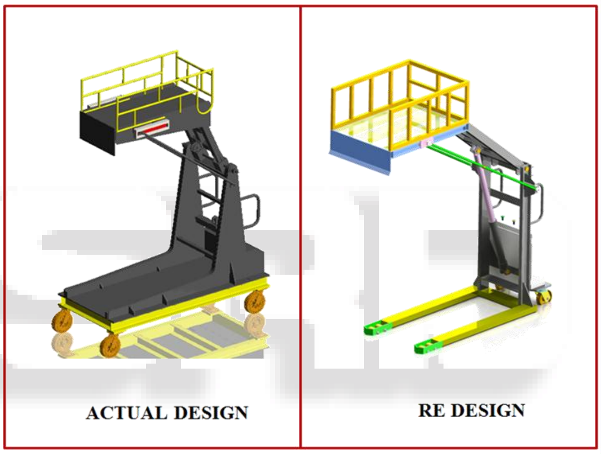


Fig. 2: Vehicle Stability Factor

SRT describes the maximum amount of lateral (sideways) acceleration a heavy vehicle can handle without rolling over. The SRT is the lateral acceleration required to transfer all the weight to one side of the vehicle, It is the ration of Stability moment to Overturning moment. This ratio had to be greater than 1.

A. Material Grade: IS2062 Specification of Structural Steel for Fabrication

Grade	C %	Mn %	S %	P %	Si	C. E. %
	Max.	Max.	Max.	Max.	Max.	Max.
A	0.23	1.5	0.05	0.05	-	0.42
B	0.22	1.5	0.045	0.045	0.04	0.41
C	0.2	1.5	0.04	0.04	0.4	0.39

Table 1: Chemical composition

Grade	UTS (MPA)	Y.S.(MPA) Min.	El. % Min	Bend
A	Min.	< 20 mm 20-40 mm > 40 mm	5.65 So	Test
B	410	250 240 230	23	3T
C	410	250 240 230	23	2T & 3T*
	410	250 240 230	23	2T

Table 2: Mechanical properties

III. DESIGN

A. Hydraulic Lifting Platform

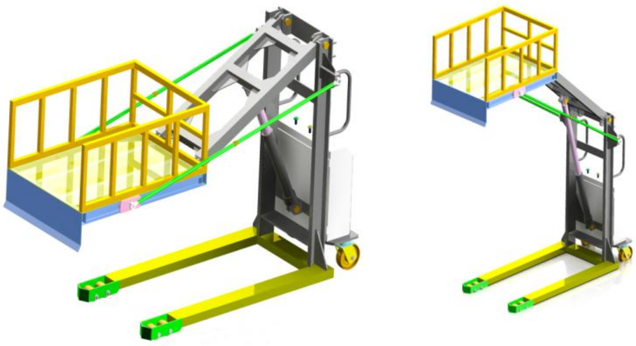


Fig. 3: Re-design model

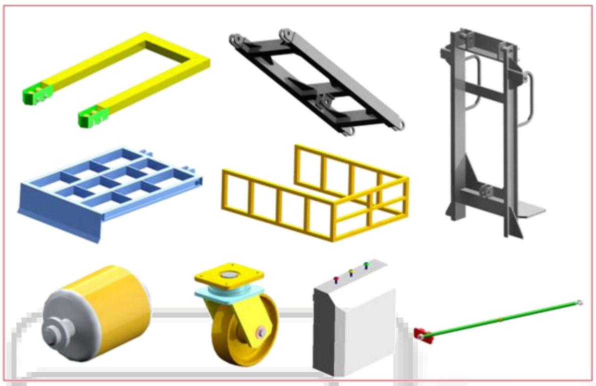


Fig. 4: Actual design part images

B. Re-Design Platform Bill Of Material

Sl. No.	Quantity	Part No.	Description
1	1	PART-01-01	Load Frame assembly
2	1	PART-01-02	Lip cover
3	1	PART-01-04	Intermediate support
4	1	PART-01-05	Support frame assembly
5	2	PART-01-06	Handle
6	1	PART-01-07	Power pack
7	4	PART-01-08	Caster wheel
8	1	PART-01-09	Railings
9	2	PART-01-10	Guide rod assembly
10	1	PART-01-11	Hydraulic Cylinder
11	1	PART-01-12	Base assembly

Table 3: Re-design platform Bill of material.

C. Design of Frame

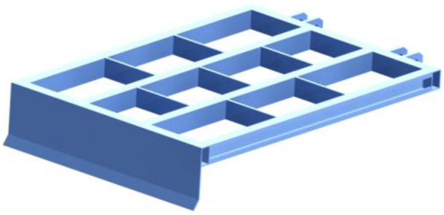


Fig. 5: Re design frame

The frame at minimum height will acts as a simply supported beam with point load. The Rectangular tube of dimension 60mm x 40mm x 4mm THK is considered for frame design.

