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COIMBATORE-641 035, TAMIL NADU



Department of Aerospace Engineering

19AST202 AIRCRAFT PRODUCTION TECHNOLOGY

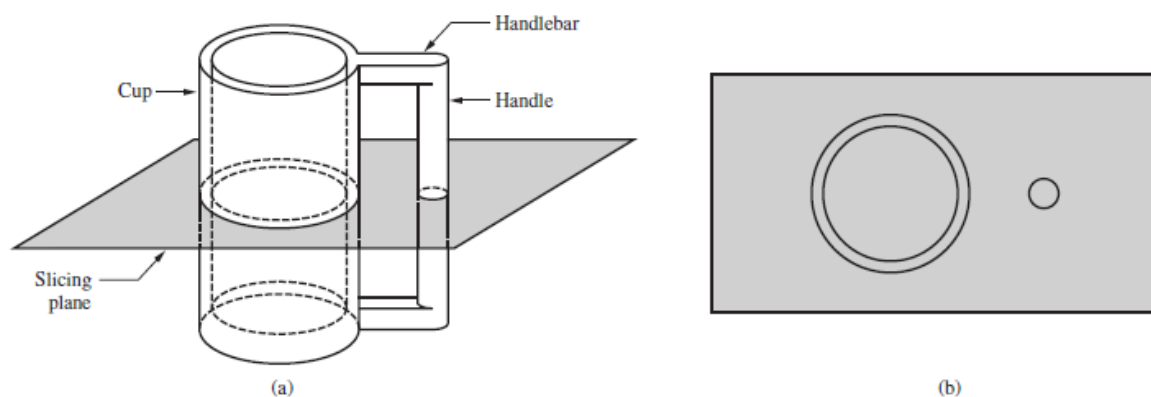
ADDITIVE MANUFACTURING IN AEROSPACE

Additive manufacturing technologies involves the following steps

1. **Geometric modeling.** This involves creation of a solid model of the component on a CAD system to define its enclosed volume. Solid modeling is the preferred technique because it provides a complete and unambiguous mathematical representation of the geometry. The important issue is to distinguish the interior (mass) of the part from its exterior, and solid modeling provides for this distinction.

2. **Tessellation of the geometric model.** In this step, the CAD model is converted into a format that approximates its surfaces by triangles, with their vertices arranged to distinguish the object's interior from its exterior. The common tessellation format used in rapid prototyping is STL, which has become the de facto standard input format for nearly all RP systems.

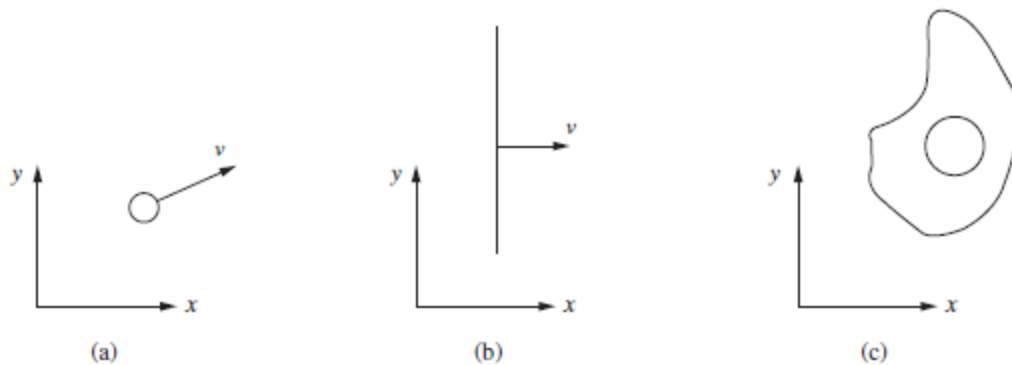
3. **Slicing of the model into layers.** The model in STL file format is then sliced into closely spaced parallel horizontal layers. Conversion of a solid model into layers is illustrated in Figure. These layers are subsequently used by the RP system to construct the physical model. By convention, the layers are formed in the x-y plane, and the layering procedure occurs in the z-axis direction. For each layer, a path is generated, called the STI file, which will be followed by the RP system to create the layer.



Conversion of a solid model of an object into layers (only one layer is shown).

Starting material types in additive manufacturing are mostly polymers and metals, although developments underway include ceramics and even composite materials. Wax is also sometimes used for part prototyping because it can readily be remelted to make other parts. The physical forms of the materials include liquids (photo-curable polymers); powders (polymers, metals, and ceramics); filaments (thermoplastic filaments, metal wire); and thin sheets (plastic, metal foil, and paper).

The formation of each layer in the AM building process is accomplished by various techniques, including ultraviolet lasers and other light sources, electron beams, printing heads based on inkjet technology, extrusion nozzles, and cutting knives. These layer-formation techniques operate by one or more of three alternative scanning modes: (1) moving spot, for example, a laser spot moving across a layer of photo-curable liquid polymer; (2) moving line, consisting of a linear array of spots that sweeps across the entire layer in one translational motion; and (3) area mode, in which the entire layer is created at the same time using a mask projection system. The time to complete each layer can be significant using the moving spot mode. The moving line mode is faster, and the area mode is the fastest. The three scanning modes are depicted in Figure.



Three scanning modes for creating a layer: (a) moving spot mode, (b) moving line mode, and (c) area mode.