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IMPACT OF RAPID PROTOTYPING TECHNIQUES FOR THE MANUFACTURING OF NEW PRODUCT

Abstract: In this article a problem of manufacturing of new products is described. It requires inter alia making a prototype with conventional or advanced technologies. Prototype can be fabricated with use of rapid prototyping technics. This technics can have great impact on the preparation of manufacturing process. An example of design and fabrication of a prototype with a FDM technics is presented. Also advantages and disadvantages of this technics and application possibilities are discussed.

1. Introduction

Implementation of manufacturing a new product requires a detailed process of design and engineering. Next the technical preparation of production and the development of technical and technology documentation in the form of drawings, lists of parts, the functional characteristics of a product and instruction cards describing the technological process of the product is needed. Verification of the prepared documentation is carried out by implementing and testing the prototype, which is a reference copy of a product that reflects some or all of the features and functions of the product [1]. Prototype is often made using traditional manufacturing techniques such as casting, metal forming, machining.

This is troublesome and time-consuming and requires the participation of highly skilled workers. So now the industries are becoming more widely used rapid prototyping techniques (RP). They use different ways for the additive manufacturing and the different technical solutions are used by various manufacturers [2]. These techniques are constantly being improved and have many advantages, which are particularly evident during the fabrication of prototypes.

2. Characteristic of rapid prototyping

The fabrication of parts with RP technology is done in one operation. On the basis of a computer model of the object created in a CAD program, with the RP machine, a physical object is created. This is created gradually, by incrementally application of successive thin layers made from specific material. In this way is possible to produce prototypes with complex curved shapes, including for example internal voids. Obtained objects can have

different properties depending on the used material. Typically, these properties are still too low as the requirements of the end products but can be successfully used as prototypes. So are mainly used in widely understood prototyping.
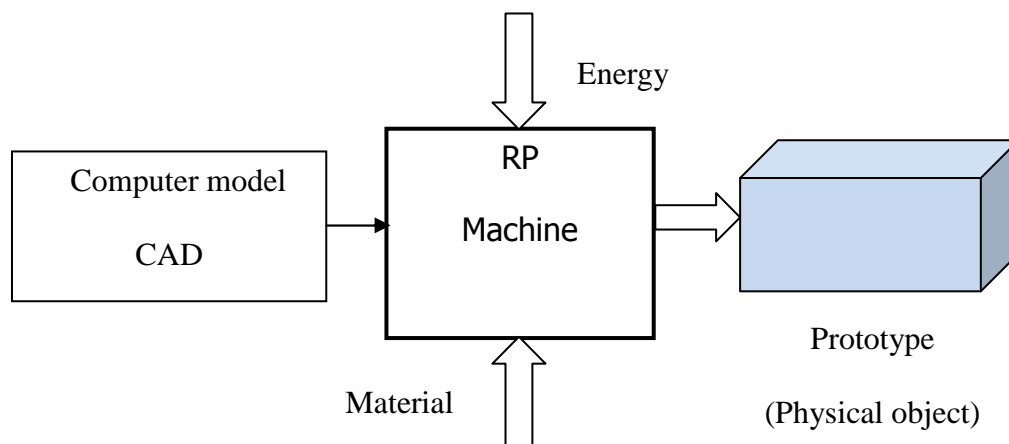

Fig.1. Schema of rapid prototyping technology

Compared to traditional manufacturing, RP techniques have many advantages. First of all, are that the objects of complex shape can be achieved much faster than with conventional methods.

Tab. 1. Main advantages and disadvantages of rapid prototyping [2,3]

Advantages	Disadvantages
- Possibility of parts with a very complex shape, - Faster than traditional methods of manufacturing, - Use of different materials, - Possibility of making tools, products or functional parts.	- High cost of equipment and materials, - Less accurate than after machining, - Worse useful properties of most RP materials, - Limited dimensions.