The frame at Maximum height will acts as an overhanging beam with point load. The Rectangular tube of dimension 60mm x 40mm x 4mm THK is considered for frame design.

D. Description of Loads

Sl. No.	Loads	Description	Load Values
1	P	Actual load acting on the frame	10000 N
2	P1	Load acting on guide rod at an angle	9184 N
3	P2	Load acting towards guide rod	17423 N
4	P3	Load acting on frame support due to guide rod	14777 N
5	P4	Load acting on Intermediate support	32080 N
6	P7	Load acting towards the Hydraulic cylinder	58260 N
7	P8	Load acting on frame support due to Intermediate support	11364 N
8	P9	Load acting on frame support due to Hydraulic cylinder	17029 N

Table 4: Loads description

E. Design of Intermediate Support

Fig. 6: Design of intermediate support

F. Design of Support Frame Assembly

Fig. 7: Design of support frame assembly

G. Design of Base Assembly

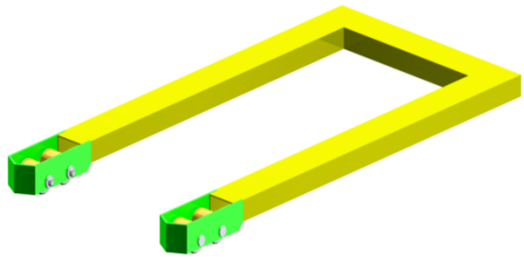


Fig. 8: Design of base assembly

H. Forces on Base Assembly

There are 3 different types of load acting on base assembly they are

- Self-weight
- Counter weight
- Pay load

IV. RESULT AND DISCUSSION

A. *Design Comparison*

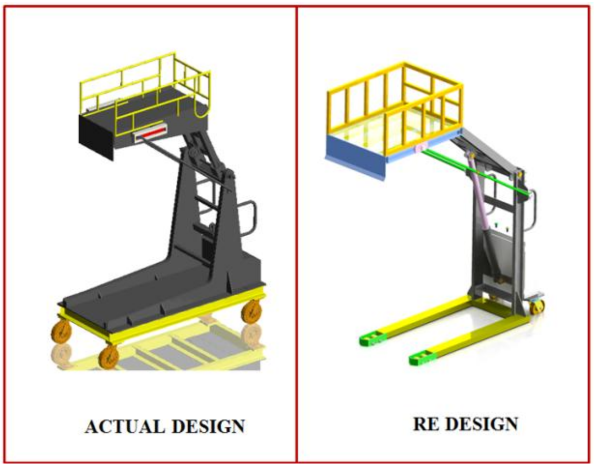


Fig 9: Actual Design V/S Re Design

1) *Actual Design*

The dead weight of equipment was very high and the weight vs load ratio was greater than 1. Since the weight was more the fabrication cost, Lead time increased. The overall dimensions were large with length and breadth of 2500 mm x 1200 mm but the platform size was only 1000mm x 800 mm. The equipment is unable to place the payload in required position. Since push pull of equipment was by manual method & Due to its high length and breadth the operator found risking in operating the load and turning of vehicle required lots of human effort. The base height of the equipment was greater than 350 mm which was one of most critical disadvantage. The vehicle movement required more aisle width. There was no counter weight

2) *Re Design*

The dead weight of equipment was less and the weight vs load ratio was lesser than 1. Manufacturing cost, Material cost, and Lead time decreased. The overall dimensions were decreased with length and breadth of 1700 mm x 700 mm with the platform size of 1000mm x 800 mm. The equipment is able to place the payload in required position. Due to decrease in weight & decrease in overall length of equipment the pull of equipment by manual method by operator found easy. The base height of the equipment was only 60mm from ground which was one of the main advantages due to which the vehicle was easily guiding in the spacing in racks at bottom and other spacing's. The vehicle movement required less aisle width. Counter weight is added

Equipment Specification Comparison			
Sl. No.	Specifications	Actual Design	Re Design
1	Rated load capacity	1000 Kg	1000 Kg
2	Maximum lift height	2500 mm	2500 mm
3	Minimum lift height	550mm	400mm
4	Shut height	1650mm	1950mm
5	Overall height	3000mm	3000mm
6	Vehicle overall dimension	1680 x 1650 x 700 wide	2500 x 1900 x 1200 wide
7	Platform size	1000 mm x 800 mm	1000 mm x 800 mm
8	Base assembly dimension	1680 x 700 x 40	2400 x 1200 x 300
9	Ground clearance	20mm	200mm
10	Base height from ground	60mm	300mm
11	Wheel size	Dia. 175mm	Dia 175 mm

