

# D.I.Y SMALL-SCALE 3-DIMENSIONAL PRINTING

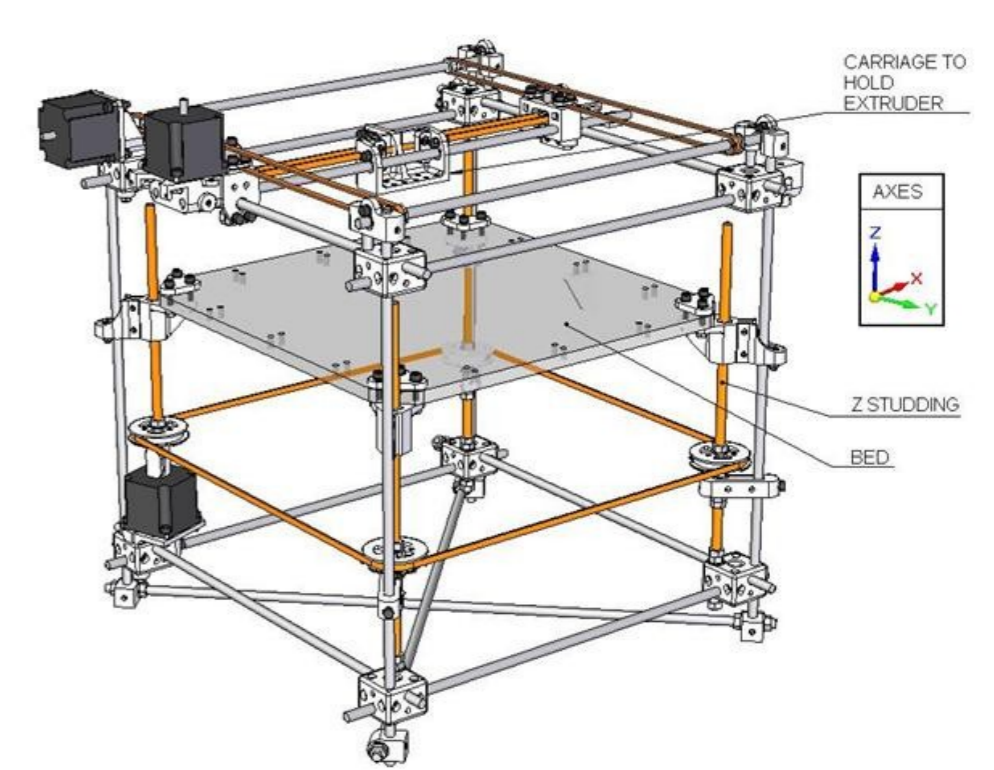
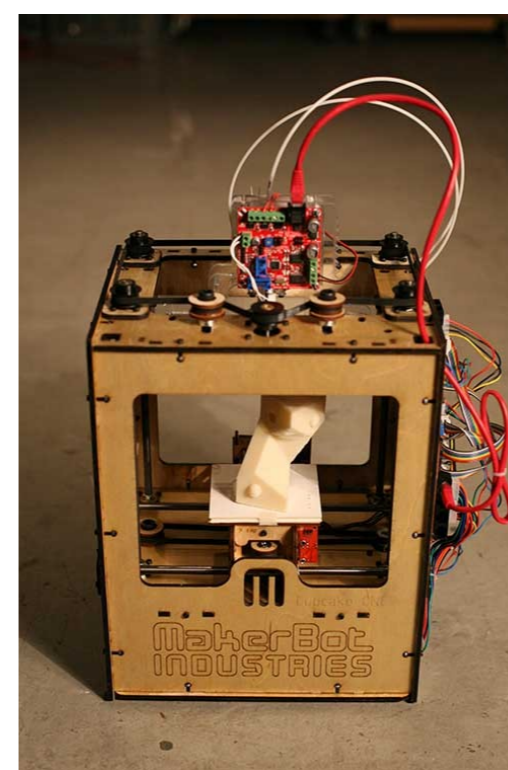
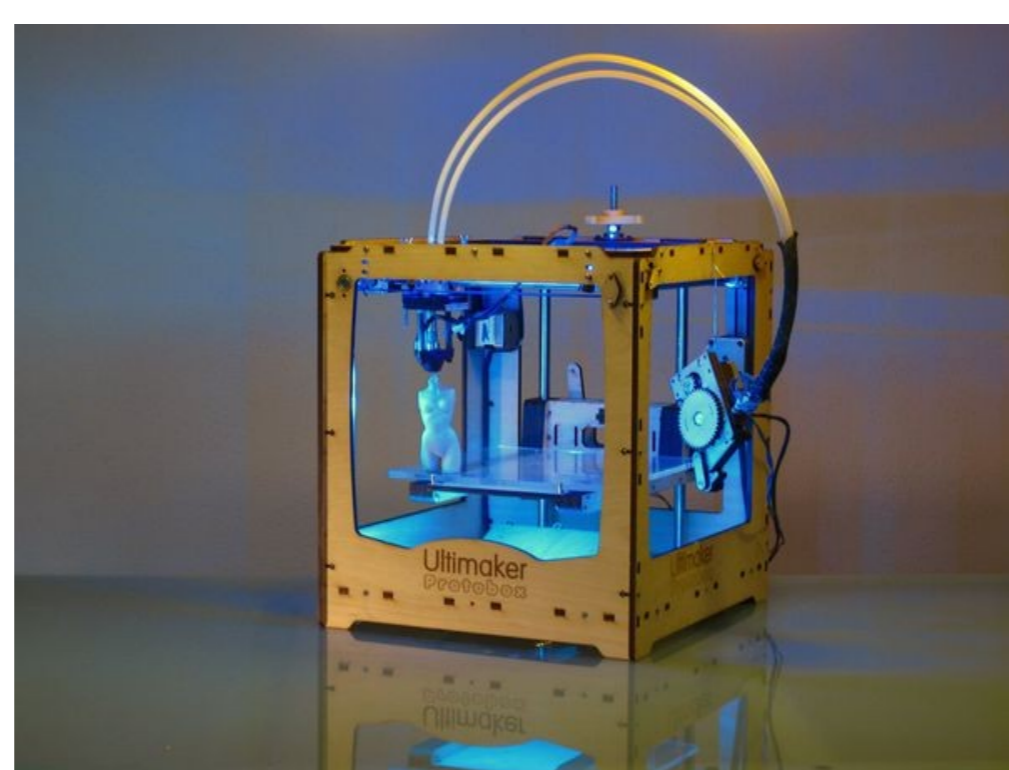
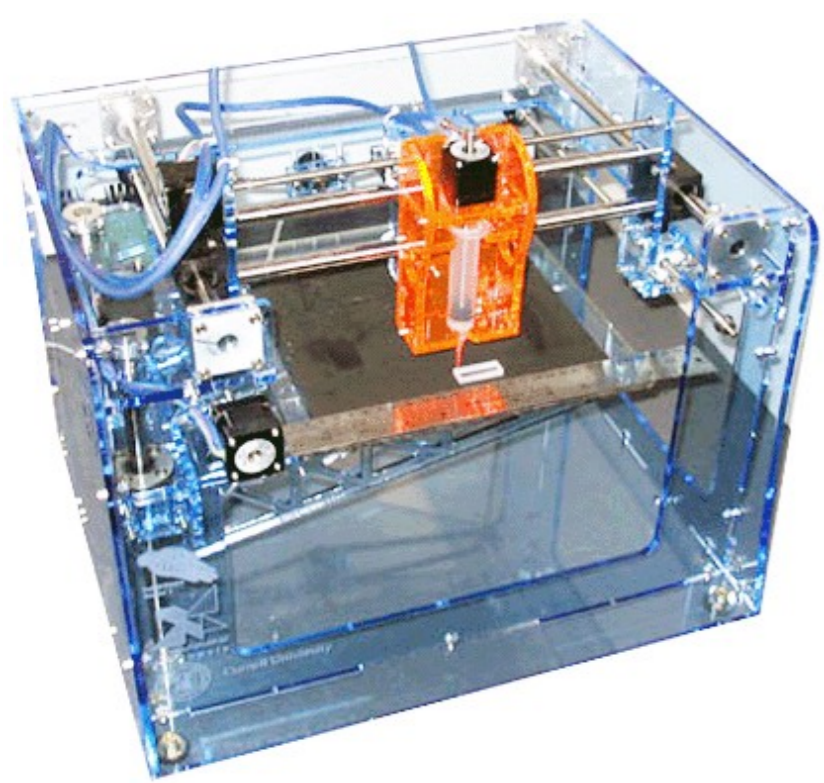
3D Printing is an umbrella term for several *additive freeform fabrication* technologies. *Additive Freeform Fabrication* is any process which produced a finished part by depositing material upon a substrate in layers. Techniques include:

