Retraction

Digital prototyping technique applied for redesigning plastic products

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It has come to the attention of IOP Publishing that this article should not have been submitted for publication owing to its substantial replication of an earlier paper: Adam Andrei et al. Procedia Technology 19 (2015) 221 – 227. This issue was first brought to our attention by one of the authors. The high degree of similarity between these papers constitutes a breach of our ethical policy. As such, this paper is being retracted by IOP Publishing.

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Digital prototyping technique applied for redesigning plastic products

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Abstract. After products are on the market for some time, they often need to be redesigned to meet new market requirements. New products are generally derived from similar but outdated products. Redesigning a product is an important part of the production and development process. The purpose of this paper is to show that using modern technology, like Digital Prototyping in industry is an effective way to produce new products. This paper tries to demonstrate and highlight the effectiveness of the concept of Digital Prototyping, both to reduce the design time of a new product, but also the costs required for implementing this step. The results of this paper show that using Digital Prototyping techniques in designing a new product from an existing one available on the market would offer a significantly lower manufacturing time and cost reduction. The ability to simulate and test a new product with modern CAD-CAM programs in all aspects of production (designing of the 3D model, simulation of the structural resistance, analysis of the injection process and beautification) offers a helpful tool for engineers. The whole process can be realised by one skilled engineer very fast and effective.

1. Introduction

After products are on the market for some time, they often need to be redesigned. New products are generally derived from similar products. Redesigning is an important part of the product development process [1]. In industrial design is always a challenge to make the proper compromise between the most desirable parts shape, manufacturing cost and how resistant the part will be. As consequence, a better, more complex shape will increase the manufacturing cost. Using modern CAD-CAM programs to designing and simulating a new product can offer a manufacturing time reduction and a significantly lower production cost [2]. The basic role of CAD is to precisely define the geometry of a design, as it is critical to all the subsequent activities in the product cycle. Similarly, CAM is the technology concerned with the use of computer systems to plan, manage and control manufacturing operations through either direct or indirect computer interface with the plant’s production resources so that a design can be materialized [3].

Redesigning products can be done using several methods:

- One of them involves using reverse engineering techniques. Reverse engineering is the opposite of forward engineering. It takes an existing product, and creates a CAD model, for
modification or reproduction to the design aspect of the product [4]. Reverse engineering is usually undertaken in order to redesign the system for better maintainability or to produce a copy of a system without access to the design from which it was originally produced [5].

- Another way to redesign includes the integration of scanned images, drawings, in the modeling process. These images serve as a guide for the user when they are modeling the virtual object. The method is called Sketch based 3D modeling and we can say that is part of Top-Down methodology. One can say this because the designer is using the drawings to make a better image of the new product [6];
- The third method is to disassemble a product (or more) and it’s re-designing orders to improve certain characteristics (new function) by adding new components [1].

2. Case study
In this paper we used modern technology based on digital prototyping and designed a new model of roulette from a model already existing on the market.

The chosen product is a tape measure device made of plastic components. Products on the market are relatively simple, they can be improved. For this we will use the existing model and redesign it to add some functional new elements that enhance the entire product.

To achieve this, we followed steps that are presented in this paper:
- Researching and choosing the reference product.

For this paper we are looking for a simple solution existing on the market today that requires and enables more features and functional components, all to contain more items in a single product making it more versatile, easy to use and inexpensive.

- Disassembling the product and studying the component.

At this stage we will use the existing product that will be disassembled and we study each component both in terms of functionality, but also in terms of the material and the degree of functionality.

![Figure 1](image1.jpg)

Figure 1. Isometric view of the exploded assembly.

We will create a CAD geometric model of each part of the studied component with the help of the CAD program SolidWorks. The figure below shows the assembly tape measure device (figure 1) in the exploded view which allows a better perspective on the components of which it is composed.