Table 5: Equipment specifications

B. *Weight Comparison*

Equipment Weight Comparison				
Sl. No.	Quantity	Description	Re design	Actual Design
1	1	Load Frame assembly	53 Kg	75 Kg
2	1	Lip cover	3 Kg	3 Kg
3	1	Intermediate support	44 Kg	57 Kg
4	1	Support frame assembly	85 Kg	325 Kg
5	2	Handle	2 Kg	2 Kg
6	1	Power pack	80 Kg	80 Kg
7	4	Caster wheel	12 Kg	28 Kg
8	1	Railings	15 Kg	15 Kg
9	2	Guide rod assembly	35 Kg	35 Kg
10	1	Hydraulic Cylinder	45 Kg	45 Kg
11	1	Base assembly	62 Kg	510 Kg
12	1	Counter weight	350 Kg	0 Kg
			786 Kg	**1175 Kg**

Table 6: Equipment weight comparison

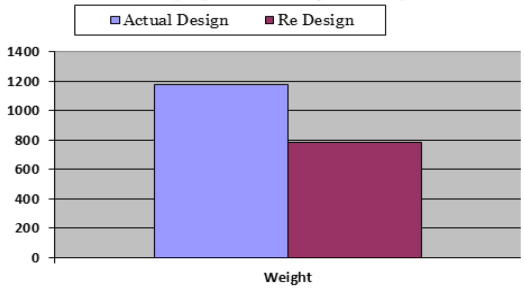
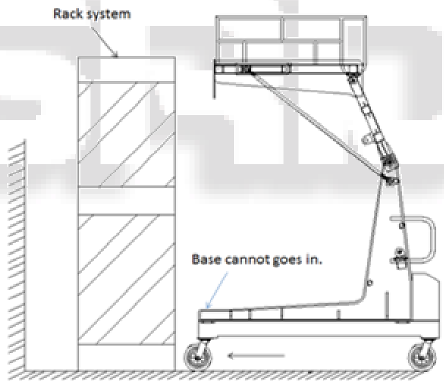


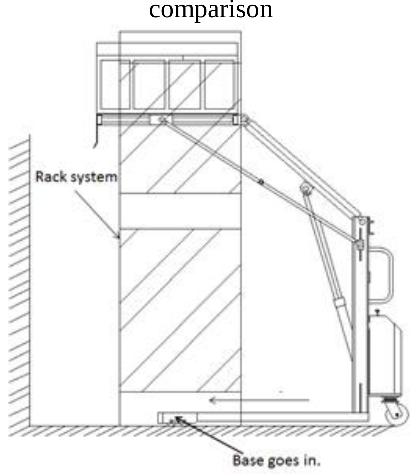
Fig. 10: Weight comparison chart.

C. *Equipment Movement comparisons*



ACTUAL DESIGN

Fig.11: Actual design of the equipment movement comparison



RE DESIGN

Fig. 12: Redesign of the equipment movement comparison

D. FEA Results

1) Vonmises Stress and Deflection Plot of Lifting Platform

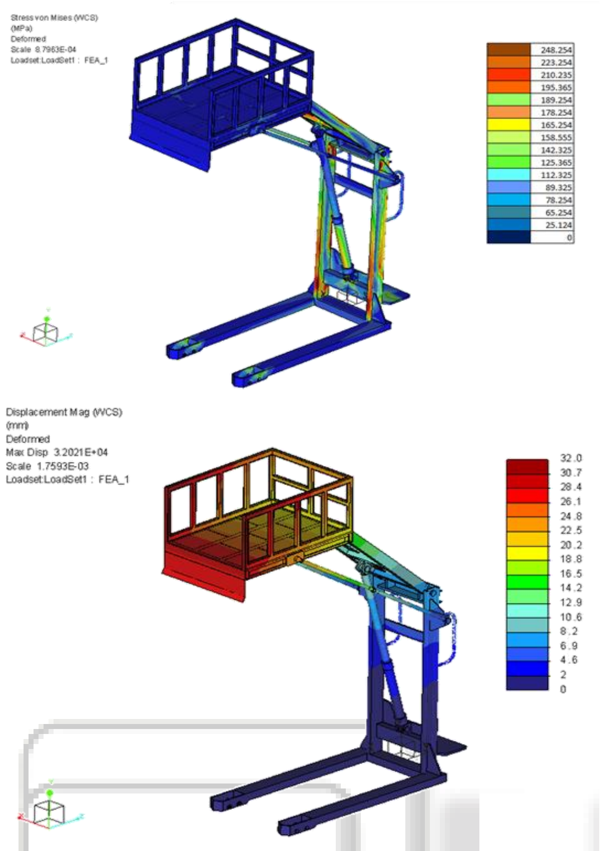


Fig. 13: Vonmises stress and Deflection plot of Lifting platform.

