

A Detail Study on Implementation of Green Technology and Reverse Manufacturing Methods in Plastic Molding Industry

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Abstract:- In this paper the modest attempt to implement green technology and reverse engineering (reverse manufacturing) methods in a plastic moulding industry to reduce pollution and increase productivity in industry. For our study we have selected a small scale plastic moulding industry in India. We have selected product water bottle of 1 litre for digitization technology and green technology (GT). From result using digitization technology 50% manual work get reduced from 18 days to 9 days. And by implementing GT CO2 emission decreases up to 40%. In this paper DEA method is used to know the impact of reverse engineering in the profit of Ford motor company which already uses RE to make automobiles. From result, we finds that DEA method is very useful in finding productivity of any organisation when there is single or various inputs and outputs.

Keywords:- Reverse Manufacturing, Green Technology, Pollution, Productivity, DEA.

I. INTRODUCTION

Reverse engineering (RE) is new concept for taking data quickly with the help of with the help of scanners (contact & noncontact). RE is very useful when the drawing of object is not available. It is widely used in various fields such as manufacturing, jewellery, automobile, medical sector. It is also useful to examine previous made product to make some good product with some better features. This paper not only presents the method to increase productivity of organisation. But implementing GT pollution reduces to certain extent. The main objective of this research work is to increase the productivity of industry and also reduce pollution along with using RE methods. The process of duplicating an existing component, subassembly or product without aid of drawing or computer model is known as RE.

II. LITERATURE REVIEW

A lot of literature are available in journal and book explaining the process of RE and its uses indifferent field some of which are as follows: Lee et. al. (1998) proposed a novel method for RE which is shown in figure 1.

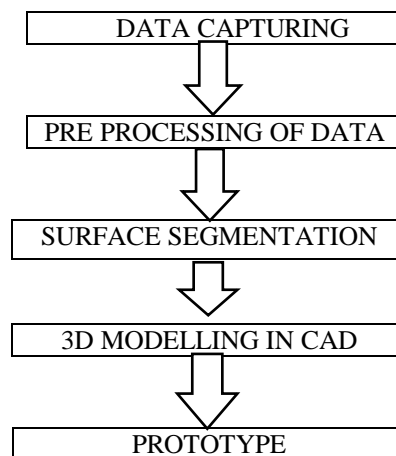


Fig.1: Flowchart of basic phase in RE

Niranjan[1] have reviewed 14 research paper on reverse manufacturing and reported several definitions, stages in RE. They found that effective use of RE reduce the product development cycle besides cost saving. **Kumar[2]** in their research paper finds that fundamental and basic limitation of RE are similar in most industries. The general practice of RE such as data collection, detailed analysis at a

micro scale, modelling, prototyping, performance, evaluation and regulation compliance, are same in principle for all industries. **Betim[3]** in their implemented RE in manufacturing of mechanical part. **Vinesh[4]** in his book briefly explained about reverse engineering technology. **Palakand Darshan[5]** in their research paper have used reverse engineering for making automatic reverse braking

system with blind spot reduction technology. **Nazaruddin[6]** in their research paper developed a chassis of electric vehicle using RE method in Indonesia. **Hieu[7]** in their research paper explained the application of RE in field of health sector. Some research paper on using green technology are given below: **Tushar[8]** in their research presented a way to reduce pollution by presenting renewable energy technology options for use of various GT in today era. **Ravi[9]** in their research paper highlighted that by using GT methods energy requirement can be reduced 60 - 70%. **Prachi[10]** in her research paper did a case study on implementation of GT method in Indian industries she finds that green technology is not only beneficial for nature but also very useful for organisation.

Tandon[11] in their research paper used DEA method to find the productivity of automobile industry. He in his work finds that DEA method is very useful in finding productivity of any organisation in term of efficiency which can be used to compare other units.

