***Materialize: 3D Printing & Rapid Prototyping***

Shemer Art Center

October 16 – November 27, 2014

The *Materialize* exhibition provides an overview of recent advances in 3D printing and computer controlled milling (CNC) and their impact on fine art practice. At the heart of these processes is the desire to translate three-dimensional objects designed in the virtual space of the computer into tangible objects. Additive and subtractive processes at a range of scales are being used in a variety of disciplines to produce tangible prototypes and sculptures with increasingly varied functional and material properties—from electronic circuits at nanometer scales, to biological substrates, to high-density tooling, to architecturally-scaled structures and functional firearms. All of these new tools and “outputs” are of interest to the “digital sculptor.”

At the front entrance of the Shemer Art Center you will see a 3D printer on display. This machine creates tangible objects by depositing plastic in extremely thin layers. The technology is relatively simple—imagine using a computer to control the position and movements of a very fine hot glue gun. A continuous bead of thermo-plastic is deposited in layers—much like a dessert chef creating decorations by squeezing frosting through the nozzle of a pastry bag.

Since the mid-80s when the initial patents on the process of 3D printing were awarded (specifically for the “stereolithography” process involving optically cured resin), the number of competing additive technologies has exploded. There have been advances in the range of materials, an increase in resolution and speed, an exploration of scales ranging from the nano- to the architectural, and the lowering of costs to the point that 3D printers have reached the consumer desktop. With respect to advances in resolution, Solidscape’s wax droplet technology deposits wax in 6 micron layers. At the other extreme, architecturally scaled elements have been successfully created using masonry extrusion devices developed at the University of Southern California (Khoshnevis, 2013). The market for low cost systems, below $1000 US, has exploded (Vance, 2011). Some 22,000 “MakerBot” systems (~$2K) have been sold since 2009. Conversely, high-end systems such as the Objet Connex 3D Printer from Stratasys (~$350K) use multiple nozzles to create composites with distinct, predictable material properties. In material science labs, structures in the 50 nanometer range using a combination of Focused Ion Beams (FIB) and Scanning Electron Microscopy (SEM) have been realized (FEI, 2013).

Advances in subtractive processes—usually known today as CNC milling and machining—have yielded expanded material palettes, high speed cutting, and novel software applications. Interestingly, the first “numerically controlled” machines were punch-card controlled “Jacquard” looms developed in the early 18th century. The first modern NC machines were built in the 1940s and 1950s, based on existing tools that were modified with motors that moved the controls to follow points fed into the system on punched tape. These early servomechanisms were rapidly augmented with analog and digital computers, creating the modern CNC machine tools that have revolutionized machining processes (Wikipedia, 2014). Computer Numerically Controlled (CNC) milling has been an industry standard since the 70s. The work of Don Vance utilizes a custom algorithm developed in Grasshopper (a Rhino3D design program plug-in) to automate the processes of 3D solid model analysis, facet intersection, and manufacturing. The works are cut subtractively using a flat-bed laser cutter. Hybrid processes in stone carving by sculptors such as Robert Michael Smith and Wang Xinggang combine hand work with CNC milling processes to honor the traditions of the studio while exploring new methods for form making. Mary Neubauer combines her love of traditional bronze casting and patination with output generated by 3D printing.

In the future, we will see machines “sintering” the sands of the Sahara and the Moon using powerful solar magnifiers that elevate 3D printing to a grand scale. On the immediate horizon is a new class of machines that combine additive and subtractive approaches using sintered metal that is “post-processed” with CNC milling. On the material science front, we will see a greatly expanded palette for functional prototyping. Materials ranging from titanium and tool steel to flexible rubbers and biological substrates are already possible. For designers, a new unit of choice may be the "voxel"—a neologism that combines the words "pixel" and "volume." Design environments using voxel data sets will soon allow an operator to specify not only volumetric information, but material or physical property characteristics. Imagine a knife blade custom-crafted to different specified levels of flexibility and density (Collins 1997, Oxman 2011). Soon, it will be commonplace for artists, designers, and engineers to not only design the look and feel of objects using computers, but also their functional performance and their capacity for human interaction. What was once science fiction is rapidly becoming an artistic reality.

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