2) Vonmises stress and Deflection plot of Support frame

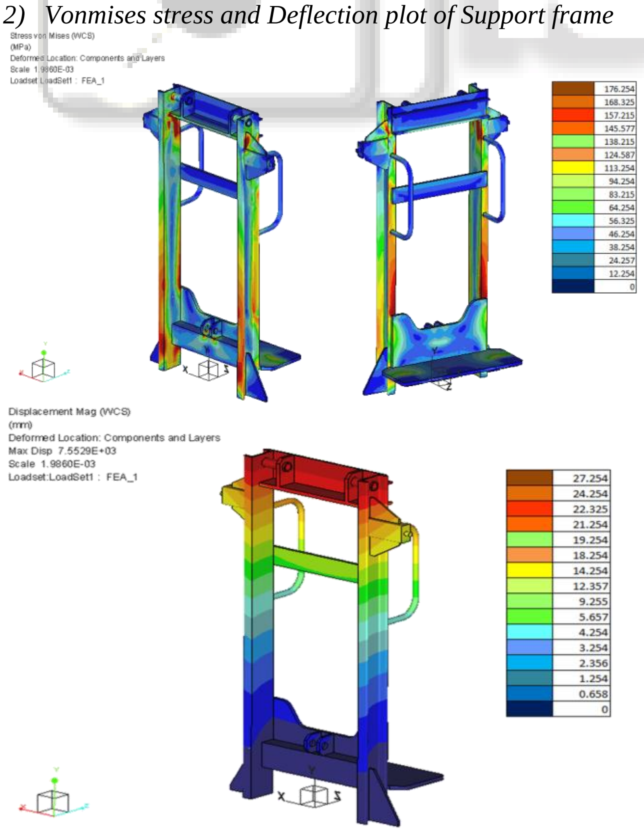


Fig. 14: Vonmises stress and Deflection plot of Support frame.

