RAPID PRODUCT DEVELOPMENT: A CASE STUDY OF ERGONOMICALLY DESIGNED MOUSE

N. Hayat, M. Y. Anwar*, M. Ajmal*, A. Idress, F. H. Shah and S. Nazir

Faculty of Mechanical Engineering, University of Engineering and Technology, Lahore
*Department of Metallurgical Engineering and Materials Science, University of Engineering and Technology, Lahore
Corresponding author e- mail: nasirhayat@uet.edu.pk

ABSTRACT: It is a well established fact that time to market is a key factor in the success of a new product in this era of free trade. The target of reducing time to market can be achieved by accelerating the development process of a new product. This paper reports a case study of an ergonomically designed computer mouse in which the concepts of reverse engineering and rapid prototyping have been successfully demonstrated. The work ranges from scanning of selected physical object till virtual mold making. By employing the suggested methodology, Small and Medium Scale Industries can lower the development cost associated with a new product. This will consequently lead towards a lower selling price per unit and help in improving the competitive advantages of such industries.

Key words: product development, laser scanning, rapid prototyping.

INTRODUCTION

New product development (NPD) is the set of activities that begins with the perception of a market opportunity and ends with the production, sale and delivery of a product (Ulrich and Eppinger, 2004). Due to higher risk of failure of a new product in the market, Small and Medium Industries cannot afford to spend huge amounts in developing a product susceptible to failure. For developing a new product, a trial and error approach i.e. develop new prototypes, test for acceptability, reformulate and repeat as necessary-can be very costly and time consuming (Lewis et al., 2010). On the other hand, product development is becoming multidisciplinary and technologically complex and occurs at intersection of different fields (Elena and Beatriz, 2011).

In the forthcoming era of free trade, the competitive advantages can be gained by developing new products or modifying existing products in a shortest possible time. During product development cycle, several trade-offs have to be made, i.e., (i) development speed (ii) product cost and (iii) product performance (iv) development program expenses (Smith and Reinersten, 1995). On the other hand, a shift in customers' trend towards customized products can also be considered due to rapidly changing socio-economic pattern. In such cases, to make customized products economically feasible, there is a need to bring down the fixed cost. For example, it may be necessary to produce a spare part when no original drawings/specifications of a component are available. Moreover, it may be necessary to modify the design of such part due to functional reasons.

The recent evolution in the field of rapid prototyping has made it possible to considerably reduce the lead-time and at the same time to minimize the fixed cost. In the present work, all the possibilities at the disposal of a designer have been explored while keeping in view the speed and efficiency of product development at the lowest price. The proposed development strategy is simple and can be easily modified to meet the needs of Small and Medium Scale Industries. The work is of purely academic nature and has no commercial intentions. Therefore, the issues regarding marketing a new product and intellectual property rights have not been covered during this case study.

METHODOLOGY

The general methodology adopted during this case study is given in Figure1.This methodology is simple and particularly beneficial for small and medium scale manufacturing industries and newly established firms. The process outlines step-by-step procedure and tools/software requirements during various development stages of a new product.

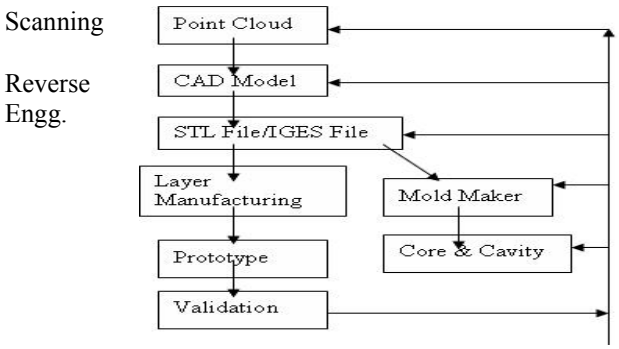

Figure1: The methodology adopted for development stage.

RESULTS AND DISCUSSION

An optical mouse, which is commonly available in the local market and is a frequently used item, was selected for the case study and is shown in Figure 2. This mouse consists of five parts with varying degrees of geometrical complexities. One of the main issues of Reverse Engineering is to obtain a geometrical model (CAD model) from a physical object whose geometrical information is partially or completely unavailable in digitized form (Smith and Reinersten, 1995, Lee and Park, 2000, Son et al., 2002, Tucker et al., 2009). A 3-D laser scanner (Faroarm, faro Technologies Inc.) was used to obtain point cloud data as shown in Figure 3. The obtained point cloud data was refined with the help of Geomagic Studio in order to remove any irregularities due to scanning. Figure 4 (a, b, c, d and e) shows the refined parts of the optical mouse. It is clear from this Figure that the parts contain holes, sharp contours and other geometrical complexities, which are difficult to reproduce.

