

### 3. Determining if Additive Fabrication Can Help You

This chapter discusses when to use additive fabrication - and when not to. It provides a basic understanding of the limitations of the technologies compared to common subtractive methods. System specifications are explained and interpreted, and the fundamental characteristics of all the common methods of additive fabrication are compared. Once you've determined if additive fabrication is likely to be advantageous, it provides the basic information you need to move ahead.

#### ***Do I really need Additive Fabrication? Do I have other choices?***

##### **Rapid prototyping is a misnomer.**

As previously mentioned, the technology is not always used to make prototypes nor is it even especially rapid in many instances. While we may speak of rapid prototyping and use the terminology without embarrassment, we are best served by thinking about these multifarious technologies in terms of their most common and defining attribute: Rapid prototyping is computer-controlled additive fabrication. Once the concept of adding materials together to make an object or a part is firmly entrenched, it becomes easier to understand when using these technologies may be advantageous for a particular application - and when it's best to avoid them altogether.

**Additive fabrication methods are not better than subtractive ones**, nor will they become complete replacements for them. Milling, turning, EDM and other subtractive methods have reached an extraordinary level of development and they continue to evolve. They are fast, versatile, inexpensive, readily available and well-understood by large numbers of practitioners. Indeed, in many if not the majority of cases they are quite sufficient to make prototypes rapidly, and as yet have no equal when it's necessary to make very precise parts in final materials.

**Additive technologies are instead complementary to subtractive ones**, just as the name implies. They should be used if the situation calls for:

- complex or intricate geometric forms,
- simultaneous fabrication of multiple parts into a single assembly,
- multiple materials or composite materials in the same part.

The first two items are closely related, of course. An assembly of multiple simple parts leads to an increase in geometric complexity and the stacking-up of just a few trivial individual parts can make for a difficult subtractive machining problem. RP circumvents complexity by reducing all geometries to a series of simple layers. The selection of additive technology is thus largely a matter of determining that a particular geometry demands it.

The third item, the use of multiple materials, is a subject of present day research and development. For most applications today, it's not an important consideration. Nevertheless, the capability is beginning to mature in several rapid prototyping technologies, and as it becomes more widely available more applications will take advantage of it. What's interesting about it is that additive technologies make it possible to completely control the composition of a part at every geometric

location. Thus, RP is the enabling technology for controlled material composition as well as for geometric control.

### ***How complex does a geometry have to be to require rapid prototyping?***

If we consider a couple of limiting cases we see that the border line is a fuzzy one at best. In fact, the only indisputable all-inclusive statements that can be made are for such limiting cases. All else is flux. For example, it's pretty clear that if what you want to end up with is a cube of some kind of metal with dimensions of a few inches on each side, the best method you can choose to accomplish this is subtractive machining by means of a CNC milling machine. Likewise, if you would like to make a similarly-sized metal cylinder, a lathe would be the obvious choice.

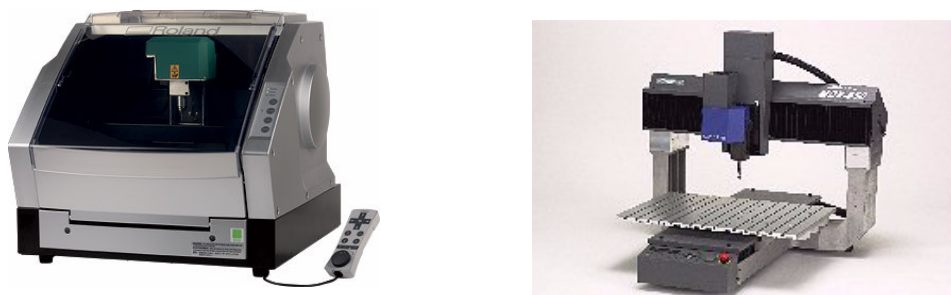


**Fig. 3.1. Simple geometric shapes are best fabricated using subtractive CNC.**



**Fig. 3.2. Complex or compound shapes are best fabricated using rapid prototyping.**  
(Courtesy, L-R: Cadem A.S; Z Corp.; Cadem A.S.)

There are a lot of choices available for small, inexpensive CNC equipment that may well be sufficient. Vendors of these machines have improved software and specifically addressed the rapid prototyping market in recent years. Nevertheless, you'll probably need a basic understanding of machining practices to use them successfully.



**Fig. 3.3. Small, Desktop milling machines. The Model JWX30, shown on the left, is specially-configured for jewelry applications.**  
(Courtesy, Roland DGA Corp.)

At the other extreme, it's also clear that if what you want to end up with is a part with complex curves, compound surfaces and undercuts the choice is obviously additive fabrication. You might not be able to make the part or the object in the required final material using RP, but avoiding complex calculations, set-ups and other daunting tasks makes the choice clear. If you can get your hands on a part that accurately reflects the desired geometry, there are lots of ways to change that into another material.

One reason that rapid prototyping is often the best choice is that the world is full of such complex shapes. Almost any consumer product, be it automobile or shampoo bottle, would be quite difficult to machine subtractively. Indeed, we ourselves, internally and externally are difficult to describe mathematically and most of our parts are difficult to machine and oddly-sized. This is also true for many sculptures, jewelry and increasingly so for modern architectural forms. But, where to draw the line? What is the defining feature that forces you to go one way or another? It's not always obvious, but the additive nature of the technologies is a help in making the determination.

### **Geometric complexity has implications.**

You probably don't need to think about rapid prototyping if what you're trying to do doesn't involve complex geometry in some way, but there may be other reasons to use it, as well. It's fairly easy to understand that the application of rapid prototyping to a complex machining task can save a lot of time, or that making a complex part or tool quickly can greatly reduce your time to market. What's not so obvious is that the very existence of rapid prototyping can change the way a product is designed in the first place and make it possible to design a part or object having much greater complexity, or with such unique functionality that only RP can be used to make it. In other words, the very existence of a process that allows for complexity can change what we attempt to make in the first place.

One interesting example of how RP is influencing an important application in terms of both geometry and materials is in the development of injection molds to make plastic parts. By incorporating cooling channels into the mold that closely follow the contours of the part being made, and by varying the composition of the metals used to make the mold throughout its volume, it becomes possible to make molded plastic parts much faster and at substantially lower cost. It would not be possible to accomplish this without the point by point control of the enabling technology of rapid prototyping.

**Fig. 3.4. Injection mold with conformal cooling fabricated by Laser Engineered Net Shaping™ (LENS®)**  
(Courtesy, Optomec.)



The geometric control afforded by rapid prototyping allows for the manufacturing of more economically. If the intent is to make a part, it is easily possible to pay for the cost of an expensive tool for a small number. But, if you need to make ten or a hundred of a part, it is possible to make a tool of any reasonable complexity, and the cost of the tool. Rapid prototyping makes it possible in many cases

**The rest of the Chapter is Omitted in this brief sample.**

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