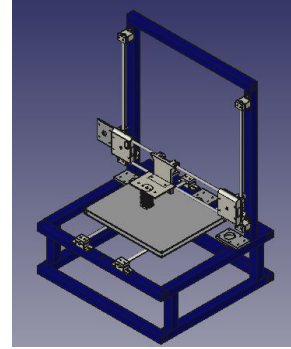


Retr3d 3D Printer BOM updated 7/27/15

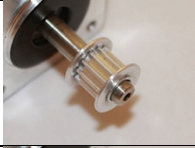
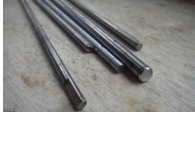
The materials needed to build the Retr3d 3D printer are divided into 3 categories: e-Waste components, printed parts, and purchased parts. Exact quantities of items like wire and steel tubing for the frame may vary, as all of the e-Waste printers are potentially unique.



E-Waste Components

See the *E-Waste Harvesting* notes for more information on how to identify, remove and group components that will work well for 3D printers. Be safe, e-waste can be dangerous!

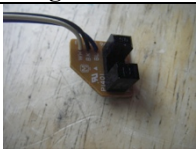
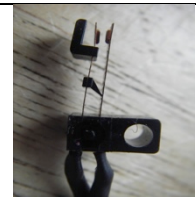
Image	Item	Quantity	Source	Comments
 or	Stepper Motor, z-Axis	2	Paper printer, photocopier or scanner	The two motors must be the same. They can be either low-resolution “Tin Can” steppers or higher resolution hybrid steppers. No belt is needed for these motors. 4, 6, or 8 wire motors will work.
	Stepper Motor, x-Axis	1	Paper printer, photocopier or scanner	This must be a high-resolution hybrid stepper. If possible, it should be salvaged with a matching belt, pulley, and idler. 4, 6, or 8 wire motors will work.
	Stepper Motor, y-Axis	1	Paper printer, photocopier or scanner	This must be a high-resolution hybrid stepper. If possible, it should be salvaged with a matching belt, pulley, and idler. 4, 6, or 8 wire motors will work.
 or	Stepper Motor, Extruder	1	Paper printer, photocopier or scanner	This can be either a “Tin Can” stepper or a Hybrid stepper motor. What is important is that it is sufficiently strong. 4, 6, or 8 wire motors will work.

					
		Pulley, x-Axis	1	Paper printer, photocopier or scanner	Salvage with the motor, matching belt and idler if possible.
		Pulley, y-Axis	1	Paper printer, photocopier or scanner	Salvage with the motor, matching belt and idler if possible.
		Belt, x-Axis	1	Paper printer, photocopier or scanner	Salvage with the motor, matching pulley and idler if possible.
		Belt, y-Axis	1	Paper printer, photocopier or scanner	Salvage with the motor, matching pulley and idler if possible.
		Idler, x-Axis	1	Paper printer, photocopier or scanner	Salvage with the motor, matching pulley and belt if possible.
		Idler, x-Axis	1	Paper printer, photocopier or scanner	Salvage with the motor, matching pulley and belt if possible.
		Smooth Rods	6	Paper printer, photocopier or scanner	Diameter should be between 6 and 12mm. Length should be at least 200 mm. The entire length of the rod should be smooth and without grooves etc. except possibly the ends which can be cut off. If possible, salvage matching bushings from the same machine.
		Spring, Extruder	2	Paper printer, photocopier or scanner	Should be able to fit around a 3 or 4 mm diameter bolt. Approximately 20 mm long. Should be fairly stiff. The bolt in the image is shown for reference on how the spring should fit.
		Spring	4	Paper printer, photocopier or scanner	Should be able to fit around a 3 mm bolt. Approximately 20 mm long. Should be fairly stiff. The bolt in the image is shown for reference on how the spring should fit.

 or 	Wire Connectors, 4 position, for stepper motors	5	Paper printer, photocopier, scanner, computer	These must have a 2.54 mm pitch. Connectors with more than 4 positions can be used and cut to size if needed. Keep as much wire attached as possible.
 or 	Wire Connectors, 2 position, for endstops and thermistors	5	Paper printer, photocopier, scanner, computer	These must have a 2.54 mm pitch. Connectors with more than 2 positions can be used and cut to size if needed. Keep as much wire attached as possible. (Top image shows two connectors)
	Wire, approximately 18 AWG	4 meters	Paper printer, photocopier, scanner, computer	For the heated bed and extruder resistor. This should be stranded wire. The wires on ATX power supplies work well and even wires taken from inside power cords. If it gets hot when it use, it isn't large enough.
	Wire, 22 AWG or heavier	8 meters	Paper printer, photocopier, scanner, computer	For hooking up the motors and fan. This should be stranded wire. It can be 22 AWG or heavier.
	Wire, 26 AWG approx..	5 meters	Paper printer, photocopier, scanner, computer	For the thermistors and endstops. This should be stranded wire. The fine wires used for sensors such as optical slot sensors, keypads etc. will work well. Heavier wire will also work.
	Power cord	1	Paper printer, photocopier, scanner, computer	Make sure it plugs into the power supply being used and that the plug fits the receptacles in the intended location for the printer.
 or 	Power Supply	1 or 2	Computer or laptop	ATX power supplies as well as 12v power bricks work. 350 Watts or more is desirable though lower power can work. In terms of amperage delivered look for 12 or more. It may be possible to use 2 lower wattage power supplies may be used instead of one larger one.