Figure 2: Optical mouse selected for present case study.

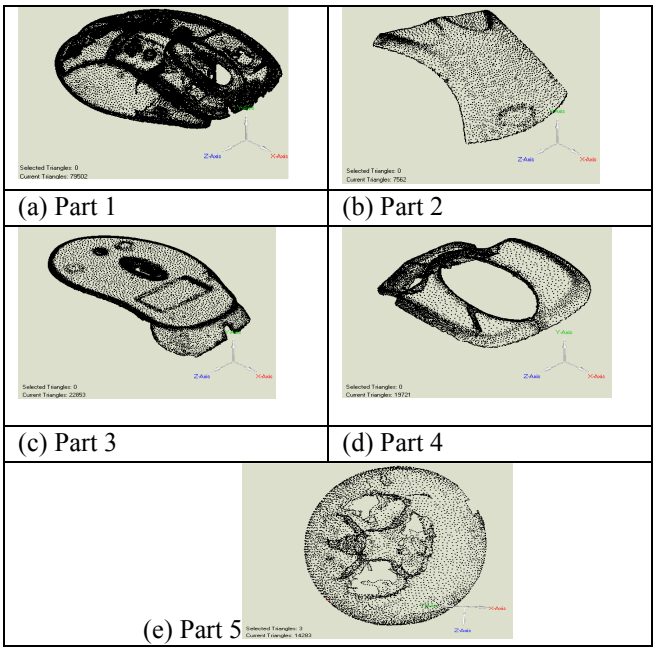

Figure 3: Point cloud data obtained using a 3-D laser scanner.

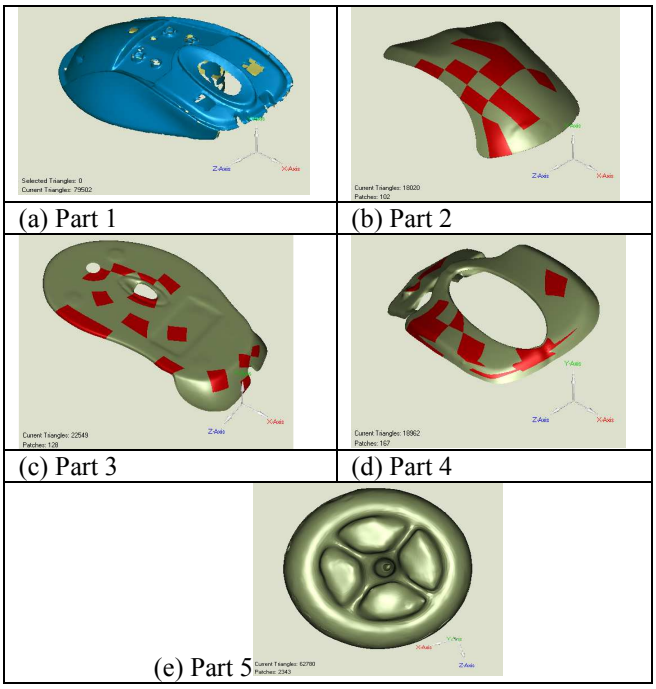

Figure 4: Parts after editing (i.e. 3-D CAD model).

Then the files were converted to STL and IGES format for further processing. The prototypes of all five parts were made through layer manufacturing with the help of STL files on a rapid prototype machine (Z-510, Z-corporation), as shown in Figure 5.

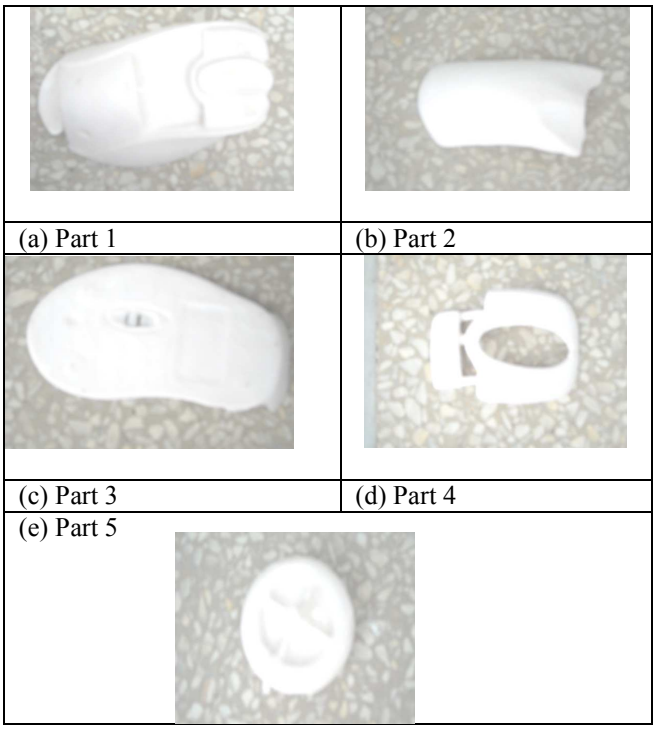

Fig. 5: Prototypes manufactured through layer manufacturing (background is a floor).

