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APPLICATION OF RAPID PROTOTYPING IN POLYMER PRODUCT DEVELOPMENT: CASE STUDIES

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Abstract: *The approach to process of development of polymer parts with application of Rapid Prototyping (RP) processes can minimize a potential faults on the product during product development. The paper will present few examples of successful application of RP processes and actual benefits of application of prototypes in polymer product development process.*
Key words: *Rapid Prototyping, development, polymer product*

1. INTRODUCTION

Injection moulding process is one of the most important processes for production of polymer parts. It must be noted that 75 % of faults in the lifetime of injection moulded polymer parts are initiated in the process of developing and designing the parts. Moreover, in the conventional product development process, approximately 80 % of faults generated during early phases of product design are recognized during production or quality control (Fig. 1). In the later development process phases it is very difficult and costly to correct these faults. This means that during product development process it is necessary to make correct decisions, and make them as soon as possible. (Raos & Ļatiĺ, 1992).

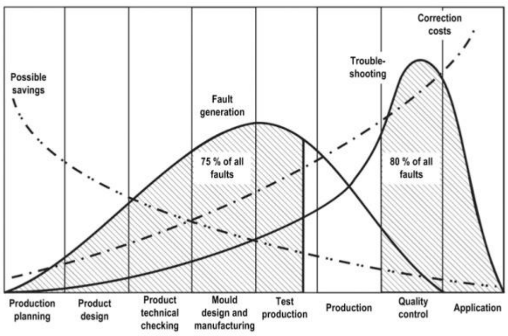

Fig. 1. Faults generation and troubleshooting in the product lifetime (Raos & Ļatiĺ, 1992)

One of possible, effective and already proven tools is application of Rapid Prototyping (RP) processes, which enable obtaining physical models in early stage of product development (Gebhardt, 2003). These models can be used in order to prevent faults in product design and function, as well as for good communication between experts involved in product development and production (Godec, 2005). The paper will present three examples of successful application of RP processes and prototypes in polymer product development processes.

2. UMBRELLA HANDLE

The task of the project was development of childrenôs umbrella handle with the shape of Coca Cola bottle. The main idea was the possibility to turn on and off the LED lights placed on the top of the umbrella. All components had to be assembled inside the handle and connected with wire with the top of the umbrella with LED lights. Therefore the handle had to be adapted to the shape and size of childôs hands, and had to act as a case for batteries and switch. At the same time, the handle had to maintain the shape of Coca Cola bottle in adequate scale (Fig. 2).

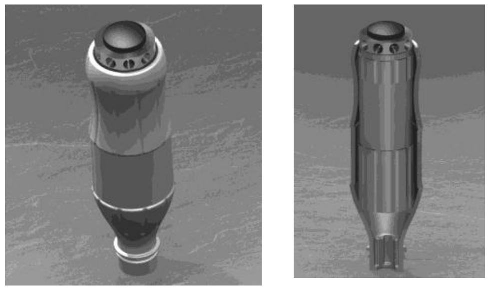

Fig. 2. Computer model of the umbrella handle

After generating first 3D computer model of handle assembly, a PolyJet RP process was used to create a functional prototype of the umbrella handle. The material used for production of the umbrella handle was from FullCure resin family (Fig. 3).

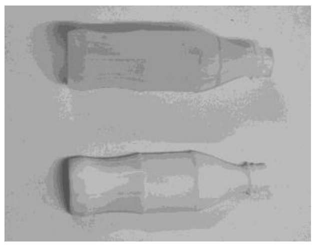

Fig. 3. PolyJet functional prototypes of handle

The benefit of application of RP model in this case was the ability to check the design of umbrella handle directly in child's hands and for checking the assembly possibilities. First of all, the assembly of the handle on the umbrella frame, and second, the assembly of the electrical components inside the handle. Moreover, application of RP process enabled finishing of the complete product within 3 weeks and participation of the product in innovation exhibition.