III. METHODOLOGY

• [PART-1] [REVERSE ENGINEERING]

In this study the selected product is plastic water bottle of capacity 1 litre for reverse engineering method. In this experiment procedure the component is scanned. Then pre-processing of data is done to reduce unwanted lines and curves and finally a solid model is made in CAD software. This model can be used to manufacture required component. Details of scanner is given in table 1 as mentioned below:

S.NO.	Scanner details	Specified Value
1.	Scanner	I Ball
2.	Model	CS – 153
3.	Sensor Type	Hand Held Scanner
4.	Made in Country	India
5.	Time to Detect Object	3 Second
6.	Total Time Required to Scan Object	10 Second

Table 1: Ball Hand Held Scanner Details

The scanner used for experiment study is shown in figure 2. Point cloud data generated by scanner is shown in figure 3. Final CAD model is shown in figure 4. Other necessary data regarding time to make solid model is given in table 2.

S.NO.	Time to make model in CAD	
1.	File Conversion into IGES	2 MIN
2.	Loading into CAD & conversion into curves	4 HRS AND 40 MIN
3.	Creation of Surfaces	1 HR AND 55 MIN
4.	Inspection & Comparison	1HR
5.	Host Computer	Core 2 duo, ≥ 2 GHZ, ≥ 2 GB RAM, ≥ 60 GB HD

Table 2: Time to make solid model in CAD software



Fig. 2: Scanner used for experimental study



Fig. 3: Point cloud data generated by using Scanner



Fig. 4: Final CAD model of 1 litre water bottle

From above result we conclude that normally 9 days are required to make solid model in CAD software in reverse engineering method. While in traditional method generally it takes 18 days to make a model which is double than RE method. Hence, RE is a fast method to bring product quickly in market reducing manual work half (50 %) with other methods.

• **[PART-2] [GREEN TECHNOLOGY]:**

By implementing green technology such as solar panel, planting more trees, recycling of waste water, using non-polluting material such as cardboard, non painted bricks, jute, stone and wooden articles. Due to use of GT energy reduces use reduces to 50%, CO₂ emission reduces to 40%, water use reduces to 40%, and solid waste reduces to 70%. Hence, GT plays an important role in reducing pollution in today's heavily polluted world.

• **[PART-3] [DEA METHOD]:**

DEA is a technique that can be used to measure the multiple dimensions of performance (efficiency) of producing units. These producing units are called decision making units (DMU). DEA allows multiple inputs and output that develop single efficiency score. DEA can be used in any organisation for measuring comparative efficiency with other industries. The main focus on DEA is to find most efficient unit among others. Their efficiency value lies between 0 and 1.

To analyse the impact of reverse engineering on efficient performance of company in a time span of 25 years.

On the basis of this objective a hypothesis is framed saying,

H₀ → There is no impact of RE on overall performance of company.

We have used 1 input output oriented model of Ford motor company. The input and output are discussed below:

The input are:

1) No of employee (1991-2015).

The output are:

1) Revenues (1991-2015).

This hypothesis will be tested through DEA method. In this method an output oriented DEA model is taken which can be used to compare other units.

The DEA mathematical model is as follows:

$$\text{Max } h = \sum_r u_r y_{rj} / \sum_i v_i x_{ij} \text{ subject to}$$

$$\sum_r u_r y_{rj} / \sum_i v_i x_{ij} \leq 1, j = 1, \Lambda, n$$

In simpler words,

$$\text{Efficiency} = \sum \text{Weighted outputs} / \sum \text{Weighted inputs}$$

Here, input includes various resources like workers, machines, operating expenses, budget etc. The outputs include actual no products produced, profits, revenues [11].

In DEA method first we will calculate efficiency of each unit then we will calculate relative efficiency which can be calculated by relation,

$$\text{R.E} = \text{Ratio of efficiency of each units} / \text{Ratio of efficiency of most efficient unit}$$

Then after calculating relative efficiency we will arrange value from higher to lower. Higher value serve as benchmark and we can compare it with other units.

The DEA analysis of Ford motor company is shown in table 1 where efficiency and relative efficiency of 25 years are listed below from which we can easily compare most efficient unit and less efficient units. The more the value of efficiency of units the more efficient it is as compared to others units.