	Power cord plug and rocker switch (optional)	1	Paper printer, photocopier, scanner, computer	This is not absolutely necessary, but a highly recommended addition.
	USB cable	1	Paper printer, scanner, computer	USB 2.0 type cable with the ends shown in the photo.
	Small fan	1 or 2	Computer or laptop	This fan should measure 40mm on an edge or smaller.
	Magnet wire	10 meters approx..	Paper printer, scanner, computer	This wire can be taken from a servomotor, stepper motor or transformer. If possible don't take it from a working stepper motor. It should be approximately 26 AWG and have a diameter between 0.35 and 0.45 mm. The particulars vary depending on the size of the print bed.

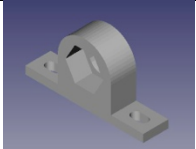
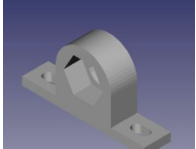
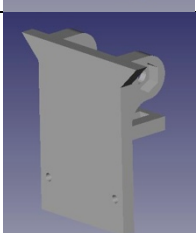
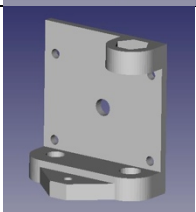
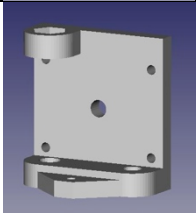
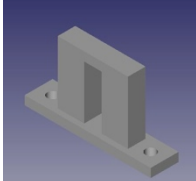
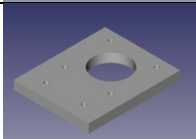
Other e-Waste components that may be useful, depending on who is building the printers

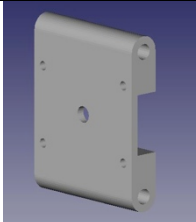
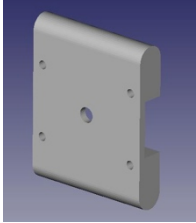
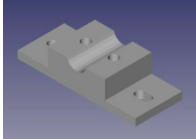
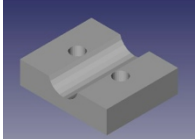
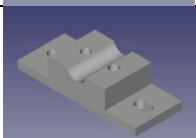
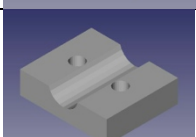
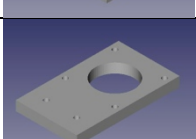
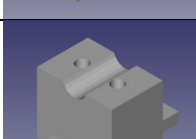
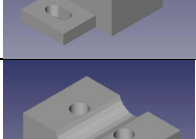
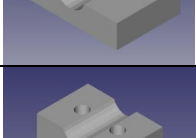
Image	Item	Quantity	Source	Comments
	Optical Endstops	3	Paper printer, scanner, photocopier	These may have 3 or 4 wires and should operate on 5 v. The main issues are attaching them to the printers properly and wiring.
	Mechanical endstops	3	Paper printer, scanner, photocopier	These should work just fine for a 3D printer, It is just a matter of adjusting the design so they can be attached properly.

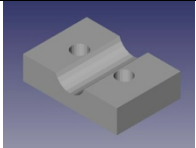
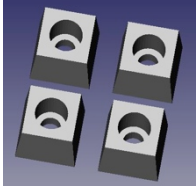
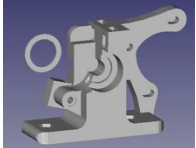
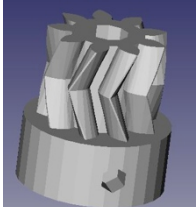
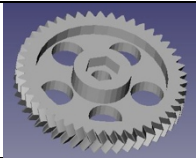
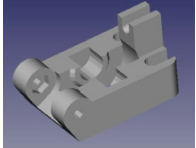
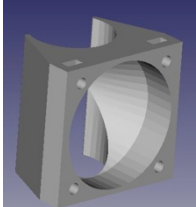
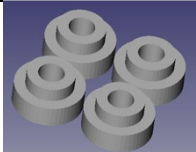
	Brass Bushings	Up to 12 or 2 per smooth rod	Paper printer or scanner	If present, these should always be salvaged with the smooth rod.
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3D Printed Parts

Keep in mind that your parts might look slightly different as their designs are modified to fit with the other parts of the printer. All of these parts should be printed with at least 2 shells and 50% infill.