It can be seen from the Figure 5 that all the parts including intricate contours and fine details have been developed successfully. The groves on the part 5 were exactly same as were on the original part. In the part 3, the groove for optical light can be seen. Part 1 has been developed as per the ergonomics details. Various shapes keeping in view the ease of operator were considered in the light of Ergonomics data. It was observed that the existing mouse may slightly be modified to make it more users friendly. Part 5 will reside in part 4 and elliptical shape of part 4 can easily accommodate the part 5 without creating any hindrance during the continuous operation of mouse for extended hours. However, the inner details were not considered during the current work.

Moldmaker module of power shape (DelCAM) was used for virtual mold making of all the parts after validation of the prototype. Codes were generated with the help of IGES file for core and cavity of all the five parts. The core and cavity for a part of mouse are shown in Figure 6. The edges of the part were treated as parting line between core and cavity.

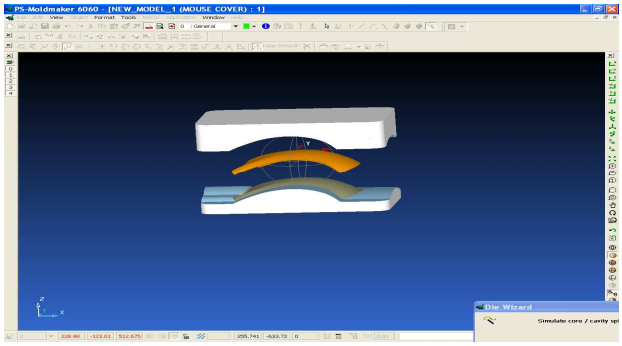

Figure 6: Virtual mold for a prototype part.

The model of mouse wheel was not water tight in GEOMAGIC , therefore, it was recreated with the help of AUTOCAD by taking the readings of the various diameters with the help of a vernier caliper (Figure 7). The model was then imported into PowerSHAPE. After ensuring that the part is now water tight, it was opened in the mold-making wizard known as PS-Moldmaker. Then core and cavity of the wheel were separately made as shown in Figure 8.

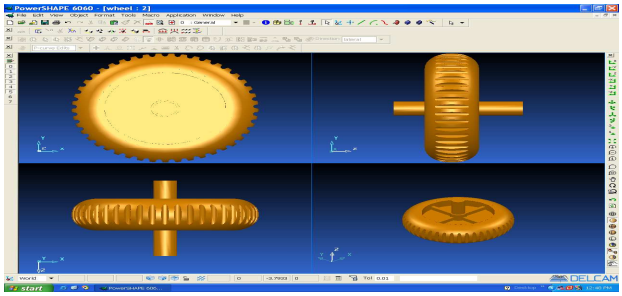

Figure 7: Water tight model of the Scrolling Wheel of the mouse.

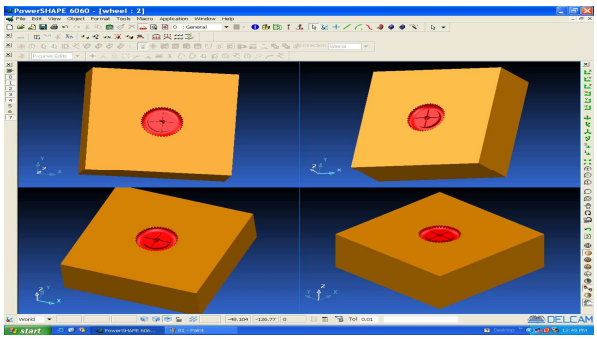

Figure 8: Core and cavity of the mouse wheel.

For each object, material, finish and color specifications may be developed and input in to CAD model to estimate the Bill-of- Material to decide the cost/unit of the developed object.

Conclusions: By making use of digital revolution, the design / redesign and manufacturing of a new product or improvements in existing products can be accomplished at a faster speed and at a lower cost. This has been successfully demonstrated by reverse engineering and virtual mold making of an ergonomically designed mouse. The work can be helpful for medium and small-scale industries trying to develop new product with limited research and development budget. By incorporating the consumers/end users' needs, the proposed methodology can be equally helpful in modification of the existing designs.

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