Rapid Prototyping for the HP CE Project

In the past few years, methods offering the possibility of transforming 3D CAD data directly into a ready-to-install part have experienced a steep upturn. These methods, which have been commercially available for about ten years now, are generally known under the catchword "rapid prototyping." Some of these methods and their combination with different replication techniques have reached the real aim of rapid prototyping, namely the reduction of time to market. Within the HP capillary electrophoresis (CE) project, rapid prototyping methods became indispensable, not only because of the ambitious project schedule, but also because of the fact that some parts, because of their complexity, could not have been produced in the traditional way without substantial compromises.

At the Waldbronn Analytical Division, these methods were used for the first time, involving significant risk because none of the people concerned could rely on personal experience. Another reason for using rapid prototyping methods certainly was the cost aspect. However, it proved necessary to balance the requirements of the individual development steps, the time available, and the complexity of the individual parts against one another. In accordance with part requirements, three methods were pursued in the HP CE project, two ways to get a resin-plastic part and a third method to get an alumina part:

- 3D data → stereolithography process → vacuum casting → plastic model
- 3D data → Solider process → vacuum casting → plastic model
- 3D data → STL file (Fig.1) → stereolithography process →STL model (Fig. 2) → vacuum casting with silicone → wax model (Fig. 3) →ceramic shell for traditional investment casting for alumina parts (Fig.4).

The real rapid prototyping step results in directly translating the 3D construction data into a solid part. The principle of all three methods mentioned above is similar: a 3D computer model is split into layers of a certain thickness by software.

Various methods are applied to copy the section in question to materials such as photopolymers or powdery thermoplastics by using different reproduction techniques. This procedure is repeated until the whole part, composed of hundreds of layers, is complete (see Fig. 5).

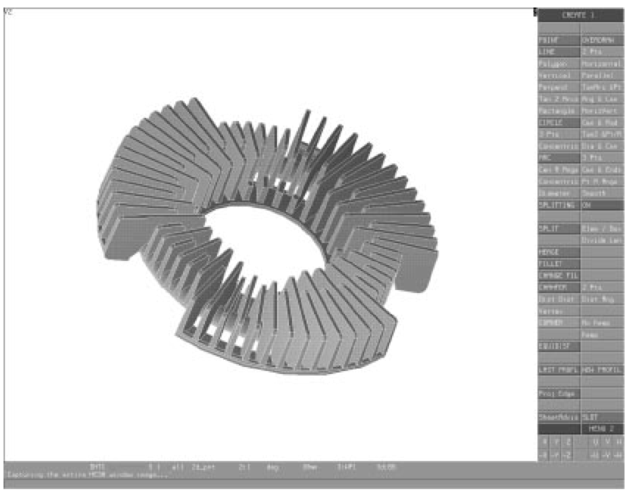

Fig. 1. STL file created with a CAD application.

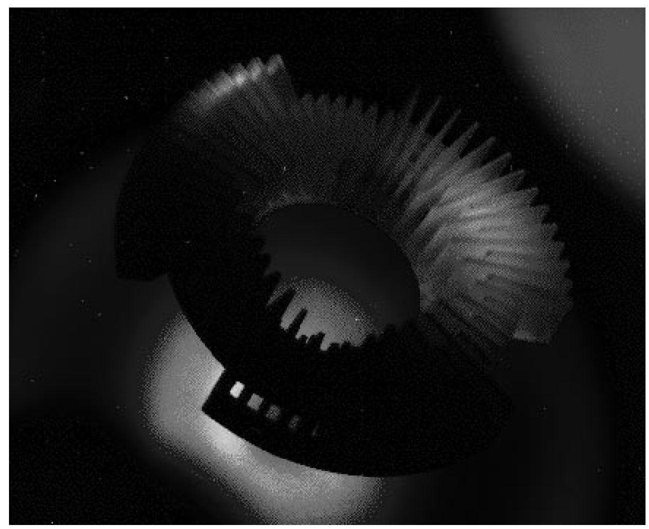

Fig. 2. STL model.

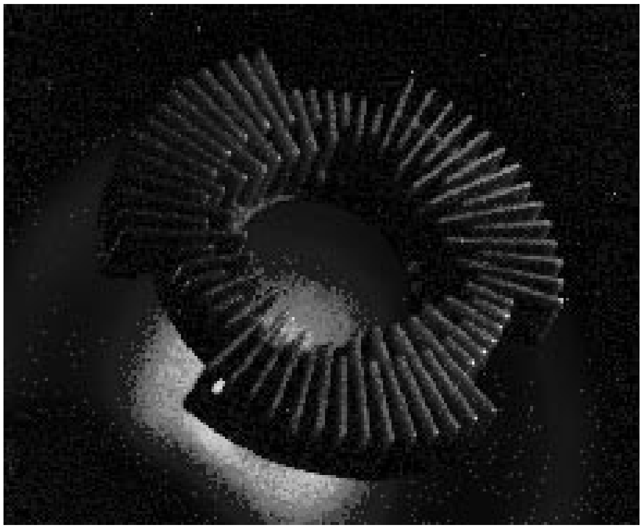

Fig. 3. Wax model.

Depending on the method applied, the 3D data has to be prepared in different ways (e.g., support framework). Regarding the actual formation of the part, however, each method has its process-specific advantages and disadvantages.

In qualification of these rapid prototyping methods, however, it must be pointed out that the parts cannot be used without costly subsequent treatment and replication—preferably with silicone—if specific requirements on surface quality, accuracy, and stability are to be met.

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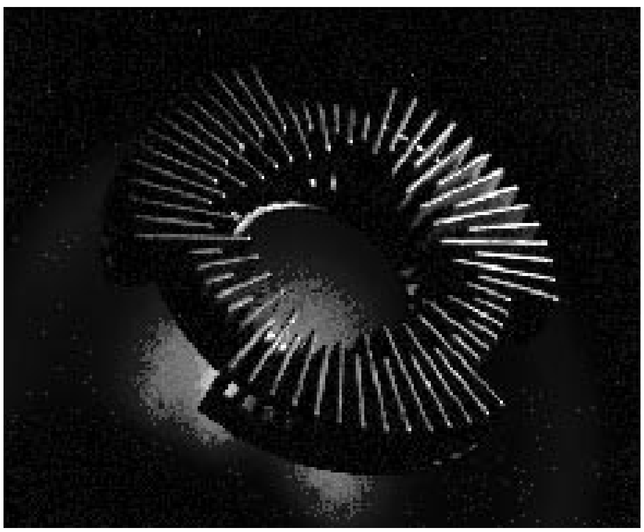

Fig. 4. Production part.

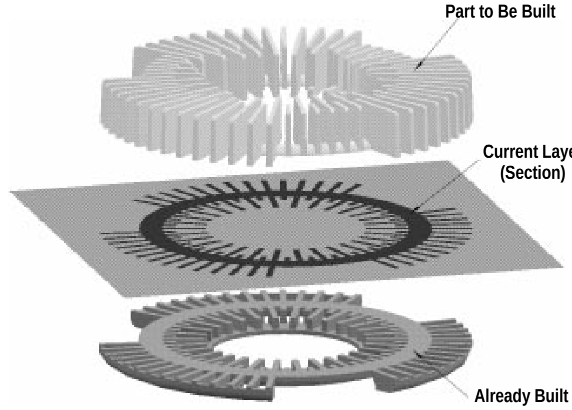

Fig. 5. The solid models are built up in layers.