Image	Item	Quantity	Notes
	PrintBedBushingHolderL	2	Print Lying down with nut trap facing upwards.
	PrintBedBushingHolderL	2	Print Lying down with nut trap facing upwards.
	xCarriage	1	Print with large flat face facing downward.
	xEndZRodHolderL	1	Print with large flat face facing downward.
	xEndZRodHolderR	1	Print with large flat face facing downward.
	yBeltAnchor	1	Print standing up as shown.
	yMotorMount	1	Print as shown.

	xRodClampL	1	Print standing up with x-Rod holes pointing upwards.
	xRodClampR	1	Print standing up with x-Rod holes pointing upwards.
	yRodSupportL	2	Print as shown.
	yRodSupportLClamp	2	Print as shown.
	yRodSupportR	2	Print as shown.
	yRodSupportRClamp	2	Print as shown.
	zMotorMount	2	Print as shown.
	zRodSupportL	2	Print as shown.
	zRodSupportLClamp	2	Print as shown.
	zRodSupportR	2	Print as shown.

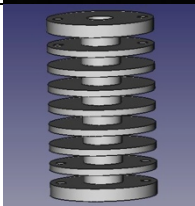
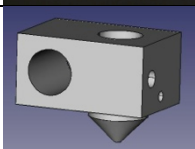
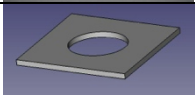
	zRodSupportRClamp	2	Print as shown.
	Feet	4	Print as shown.
	Extruder Body	1	Print lying down. Image shown is nearly a top view for printing.
	Extruder pinion	1	Print as shown.
	Extruder gear	1	Print as shown.
	Guidler	1	Print as shown.
	Fan Shroud	1	Print as shown with support.
	Arduino standoffs	4	Print as shown.

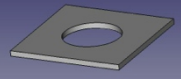
Purchased Parts

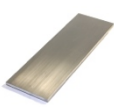
The following parts usually need to be purchased and sometimes imported. Some of the items are purchased as raw materials and then worked into their final shape. See the notes on *Purchasing Parts* for information on where to purchase parts and what to look for. The bolts will vary in length depending on the design generated. Purchase after doing the design work to avoid problems. Prices are estimated in USD and may vary greatly based on supplier, shipping costs and import duties. The total cost estimate is \$82.

Image	Item(s)	Quantity	Price	Total	Notes
	1 Bolt 1 Nut 2 Washers	16	0.05	0.8	For mounting rod supports. These can be hex head, pan head or socket. 3 or 4 mm diameter usually works well. If making a wooden frame, these will be wood screws with one washer each.
	1 Bolt 1 Nut 2 Washers	6	0.07	0.42	For mounting the motor mounts. These can be hex head, pan head or socket. 3 or 4 mm diameter usually works well. If making a wooden frame, these will be wood screws with one washer each.
	1 Bolt 1 Nut 1 Washer	16	0.06	0.96	For joining the clamps to the rod supports. These can be hex head, pan head or socket. 3 or 4 mm diameter usually works well.
	Bolt	20	0.04	0.80	For mounting stepper motors. They must match the motors so sizes/lengths may vary (frequently 3mm dia). "Tin can" motors will only require two mounting bolts instead of 4.
	1 Bolt 1 Nut 2 Washers	8	0.07	0.56	For bolting the xEnd parts together. Depending on how the x endstop is mounted, one of these may need to be longer than the rest. These can be hex head, pan head or socket. Check the printer design before purchasing.
	1 Bolt 1 Nut 2 Washers	8	0.07	0.56	For bolting the bushing holders onto the print bed support. These can be hex head, pan head or socket. Check the printer design before purchasing.
	1 Bolt 1 Nut 2 Washers	4	0.07	0.28	For bolting the Arduino mounting plate to the frame. 3mm or something similar will work. These can be hex head, pan head or socket.
	1 Bolt 1 Nut 2 Washers	4	0.07	0.28	For bolting the printed feet to the frame. 3mm or something similar will work. These can be pan head or socket.