YEAR	No of employees (000's)	Revenues	Efficiency	Relative efficiency
1991	332	72051	0.217	0.244
1992	325	84407	0.259	0.291
1993	322	91568	0.284	0.320
1994	338	107137	0.316	0.356
1995	347	110496	0.318	0.358
1996	372	118023	0.317	0.357
1997	364	122935	0.337	0.379
1998	345	119083	0.345	0.388
1999	375	135022	0.360	0.405
2000	352	140765	0.399	0.449
2001	359	130736	0.364	0.410
2002	350	134273	0.383	0.431
2003	328	138442	0.422	0.475
2004	325	147134	0.452	0.509
2005	300	153413	0.511	0.576
2006	200	141727	0.708	0.798
2007	245	152691	0.623	0.702
2008	205	127635	0.622	0.701
2009	117	103868	0.887	1
2010	164	119280	0.727	0.819
2011	164	128168	0.781	0.880
2012	171	126567	0.740	0.834
2013	181	139369	0.769	0.866
2014	187	135782	0.726	0.818
2015	199	140566	0.706	0.795

Table 3 : DEA analysis of Ford motor company

IV. RECOMMENDATION

This study is done on plastic molding industry in India. The main focus of this research is to provide alternative to plastic and stop the use of plastic for always. As most of pollution is due to plastic in whole world. The option for this problem can be solved by using clay pots, ceramic, crockery, stone, wood made articles can be used to reduce the use of plastic products. It is not only harmful for nature but also harmful for health of people as 50% of health problem issues occurs due to uses of plastic products.

V. RESULT

ON THE BASIS OF OUR RESEARCH WORK WHILE DOING EXPERIMENT WE HAVE FOUND SOME IMPORTANT INFORMATION WHICH ARE AS FOLLOWS-

Time taken to make plastic water bottle of 1 litre in traditional method is given in table 4.

TRADITIONAL METHOD (FOR 1 BOTTLE)		
S.NO	PROCESS	TIME
1	Molding	30 sec
2	Finishing	20 sec
3	Inspection	20 sec
4	Assembling	15 sec
5	Packing	30 sec
6	Model Time	18 days
7	Total time to make product	18 days 115 sec

Table 4: Traditional method

Time taken to make plastic water bottle of 1 litre in reverse engineering method is given in table 5.

REVERSE ENGINEERING METHOD (FOR 1 BOTTLE)		
S.NO	PROCESS	TIME
1	Moulding	30 sec
2	Finishing	10 sec
3	Inspection	10 sec
4	Assembling	5 sec
5	Packing	10 sec
6	Model Time	9 days
7	Total time to make product	9 days 65 sec

Table 5: Reverse Engineering method

In traditional method production of 1 ton of plastic product takes 4 mega joules of energy, CO₂ emission 3 ton , water use 3000 litre, solid waste increases up to 90%. Hence, green technology plays a vital role in reducing pollution. The plastic water bottle of 1 litre using green technology as comparison to traditional method is given in table 6.

GREEN TECHNOLOGY METHOD (FOR 1 TON OF BOTTLES)		
S.NO	PROCESS	
1	Energy use	2 mega joules
2	CO ₂ emission	1.3 ton
3	Water use	1333 litre
4	Solid waste (Decreases)	70%

Table 6: Green technology method]

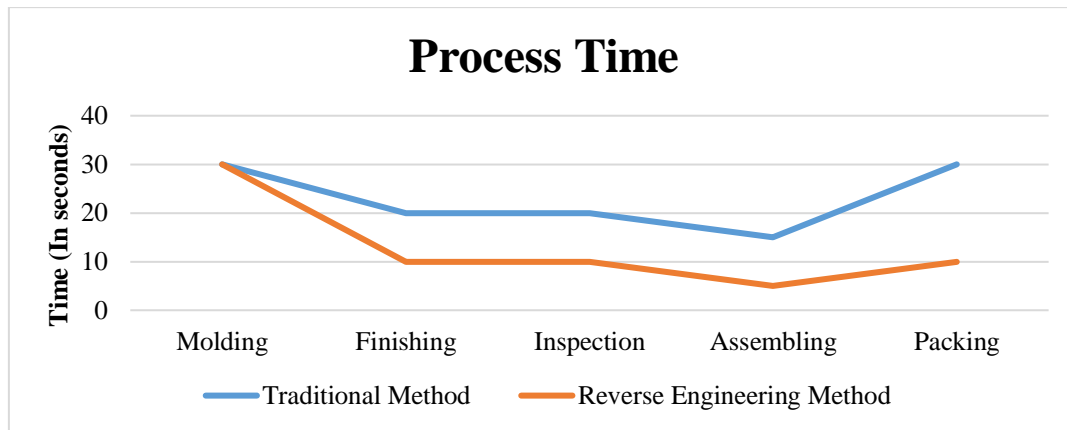


Fig. 5: Comparison of RE &TM (For making 1 litre water bottle)