- True *3-dimensional printing* where layers of material powder are bonded by an adhesive or polymer medium deposited using an inkjet-like printer head.
- *Stereolithography*, where volumes of liquid light-sensitive polymer are selectively solidified by laser or focused high-intensity light.
- *Laser sintering*, where layers of material powder are directly melted into desired cross-sections by a scanning high-power laser
- *Fused deposition*, where plastic objects are constructed layer-by-layer using a precisely extruded plastic filament

Of these technologies, Fused Deposition Modeling (FDM) is the one which has become widespread outside of commercial machines. Several printer designs are available as kits for US\$1000-1500 (S\$ 1300-1900), with plans and parts made open-source. While the print quality, speed, and maximum volume of these machines are limited compared to commercial machines, they are built by many hobbyists, students, and amateur engineers and can be freely modified and improved by the builder because of their open nature.



The *uPrint* by Stratasys Corporation is an entry-level commercial FDM machine. Parts are printed in ABS plastic, a durable structural plastic. The machine's cost, US\$15,000-20,000 places it out of reach of most hobbyists and students, despite its abilities.



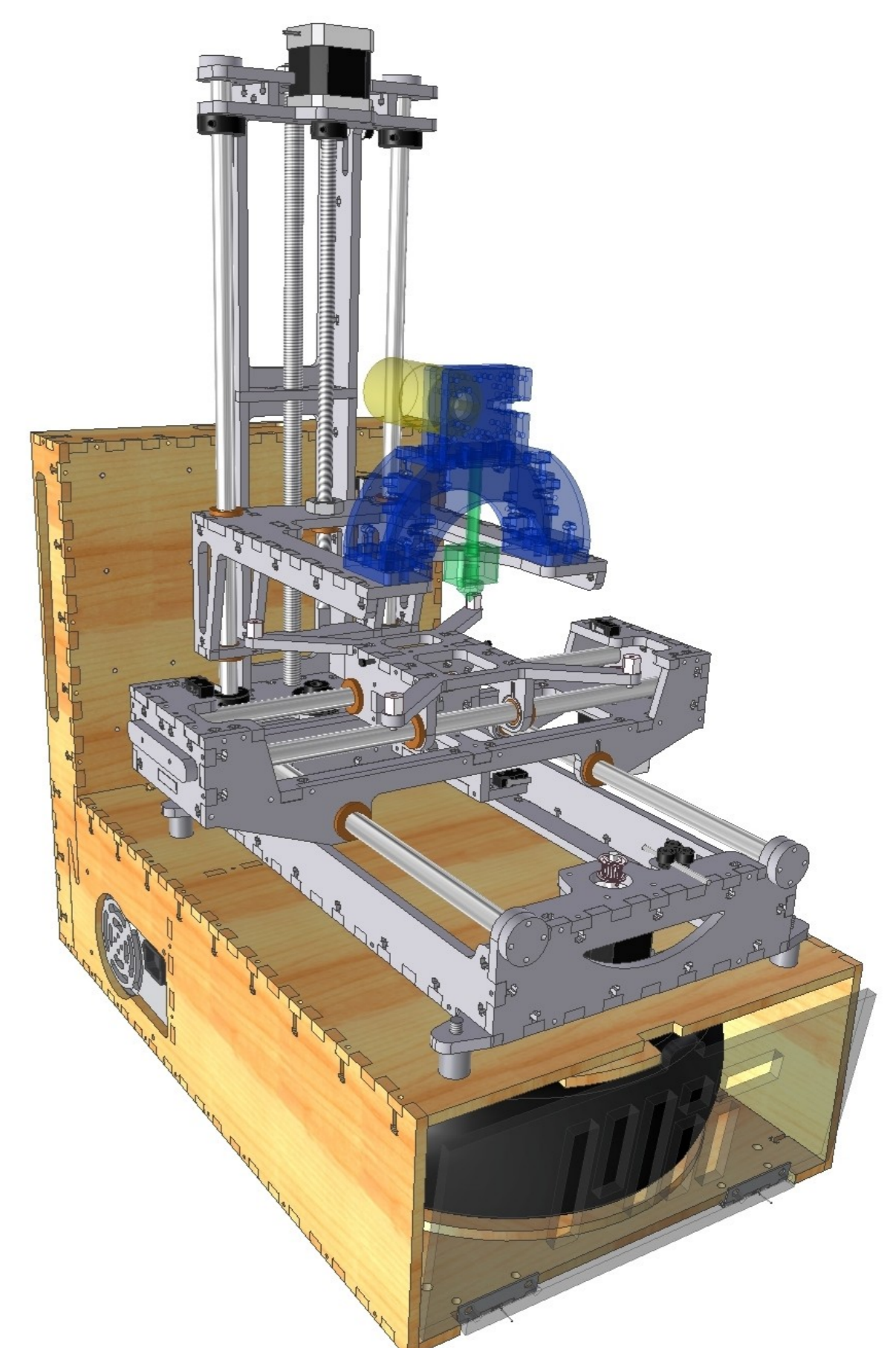
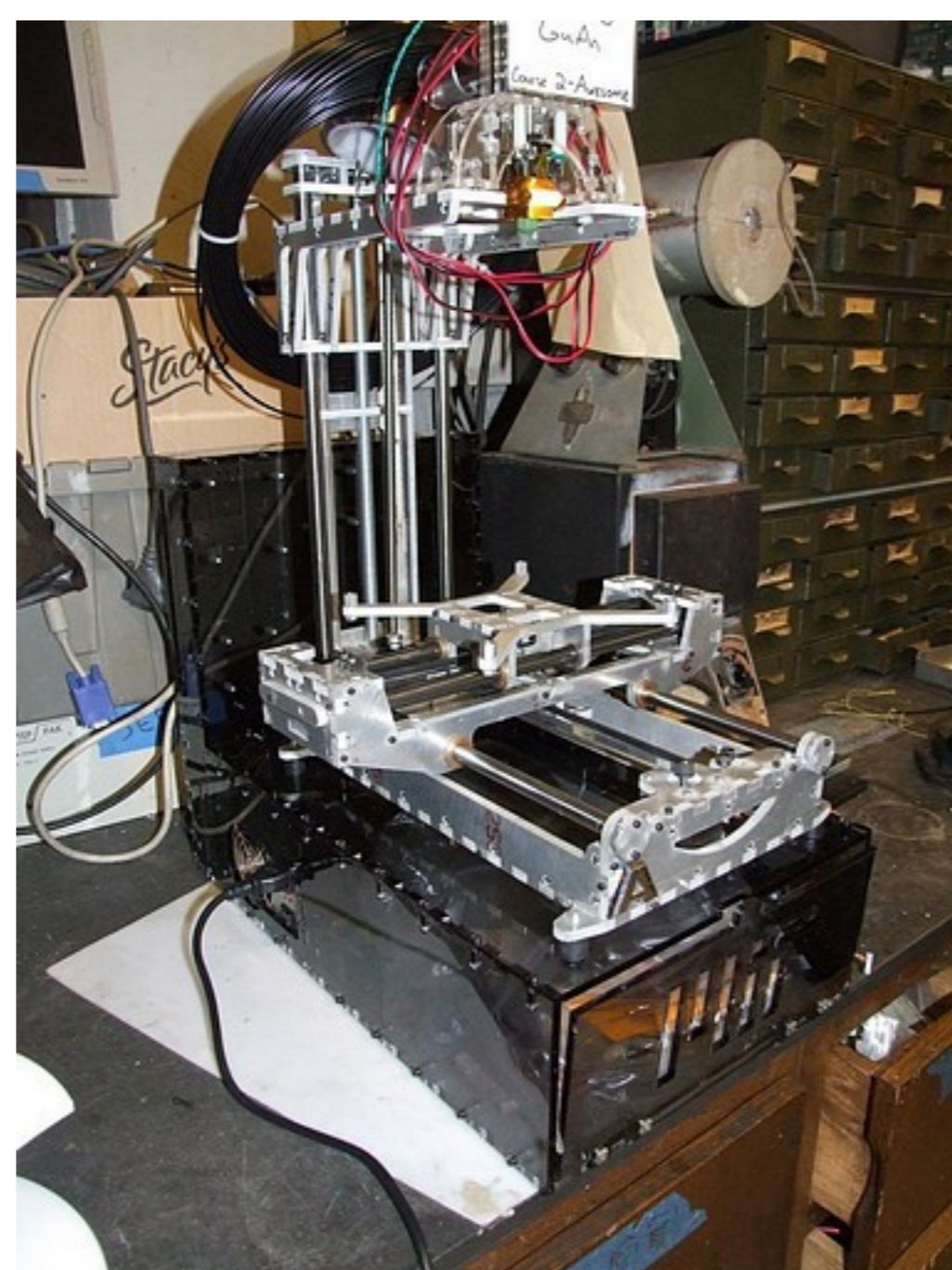
From left to right: the Fab@Home Model 2, Ultimaker, MakerBot Cupcake CNC, and RepRap Darwin are all open-source FDM-type machines. The RepRap project was begun as an attempt to make a machine that is capable of self-replication (i.e. can make all of its own parts). FDM-type machines can generally manufacture replacement parts for themselves or other machines. The Cupcake CNC is the most popular kit machine as of 2010.

The *FABulus* printer was designed and built at MIT. The printer uses a kit extruder head and control electronics from MakerBot with a fully custom machine frame design, primarily built from ¼ inch (6.35mm) aluminum plate which was cut to the designed profiles using a *abrasive waterjet cutter*. The base was fabricated from 6mm acrylic plastic panels using a laser cutting machine.



Above: The parts of FABulus were made on a campus abrasive waterjet cutter

Right: The completed machine after assembly



## FABulus

Print Envelope (mm)	150 x 150 x 200
Print Speed (mm/s)	40 - 60
Layer Thickness (mm)	0.25 - 0.4
Materials	ABS, PLA plastic