	1 Bolt 1 Nut	4	0.05	0.20	For bolting the print bed onto the print bed support. 3mm bolts 20 mm long work well though other diameters will also work. These can be hex head, pan head or socket.
	1 Bolt 1 Nut 1 Washer	4	0.06	0.24	For mounting the extruder mount plate and extruder mount angle to the xCarriage. 3mm is standard but other similar diameters will work.
	1 Bolt 1 Nut 1 Washer	2	0.06	0.12	For mounting the geared extruder to the extruder mounting plate. 4mm is standard, but 3mm or something similar will also work. These can be hex head, pan head or socket.
	Bolt	2	0.4	0.08	For mounting the hotend to the extruder mount plate. These can be hex head, pan head or socket. 3mm is standard but other similar diameters can be used.
	Brass Nut	11	0.35	3.85	For bushings. Sizes depend on diameters of the smooth rods and available brass nut sizes. Check the printer design before purchasing.
	1 Bolt 1 Nut 3 Washers	1	0.10	0.10	For mounting the y-Axis idler. Must be sized to match the diameter of the y-Axis idler.
	1 Bolt 1 Nut 5 Washers	1	0.10	0.10	For mounting the x-Axis idler. Must be sized to match the diameter of the x-Axis idler. Use the extra washers to fill the space between the idler and the parts it mounts to.
	Threaded Rod 2 Nuts	1 meter	2.10	2.10	For the two z-Axis lead screws. 5mm works well though other diameters can also be used. The exact length will be determined by the printer design so check before purchasing.
	Vinyl tubing	10 cm	0.50	0.50	For attaching lead screws to z-Axis motors. The size depends on the diameter of the lead screws and the motor shaft or pinion.
	50mm wide Kapton tape	160 cm	0.40	0.40	For attaching the resistor wire to the bottom of the heated bed.

	100K EPCOS thermistor	2	.90	1.80	For heated bed and extruder temperature sensing.
	5.6 Ohm resistor	1	0.78	0.78	For heating the nozzle. Use 5 watt power resistors. Make sure that the fit snugly into the heater block on the extruder.
	Teflon tubing, 5/16" dia	5 cm	0.16	0.16	For insulating the heater resistor leads.
	Teflon tubing, 3/32" dia	10 cm	0.16	0.16	For insulating the thermistor leads on the hotend and heated bed.
	Extruder Barrel	1	0.65	0.65	Made from 25mm diameter Aluminum rod.
	Teflon Tubing, 1/4 in OD, 1/8 in ID	60mm	0.65	0.65	For lining the extruder barrel.
	Extruder Nozzle and heater block	1	0.16	0.16	Made from 13x19mm aluminum bar.
	Bolt	2	0.05	0.10	For attaching heater block to barrel.
	1 Bolt 1 Washer	1	0.05	0.05	For retaining the thermistor.
	Stainless steel spacers	3	0.05	0.15	For separating the heater block from the barrel. Made from stainless steel sheet metal. Normal steel will work if stainless is unavailable.

	Engine gasket spacers	4	0.02	0.08	For separating the heater block from the barrel. Made from fiber gasket material
	Nozzle harness	1	0.05	0.05	For holding the nozzle onto the barrel. Made from stainless steel sheet metal. Normal steel will work if stainless is unavailable.
	1 Bolt, 8mm dia 60 mm long 1 lock nut 5 washers	1	0.60	0.60	For making the hobbed bolt for the extruder.
	1 Bolt, 60 mm long 1 nut 2 washers	2	0.40	0.80	For extruder. These are the bolts that clamp the filament against the hobbed bolt.
	1 Bolt 1 Nut	1	0.06	0.06	For attaching guidler to the extruder body. Normally 3mm.
	8mm rod, 20 mm long	1	0.05	0.05	Shaft for the guidler bearing. Can be cut from an 8mm bolt or rod. Threaded or smooth.
	608zz ball bearing	3	0.75	2.25	For the extruder body.
	Heat Shrink	25 cm	0.75	0.75	For insulating soldered joints in the electronics. Two different sizes may be useful. One for fine wires like 22 AWG and another for larger 18 AWG wires.
	Arduino mega 2560	1	17.00	17.00	This must be an Arduino mega 2560.
	Ramps 1.4	1	13.00	13.00	This is the interface between the Arduino and the rest of the printer.

	Pololu A9488 Stepper driver	4	2.00	8.00	These or compatible stepper drivers are needed to drive the stepper motors.
	SD card reader	1	2.88	2.88	Optional. Enables printer to be used without a computer.
	Aluminum plate, 200x200x1.5 mm	2	6.50	13.00	For the print bed and the print bed support. This aluminum plate must be very flat. Dimensions will vary depending on the printer design.
	Aluminum Bar, 50x80x3 mm	1	0.32	0.32	For the x-Axis motor mount.
	Square Tubing, 20x20 mm	6 meters	4.50	4.50	For the printer frame. Can be fairly lightweight. Larger sizes will also work.
	Zip ties	1 pack	1.00	1.00	For cable management.