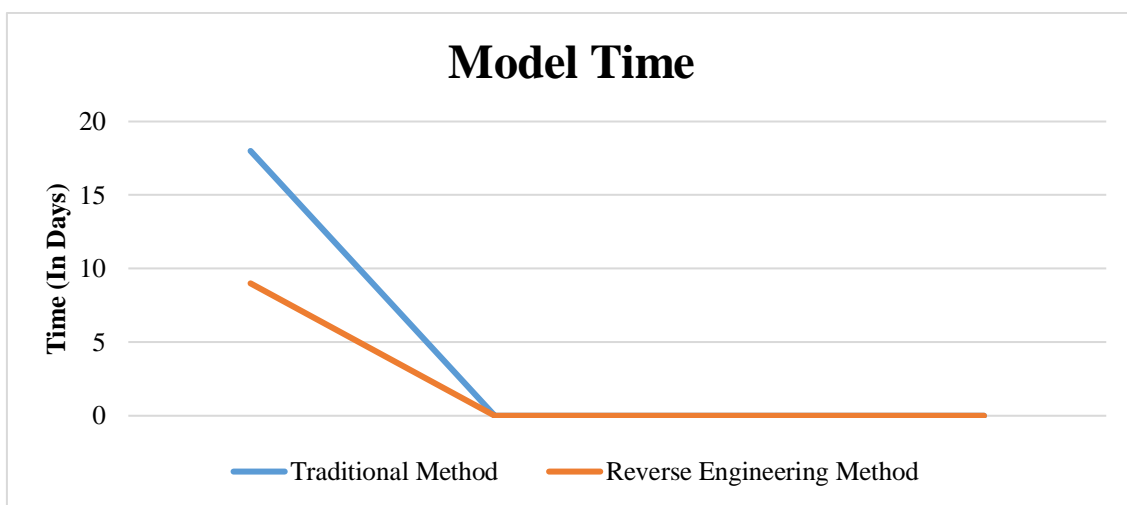
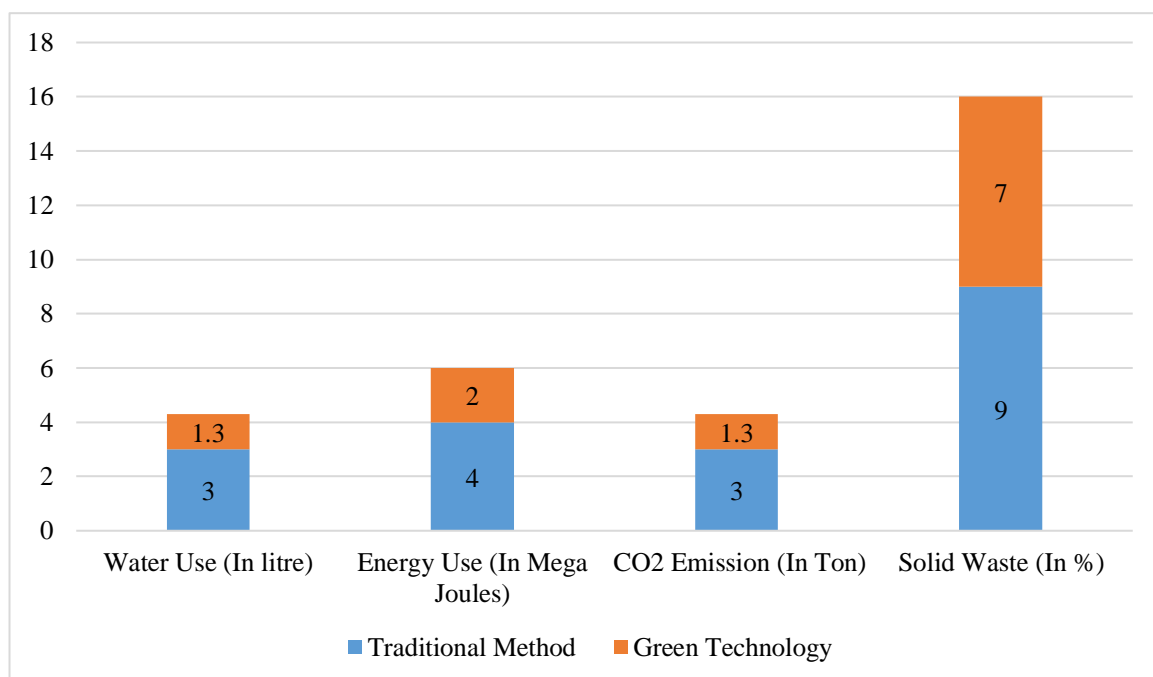


