Composite Laptop Lid Design – A Conceptual Cost Reduction Technique

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Abstract - **With the ever growing computer centric technology, the demand for customer satisfaction in terms of cost has been the prime concern of manufacturing industry. Mostly industries deal with cost factors with the help of concurrent engineering and reverse engineering but seldom go for a new material, since it is a very slow and cumbersome process to try a new material every now and then. Moreover, standards of the industry set a limit on this aspect. The paper talks of a new material in the laptop lids to reduce environmental impact and also cost.**

Keywords: *Laptop lid design, Aluminium, Composite material*

I. INTRODUCTION

AN intentional initiation of change is often called 'Design'[1]. A change of material in a product may lead to environmental benefits in terms of carbon pollution, directly or indirectly. This paper investigates the possible technical options to reduce steel scrap in the market segment- computer peripherals. The paper takes the case of laptops. A laptop consists of many components, enlisted in Table 1.

II. LITERATURE SURVEY

Song *et al.* estimated the critical factors involved in the widespread use of composites and one such factor is the energy consumed during the lifetime of a composite [3]. Molcho *et al*. suggested forty factors governing part cost and ranked them according to cost impact. Based on them, they proposed a cost estimator which is good fit with the actual manufacturing costs [4]. Koonce *et al*. presented a cost estimation tool FIPER – Federated Intelligent product Environment. It provides necessary design data and a directed search toward optimality with respect to costs and other constraints. FIPER helps designers reduce costs while meeting their performance constraints [5]. Shehab *et al*. discussed the development of the proposed system for cost modelling of machining processes. The paper considered the parameters *viz.* CAD solid modelling system, user interface, material selection, process/machine selection, and cost estimation techniques. The paper addressed the uncertainty in cost estimation model by implementing a fuzzy logic based knowledge representation in the developed system [6]. Weustink *et al*. proposed a generic framework to reduce costs in the product development in sheet metal processes. The framework which controls the production costs considers account design, process planning and production planning aspects [7].

TABLE 1- COMPUTER PERIPHERALS AND THEIR MATERIALS [2]

Component	**Material**
Processor	Silicon, copper, aluminum, and various plastics.
Hard drive	Glass and ceramic
LCD display	Glass substrate
Display screen guard (lid)	Aluminium
Optical drive	Poly carbonate plastic
Ethernet and external ports	Polyvinylchloride

III. METHODOLOGY

In the present world of growing computer centric technology, laptops have become a common man need. These laptops' life is usually three to five years. After the service life, the laptops are great amount of scrap to deal with. Among these laptop parts, the back screen is completely made of aluminium and is a reason for a lot of scrap. The scrap has to be melted and it entails a lot of cost and a lot of carbon emissions both in the production and re-cycling.

There are a variety of composite available in the commercial world which could replace this aluminium in a laptop to a certain extent. Figure 1 depicts the back screen surface being replaced and riveted to an aluminium frame in the laptop.

Once the laptop is scrapped, these composite sheets are removed by pulling out the rivets and re-used in another laptop back surface. This reduces the overall weight of the laptop since composites are very less in weight and high in strength when compared to aluminium alloys. However, bending or buckling of composites is a serious threat. But the laptop is designed as a no load member. Ideally speaking, laptop back screen has no load to be put on it. And its primary purpose is to protect the inner LCD screen from any kind of atmospheric pollution or damage. The composite must be tested for any possible pin loads on any point of the composite surface.

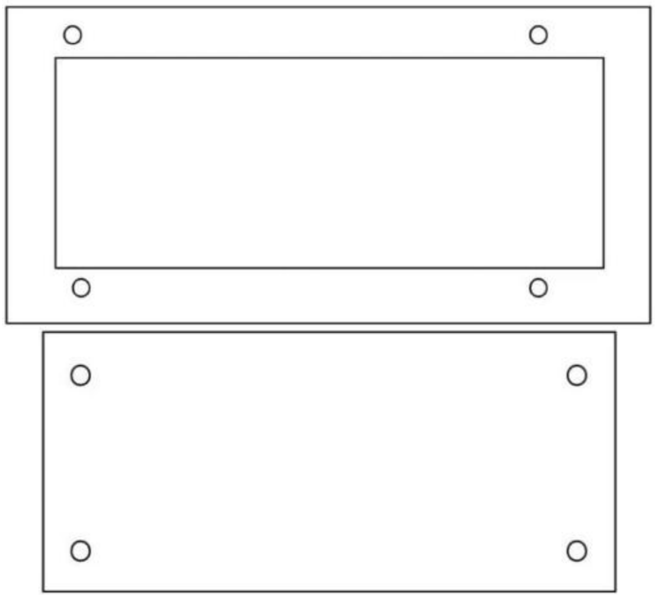

Figure 1. Composite surface plate to be riveted into the aluminium frame.

IV. HYPOTHESIS

Aluminium replaced by any composite would result in a cost reduction of 64.33 percent.

Analysis: The analysis of comparison between aluminium and composites is with respective strength-to-weight ratio. Strength-to weight ratio is defined as the specific strength at failure. It is the measure of strength per unit mass of material before failure. The ultimate tensile strength of 6xxx-Al alloy used in laptops is 310MPa. Aluminium has an density of 2.7 g/cm^3[10].The 6xxx-aluminium be replaced by Aluminium-Silicon Carbide and titanium boride metal matrix composite. The maximum limit of titanium boride is 2.5 % for 10 % SiC reinforcements[11].

Table 2 lists the respective values and Table 3 measures the percentage cost reduction in recycling because of the frequency of recycling.

TABLE 2 - STRENGTH-TO-WEIGHT RATIO OF ALUMINIUM ALLOY AND COMPOSITES [9]

Parameter	**Aluminium**	**Composite**
Material	6000 series Aluminium alloy	Al SiC-TiB_2 MMC
Tensile strength (MPa)	310	460
Strength-to-weight ratio(kN.m/kg)	114.22	169.5

TABLE 3 - ANNUAL RECYCLING COST REDUCTIONS

Parameter	Aluminium	Composite
Recycling cost[8]	9.45 INR per kg	5 INR per kg
Frequency of recycle	5 years	(169.5/114.2)*5 =7.42 years
Annual recycling cost per ton of material	9.45*1000/5 =1890 INR	5*1000/7.42 = 674 INR
Annual Cost saving per ton of material		1890-674 =1216 INR
Percentage reduction in cost	(1890-674) /1890= 64.33	

V. CONCLUSION

A composite is made of two distinct phases of materials- a matrix and a reinforcement. In this paper, both SiC and TiB_2 are reinforcements and the metal matrix is aluminium. This composite when replaces the conventional 6xxxx- aluminium alloy in the laptop lids, results in a percentage cost reduction of 64.33. This is because of reduced recycling of aluminium lids. Thus, the newer material also benefits the environment in the form of reduced carbon emissions.

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