After we fully understand the functionality of the product, and we have studied each component we will draw, in close cooperation with the department of design and concept, a series of sketches (figure 2) with the purpose of changing, adapting and improving these components. These drawings are intended to cover the requirements of customers, their needs and to provide insight into new products. However, these drawings are not the final version of the products as they are just the reference to the client and design engineer.
Figure 2. Concept sketches with different views and accessories.

3. Designing the product
In order not to substantially increase production costs for this type of product and also to not completely change the entire production line, the redesign decision was reached only for a few components, namely housing tape measure device (figure 3). Along with these changes we will add other new components which will modify and enhance the functionality of the product.

Figure 3. Upper and lower housing.
Components to be presented will be part of the new assembly. The first thing that is added to this new product is a laser sub-assembly. The assembly consists of the laser itself, a switch and batteries needed to power it. The purpose of this laser is to help draw a straight line on a wall, to help fixing of wall cabinets or shelves, etc. The following subset is a tripod that serves to support and stabilize the tape measuring device when the laser is on. The tripod can tilt after any surfaces roulette can be placed in almost any location. Also, with tripod to achieve stabilization and flatness roulette are introduced bubble levels. To keep the batteries in place and to maintain permanent contact between them and close the circuit we will introduce a cap. Its role is not only to keep the batteries but also to allow quick and easy replacement thereof. Another element that is added to this new product is a magnetic support for the scale rule that comes attached to its end.

4. Structural analysis and simulation of the new product assembly
Simulation of a product offers a number of useful data for its design. The simulation results may determine a number of changes, such as the shape and material of the product. In order to simulate this assembly is required to follow certain steps to get the most accurate results compared with the reality. For the simulation we used the Simulation package provided by the CAD program SolidWorks.

Below is the assembly in the final version (figure 4) with all components placed in the operative position.

![Figure 4. The final assembly of the redesigned product.](image)

Simulation of a fall from 1.5 m
An analysis is made of the impact test for the plastic housing, as a first step towards the simulation of the impact event for design and development purposes. This simulation provides important data on the resistance assembly instant shock. We run the simulation on the plastic housing with the added mass of all the new components except the tripod.

To achieve this simulation we must follow these steps:
- The choice of simulation;
- The choice of material (ABS);
- The choice of fall distance (h = 1.5m);
- Realization of the mesh (the more complex, the more the results will be accurate);
- Interpretation of data.

The maximum Von Misses stress resulted from the finite element simulations for the drop impact test of the housing tape was 18.952 [MPa] (figure 5). The maximum yield strength for ABS from the literature [7] is 42.5 [MPa] up to 44.2 [MPa].

Analyzing the data from figure 5 we conclude that upon impact, the housing tape measure does not suffer major damage leading to redesign it.

Analysis of the injection molding process
This analysis produces a set of parameters that are very important for the production of such components. The CAD software used was MoldFlow. The parameters are: the speed of injection, the
filling time of the mold, 1.09 sec. (figure 6), the cooling times, 13.39 sec. (figure 7). The material chosen for this product is ABS (acrylonitrile-butadiene-styrene) because of its higher injection load resistance and a significantly melt flow rate (MRF = 45 g/10min).

Figure 5. Interpretation of data.

Figure 6. The time required to fill the mold (1.09 sec).

Figure 7. Product cooling time (13.39 sec).

4. Conclusions
In this paper we presented a modern and fast way of creating a new product from an existing one. There were used both known techniques for modeling parts and components and modern techniques for simulation and analysis of the product. Finally, we obtained a new product with new features that can be used in many fields.

The results of this paper show that using advance CAD-CAM techniques in designing a new product from an existing one available on the market mould offers a significantly manufacturing time and cost reduction. The ability to simulate and test a new product with modern CAD-CAM programs in all aspects of production (designing of the 3D model, simulation of the structural resistance, analysis of the injection process and beautification) offers a helpful tool for engineers. The whole process can be realised by one skilled engineer very fast and effective.
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