Fabrication and testing of the prototype allows to validate the technical assumptions and design documentation. Also allows to specify the errors and weaknesses that can be improved in the early design stage of a product. Some RP technics used advanced materials which allows building of functional prototypes that can be used as tools, new parts or spare parts [3]. Obtained after RP parts can be also treated with machining, painting, gluing etc.

3. Practical example

Problem Description: There is new robot in our laboratory. It has otherwise terminated connection, therefore, the gripers that have been used do not fit into the mounting flange due to the different arrangement of holes for mounting screws. Robot and gripper flanges have similar size but are different in shape and other dimensions and spacing of holes. The proposed solution involves design of a new adapter that allows attachment of existing grippers at the new robot.
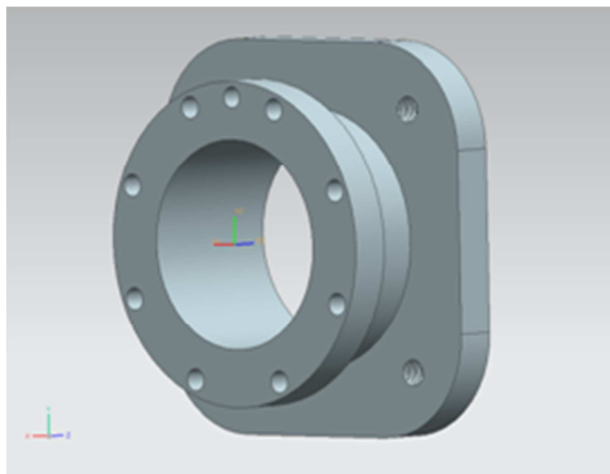

Fig.2. Design of the adapter in CAD system

For the design of an adapter the CAD software NX 7.0 was used. The designed adapter is shown on the figure 2. It has two different mounting flanges and cylindrical connecting part. Manufacturing this adapter with conventional methods requires cutting of metal, welding and machining. This is complicated and needs special machines, workers and much time. Because only one part was needed, therefore a rapid prototyping technic was used. We decided to use a FDM (Fused Deposition Modeling) technics because of good properties of the material. In particular the strength and stiffness is better than with other RP technics.

This method requires preparing of the CAD data in STL file format. FDM begins with a software process, which processes an STL file mathematically slicing and orienting the model for the build process. If required, support structures are automatically generated. The machine dispenses two materials – one for the model and one for a disposable support structure.

FDM works on an "additive" principle by laying down material (ABS type) in thin layers that have thickness about 0,2 mm [4]. A thermoplastic thin wire supplies material to an extrusion nozzle which can turn the flow on and off. The nozzle is heated to melt the material and can be precisely moved in both horizontal and vertical directions by a numerically controlled mechanism. Whole building process of a part requires a few hours. Then soluble support material is dissolved with specialized mechanical agitation equipment utilizing a heated sodium hydroxide solution.

Finished adapter (white color) with gripper mounted on a robot is shown on the figure 3. This robot gripper is designed for small payload under 5 kg. Tests that have been done with robot gripper show that all works very well and no correction of design were required.

Fig.2. Finished adapter (white) mounted on the robot

4. **Conclusion**

The prototype tests show that adapter fulfilled its task and can be used as a functional part of a robot, expanding his opportunities. Application of RP in this case has brought tangible benefits consisting principally of obtaining the finished item faster than by using traditional manufacturing techniques. Tests performed on the prototype proved to be dimensionally accurate enough that no additional treatment was needed. Although the used material has a lower strength than steel, was found to be sufficient in this case.

The cost of prototyping methods is still quite high but compared with the traditional methods of small production, the costs are at similar level. RP methods are constantly being improved. New modern machines and materials can be used. Also the cost of RP is decreasing and therefore they are gradually becoming more widely used. Now is possible the use of so-called rapid manufacturing or rapid production using RP techniques such as Selective Laser Sintering or Vacuum Casting [2]. This allows small scale production with variety number of pieces in the batch from a several to over a dozen parts.

 This increases the flexibility of production, allows to better compete for customers and gives the benefits from reducing production time and cost savings.

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