3. MARGARINE CONTAINER

The task of the project was to develop a new packaging for margarine. The main demands were to generate a new, recognizable packaging that will assure a design divergence from competitors, the container had to be a thin-walled product (wall thickness below 0.5 mm), and container volume had to be enough for 20 g of margarine. (Bujaniĺ at al., 2004) The time-to-market was very important in the project because the final product was intended for hotels during summer holidays. The whole project had to be finished in two months.

The first step of the development process was the creation of 3D computer model of margarine container (Fig. 4). In the next step, a Selective Laser Sintering was used to create a functional prototype of the container (Fig. 5). The material used for production of the prototype was PA (Duraform).

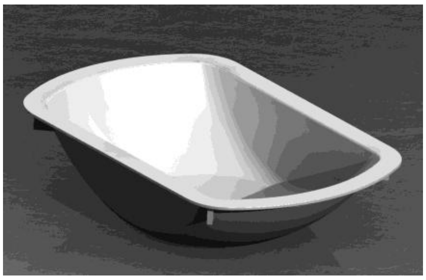

Fig. 4. Margarine container ï 20 g (3D computer model)

The prototype was used initially for communication with people from food industry, but also for the purpose of ordering a margarine line and for quotations for mould for injection moulding production.

Fig. 5. Margarine containers (SLS prototypes)

The main benefit of application of the functional model was recognition of a fault during container design. Container designer had the information about the density of the margarine in the solid state. However, the margarine is filled in-line into the container in the molten state, which means that for the same weight (20 g) margarine needs a larger volume. After testing of the prototype container in-line, the conclusion was that the container has to be enlarged. The conclusion was made in the early stage of product development, and container redesign took only few hours. The main saving in the project was avoiding of production of mould for injection moulding based on too small container volume.

4. PLOTTER SLIDE MECHANISM

The task of the project was the replacement of the broken part of slide mechanism of the older HP Design Jet plotter (KoliÍ, 2007). The main problem in such situation is a lack of spare parts. Therefore, the broken part was measured, designed (Fig. 6) and the PolyJet process was used to create new part. The material used for the production of new plotter part was of FullCure resin family.

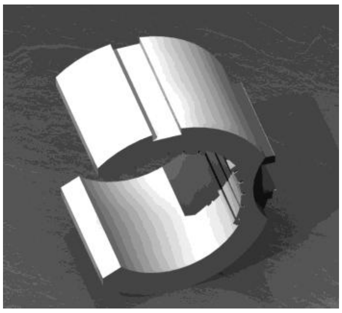

Fig. 6. Computer model of new spare part of the plotter

The main benefit of the application of Rapid Prototyping process was the ability to produce a spare part which would otherwise be very difficult to find at the market. PolyJet process enabled the production of accurate part that was actually used in the plotter.

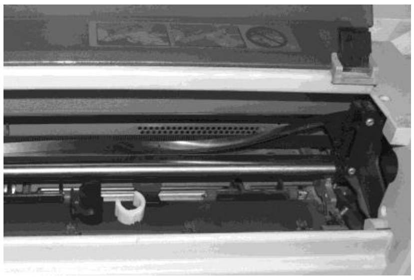

Fig. 7. Spare part produced with PolyJet process

5. CONCLUSION

Modern approach in the product development from idea to final product more and more involves application of Rapid Prototyping processes in order to reduce a time to market of certain product and to raise the quality of the final product to a higher level. The application of Rapid Prototyping processes enables generating a physical model of future product at any stage of product development, which enables higher quality of product analysis and communication between all experts involved in product development process. Moreover, in many cases, the models produced by Rapid Protoyping processes are used directly as final products.

Presented cases in the paper are examples of successful application of Rapid Prototyping processes and RP models in different projects. Each one of the shown projects resulted in high quality final products in very short time, mainly thanks to application of Rapid Prototyping in development or production processes. The difference between products shows that there is practically no limit of application of Rapid Prototyping in product development and production. New materials for the production of RP models enable constant spreading of their application area.

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