



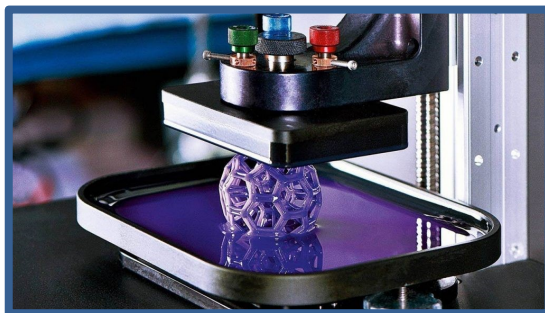
3D printing, or additive manufacturing, is a manufacturing technique that constructs three-dimensional objects from a digital 3D model. A 3D printer extrudes one layer of material like resin or filament at a time, eventually building an object. There are two major types of 3D printing: filament and resin. Filament printing feeds a thin rope of plastic filament through a heating apparatus where it is extruded into place. Some of the most popular printing filaments are made of polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), and thermoplastic polyurethane (TPU). Resin printing uses a laser to draw the layers of the print onto a layer of resin, which hardens upon contact with the laser.

Schools can use 3D printing to supplement and encourage students in their studies. For example, Florida Museum of Natural History and University of Florida are using 3D printers and modeling software to teach students about dinosaur fossils. Other classrooms print figurines and other prizes to encourage student participation.



How to Reduce 3D Printing Waste

One way to decrease the amount of 3D printed waste is to design models that use less filament. For example, printing well designed models can rely on base adhesion layers less. If a model is having trouble printing well without the support of an adhesion layer, a base adhesive could be used instead. Some popular base adhesives are school glue sticks and blue painter's tape. Models can also be designed to rely on supports less. Printing with arched angles rather than 90 degree angles could support layers of print without the need for extra support pieces.

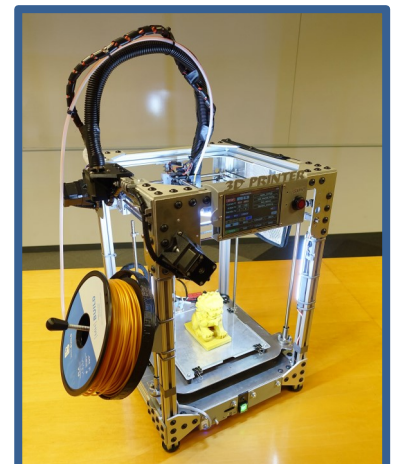


PLA, ABS, and TPU filament scraps can be processed into new filament, but that may require extra equipment. Filament scraps can be ground into pellets and extruded as filament. Grinding and heating these filament scraps might create dangerous particulate matter or fumes, requiring necessary personal protective equipment (PPE) like a respirator.

What to do with 3D Printing Waste?

Even if a model is designed to minimize waste, some waste is unavoidable. 3D printing waste can be categorized into two different types: solid or hazardous waste. Solid waste is made up of trash that is taken to a landfill without posing any hazards to the environment. Hazardous waste is made up of materials that could cause harm and needs to be handled in a specific way. Most filaments are #7 plastic and can be disposed of with solid waste; as of 2023 most communities in Kentucky are only able to accept #1 and #2 plastics for recycling.

Resin printing waste is different. Resin waste cannot be recycled and may need a waste determination to determine if the waste is hazardous waste. Any onsite treatment of hazardous waste, like letting resin cure before disposal, may require a permit through Division of Waste Management (DWM). A single location can generate and store



up to 220 lbs of hazardous waste each month before being required to register with DWM as a small quantity hazardous waste generator. Hazardous waste should be sent to a registered treatment, storage, or disposal facility (TSDF). A third party company can be utilized to transport hazardous waste. Many transporters may require a school to have an EPA ID number, which can be obtained through registration with DWM.

Sometimes 3D printing takes advantage of solvents to dissolve filament and make a higher quality product. The United States Environmental Protection Agency maintains four lists of hazardous chemicals: F, K, P, and U lists. If a solvent is found on the P List, Kentucky has stricter rules about how to dispose of it. If a facility generates 2.2 lbs or more of an acutely hazardous waste, DWM will require a Hazardous Waste Generator registration. As mentioned above, acutely hazardous waste should be disposed of through registered facilities.

What Not To Do

1. Do not throw uncured resins, inks, or solvents into trash or down sink drains. Sink drain disposal requires prior written approval from the local water treatment facility that services your facility.
2. Do not treat hazardous waste yourself without permission from DWM. This includes things like setting resin aside to cure or letting solvents evaporate. Please contact your local Division of Waste Management Regional Office for any questions about treatment. <https://eec.ky.gov/Environmental-Protection/Pages/regional-offices.aspx>

How to Print Safely

Recommended PPE for 3D printing includes gloves and eye protection when handling liquid resin or solvents. A respirator would also protect against volatile organic compound (VOC) fumes and ultrafine particulate matter (UMP). If the 3D printer uses a laser, laser eye protection could be necessary. Most 3D printers are not designed with exhaust filtration or ventilation; a well ventilated area is also recommended to reduce hazards from potential VOC fumes and UMPs generated by printing.

Additional information on hazardous wastes can be found below:

- ⇒ What is a Hazardous Waste?
<https://www.epa.gov/hw/learn-basics-hazardous-waste>
- ⇒ Categories of Hazardous Waste Generators
<https://www.epa.gov/hwgenerators/categories-hazardous-waste-generators#large>
- ⇒ F, K, U, and P Listed Wastes
<https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes>

Have additional questions?

- ⇒ Kentucky Division of Waste Management Hazardous Waste Branch
<https://eec.ky.gov/Environmental-Protection/Waste/hazardous-waste/Pages/default.aspx>
- ⇒ Environmental Compliance Assistance Program:
<https://eec.ky.gov/Environmental-Protection/Compliance-Assistance/Pages/default.aspx>



This publication is for informational purposes only and is not a substitute for reading and understanding federal and state regulations for handling hazardous wastes.