3) Vonmises stress and Deflection plot of frame

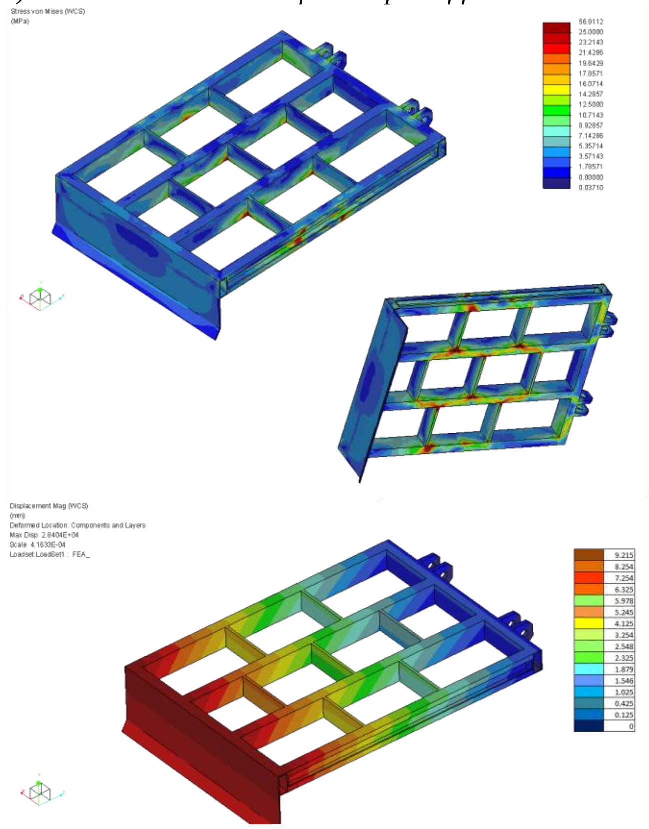


Fig. 15: Vonmises stress and Deflection plot of frame

4) Vonmises stress and Deflection plot of Intermediate assembly

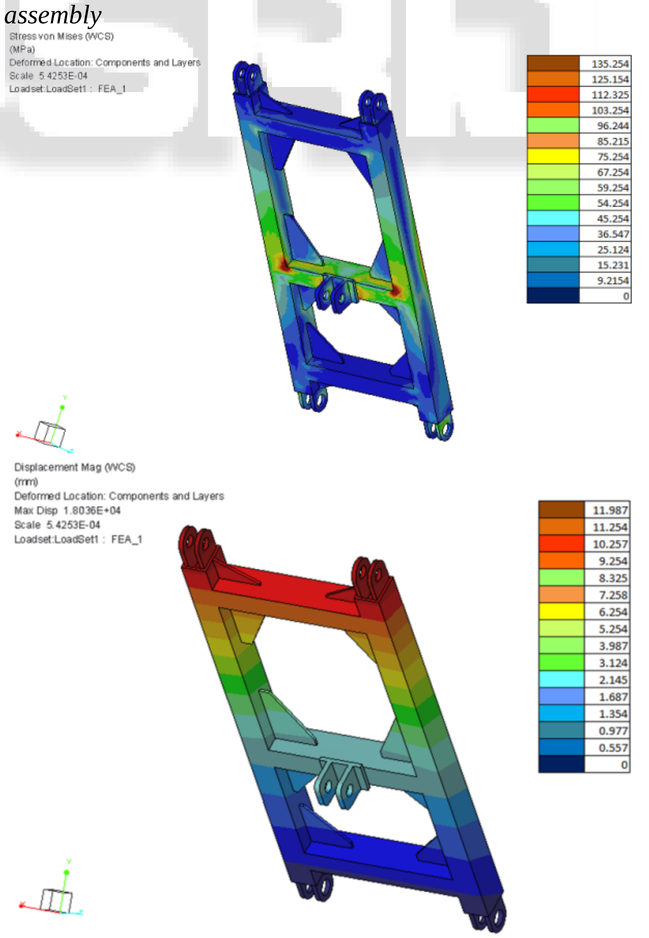


Fig. 16: Vonmises stress and Deflection plot of Intermediate assembly.

5) Vonmises stress and Deflection plot of Base assembly

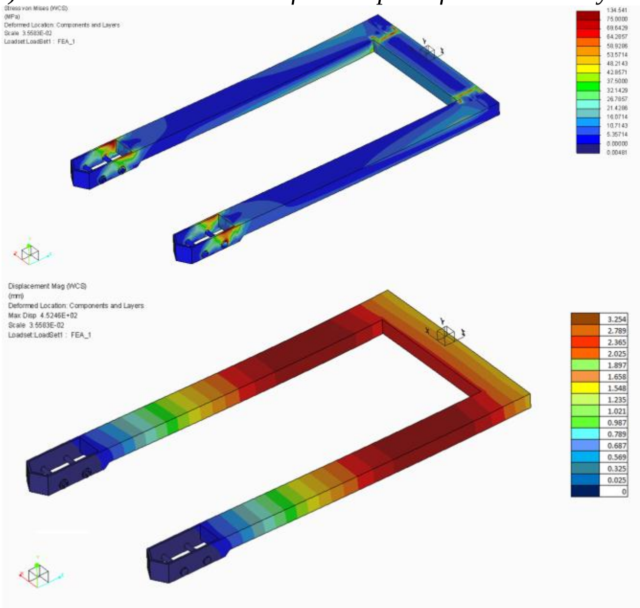


Fig. 17: Vonmises stress and Deflection plot of Base assembly.

V. CONCLUSION

This project dealt with the required factors and criteria required to obtain a functional long life Hydraulic lifting platform with keeping focused in low-cost, high manufacturability, long-term reliability and resistance to severe working duty and cost factors in mind. This project helped to set the lines of manufacture of future platforms of overall lesser product dimensions along the same lines with guaranteed safety on the working of this system. Performance characteristics of equipment such as Material stress, Bending moment, Load on wheels, Cylinder selection, Vehicle stability were calculated theoretically for critical parameters.

In order to obtain the objectivity this project has shown all the limiting factors as to which fails first under loads and the required parameters to run this system along with conditions which the system may be subjected to. The dimensional calculation of all the part values has prevented the use of unwanted materials.

The development of Re design of Lifting platform substantially improves working condition in an engineering environment, the development will be faster when teams work together and continuously. The results can be represented faster with increases in control level, rightfulness & investment application with Design for assembly as a methodology of work.

The concept of Re Design improved the communication between the operational, planning, quality & design become better which improvises the transfers of information from the Product engineering to the Industrial engineering which improved the manufacturing section. Overall this communication improved lead time.

The Redesign was avoided, good economy was achieved and the parts was designed more than one time and the final components was manufactured once which saved money in building the prototypes, testing and lead time, The parts which were designed for production line had fewer parts and there were speeds up in assembly line.

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