Fig. 6:



Comparison of RE & TM (Time required to make model)]

Fig. 7: Comparison of GT &TM (For making 1 litre water bottle)

Comparison of reverse engineering and traditional method for making 1 litre plastic water bottle is given in figure 5. Time required to make model in reverse engineering and traditional method is given in figure 6. Comparison of green technology and traditional method for making 1 litre water bottle is given in figure 7.

On the basis of result obtained through experiment we conclude that reverse engineering along with green technology plays important role in reducing pollution as well increasing productivity of organisation.

We have also checked impact of reverse engineering in productivity of company through DEA method.

On the basis of result obtained by DEA method the relative efficiency of Ford motor company is higher (13 times) than other financial years. The minimum being year 1991. On an average Ford is almost near to efficiency. So, we conclude that reverse engineering plays important role in productivity of Ford motor company.

VI. CONCLUSIONS

Reverse engineering is the process of investigating the principles of a device to know its different parts for study or to make a better product than the previous one. The RE is a process in which manual work gets reduced to half (50%) i.e. from 18 days to 9 days. Inspection time also reduced to half when used CAI, CMMs, scanners. Due to use of RE production development cycle and cost also reduce as a result of which, productivity of industry increases.

Green technology use in any industry can be very useful as energy use reduces to 50%, CO₂ emission reduces to 40%, water use reduces to 40%, Solid waste reduces to 70%. Hence, RE and GT play an important role in increasing productivity and reducing pollution.

This study revolves around the impact of reverse engineering on the performance of Ford motor company. Since 1903 till 2015 many changes happened to Ford. But due to use of reverse engineering Ford emerged as a winner of all time. From result of DEA analysis we conclude that reverse engineering plays a vital role in productivity of Ford Company.

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APPENDIX-1
[DEA VARIABLES FOR THE STUDY]

YEAR	No of employee (000's)	Selling administrative expense	Automotive revenues	EPS	Total expense
1991	332	3993	72051	0.93	75820
1992	325	4434	84407	-2.4	86182
1993	322	4968	91568	-7.81	90136
1994	338	11280	107137	2.27	101311
1995	347	7860	110496	4.97	11420
1996	372	6625	118023	3.58	115507
1997	364	7082	122935	3.73	115989
1998	345	7616	119083	5.75	112398
1999	375	11010	135022	18.17	128594
2000	352	9838	140765	3.69	135489
2001	359	9778	130736	-3.02	138222
2002	350	9758	134273	-0.55	162077
2003	328	10152	138442	0.27	163970
2004	325	11455	147134	1.21	168042
2005	300	24588	153413	0.88	178408
2006	200	19148	141727	-6.73	177038
2007	245	21169	152691	-1.4	177751
2008	205	21065	127635	-6.5	159296
2009	117	13029	103868	0.91	119715
2010	164	11909	119280	1.9	122296
2011	164	10884	128168	5.33	129321
2012	171	11494	126567	1.47	127961
2013	181	13176	139369	1.83	134108
2014	187	14117	135782	0.81	143745
2015	199	14999	140566	1.84	141911