Additive Manufacturing of Complex Materials

Elizabeth Cosgriff-Hernandez, The University of Texas at Austin

Additive manufacturing, broadly known as 3D printing, is a class of manufacturing processes in which a 3D construct is built through sequential layer fabrication. This rapid prototyping methodology is transforming how products in a wide range of industries are designed, developed, and manufactured by enabling low-volume and on-demand production without dedicated equipment or tooling. In brief, computer-aided design (CAD) software is used to generate a 3D model that is then exported into a file format that describes the volume or surface mesh in 3D space. Another program, generally known as a "slicer", is then used to translate the 3D data into individual layers to be printed using a multi-axis positioning system through a variety of processes including extrusion deposition, solidification, polymerization, sintering, or binding. There are numerous additive manufacturing modalities with new commercial variants under continuous development. In an effort to structure this rapidly expanding portfolio of technologies, process categories were utilized to group these techniques based on the material type and method used to combine each layer. The following figure highlights common families of 3D printing processes as published originally in the 2012 ASTM F2792 − 12a Standard Terminology for Additive Manufacturing Technologies. A subset of additive manufacturing includes living cells during the printing process and has been termed bioprinting.

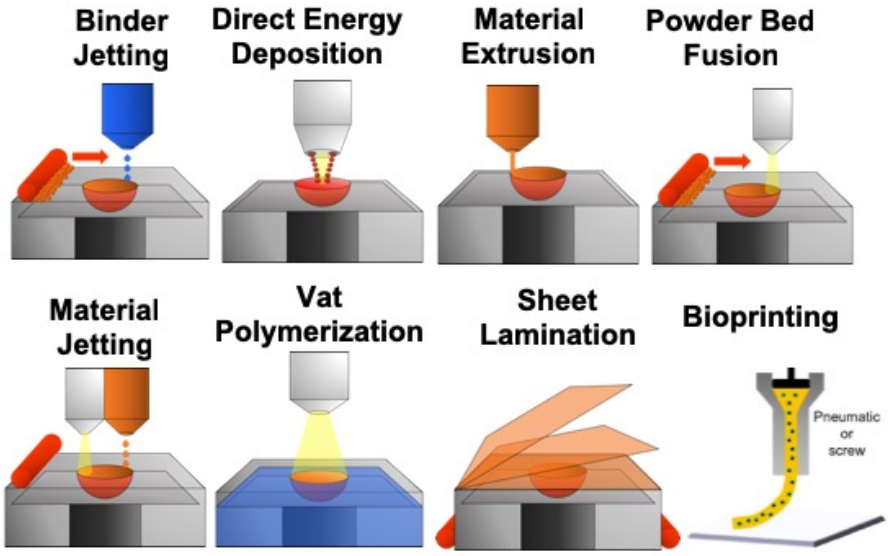

Figure 1: Common families of 3D printing processes.

3D printing has revolutionized product development in a broad range of fields from biotechnology to fashion. 3D printing has provided product designers with access to a high level of spatial control and complexity that was not previously available with traditional fabrication or limited by the high cost of manufacturing equipment. Furthermore, the unprecedented access to rapid prototyping of complex shapes has accelerated product innovation and design. In addition to the current design space of architectural control, we are currently in the advent of 3D printing increasingly complex materials that offer additional axes of functional complexity. The development of new inks, multimaterial printing, and bioprinting permits new integrated product design. This presentation will provide an overview of common 3D printing modalities, the impact of 3D printing on product development, and future perspectives. As an illustrative example, current

applications of 3D printing technologies in different facets of the medical field are highlighted to demonstrate the current and future impact of additive manufacturing in healthcare.