Chapter 15
Selection of Prototyping Process and Part Orientation for Virtually Manufactured Gears

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ABSTRACT

This chapter explores transformation of a virtually produced gear to a physical product using rapid prototyping technique. The same can be segregated into two parts. The first being selection of the best possible rapid prototyping technique using dynamic mechanical analysis and the next was optimization of the process parameters of the selected rapid prototyping technique considering tensile strength as the criteria. The results indicated that fused deposition modeling process provides the best solution amongst the techniques studied. Moreover, as orientation of the product in rapid prototyping techniques plays an important role in providing the strength and also accuracy of the product profile, from results it was also ascertained that strength and profile accuracy of the product was optimized with horizontal position.

INTRODUCTION

The most prominent challenge faced by product designers is to be able to present a tangible product. Despite advancements in 3D CAD technologies, such situations usually end with the product designer being asked: “Can you prove it?” Additive manufacturing or in the context of this work, rapid prototyping, has come as a shot in the arm. With the ability to present a tangible representation of the concept in the form of a physical object within short product lifecycles and even shorter development times, this concept is gaining importance and popularity with designers and engineers.

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In the present work, an arrangement is required to be made to transform a virtual object into reality using Rapid Prototype (RP) technique in order to produce a virtually manufactured gear. The database of the output product i.e. the virtual gear serves as the input files for RP machine and plastic gears are manufactured.

RAPID PROTOTYPING TECHNIQUES

Rapid prototyping or 'Layered manufacturing technology' describes a wide range of techniques wherein 3-dimensional objects are constructed in laminated form. Though diverse, each of these shares the same set of fundamental parameters.

First, the object to be fabricated must be described in terms of an accurate 3-dimensional design representation. This must then be reformatted to describe the object in terms of a number of slices with finite thickness. This "slice information" is then used to fabricate the appropriate number of slices from the desired material. These slices are assembled to form the solid object. In practice, a number of the current technologies combine the slice fabrication and assembly processes by using a previously deposited slice as a template for the deposition of subsequent slices. Hence Rapid prototyping (RP) or layered manufacturing technology got its existence to fill the need in the manufacturing industry for development of representative or functional prototypes of objects normally manufactured in large quantities by tooled processes (Kai and Fai 1997). Models and prototypes manufactured with RP technology not only for visualization purposes but also to build functional parts. It is an important technology as it has potential to reduce the manufacturing lead time of the product up to 30–50% even when the relative part complexity is very high (Massod et al. 2001).

However, many RP techniques are available and the output of these processes also differs. Therefore, it is essential to select the appropriate RP technique for the generation of the gears. The quality of rapid prototyped parts mainly depends on careful selection of process variables. Hence, identifying the RP process parameters that affect the quality of processed parts is of utmost importance. In recent years, eminent researchers such as Masood, S.H. and his team (Massod et al. 2000, Massod et al. 2003, Omar et al. 2015 and Omar et al. 2016) have explored a number of ways to improve the mechanical properties and part quality using various experimental design techniques and concepts.

DIFFERENT RP PROCESSES

Various RP processes have been developed and also being developed in order to improve the realization of a virtual product to the extent possible. In this case as the product to be produced is of a non-metallic material hence out of all the RP techniques available only Stereolithography (SL), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM) and Laminated Object Manufacturing (LOM) have been studied.

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