Chapter 11

SELECTION OF RAPID MANUFACTURING TECHNOLOGIES UNDER EPISTEMIC UNCERTAINTY

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Abstract:

Rapid Prototyping (RP) is the process of building three-dimensional objects, in layers, using additive manufacturing. Rapid Manufacturing (RM) is the use of RP technologies to manufacture end-use, or finished, products. At small lot sizes, such as with customized products, traditional manufacturing technologies become infeasible due to the high costs of tooling and setup. RM offers the opportunity to produce these customized products economically. Coupled with the customization opportunities afforded by RM is a certain degree of uncertainty. This uncertainty is mainly attributed to the lack of information known about what the customer's specific requirements and preferences are at the time of production. In this paper, we present an overall method for selection of a RM technology under the geometric uncertainty inherent to mass customization. Specifically, we define the types of uncertainty inherent to RM (epistemic), propose a method to account for this uncertainty in a selection process

(interval analysis), and propose a method to select a technology under uncertainty (Hurwicz selection criterion). We illustrate our method with examples on the selection of an RM technology to produce custom caster wheels and custom hearing aid shells.

Key words:

Rapid Manufacturing; Selection; Epistemic Uncertainty; Decision Support Problem Technique.

11.1 Introduction

Rapid Prototyping (RP) is the process of building three-dimensional objects, in layers, using additive manufacturing. This process is done quickly, relative to other "one-off" manufacturing techniques. Companies of all sizes rely on RP in an effort to reduce time to market, improve quality, and reduce costs[1].

Rapid Manufacturing (RM) is the use of the RP technologies to manufacture end-use products, or finished parts. Recent studies have shown that companies have a strong interest in using RP to produce customized products. Some examples include Siemens and Phonak (hearing aid shells), Boeing's Rocketdyne (manufacturing hundreds of parts for International Space Station and the space shuttle fleet, F-18 fighter jets, etc.), etc[1]. There is also strong interest by the biomedical field in these types of technologies.

Given RM's relatively recent introduction, there is still a lot of skepticism surrounding these technologies. Some particular areas of concern are the part cost, build time, and production quality of the parts produced using RM, compared to that of traditional manufacturing technologies. Equally important, how does one select one of these technologies out of over 34 worldwide manufacturers of these machines? We believe that a systematic method for selection of the RM technologies will be critical to its emergence in the manufacturing enterprises of tomorrow.

One of RM's main advantages is its ability to produce customized parts. At large lot sizes, conventional manufacturing technologies have proven to be the most economical. At small lot sizes (such as the case for customized parts), because of the high cost of tooling and setup, conventional manufacturing technologies become infeasible. This is where RM is a key. RM offers the ability to produce large amounts of highly customized parts at a relatively fast pace. This customization ability introduces considerable