**Up-Cycle Your Bi-Cycle**

**ReBar for 3DPrinting - *3Bar!***

Turn Trash  into Treasure 

***Re-use* spent/discarded bicycle spokes as a form of “Re-Bar” for 3D printing**.

I stumbled upon a method to both solve a problem and save a little coin in the process by using ‘trash’\*; and thought to myself: “Hey; this might solve some other folk’s problems and save *them* a buck or two as well.” So I’ve created this *Instructable* showing how to use discarded Bicycle Spokes to strengthen 3D Printed parts; which have strength and rigidity issues in some applications.

\*Incidentally, I have issues with that word ‘trash’; it’s *not* trash, it is pre-processed materials [PPM]. ☺

Anyway; you can use the discarded bicycle spokes, trimmed to length with a pair of light duty bolt cutters, to stiffen and strengthen 3D printed items. Re-Bar for 3D-Printing ‘*3Bar’*; a similar concept to rebar for concrete foundations and structures. You can use various gauge wire to accomplish this same task but re-using old discarded bike spokes, which are ‘just the right size’ for most home & craft projects, seems more environmentally conscious, at least to me ☺. And does not entail straightening the wire, saving time, effort *and* cash☺. And will even reduce the amount of trash we produce, win, win, win, and win!

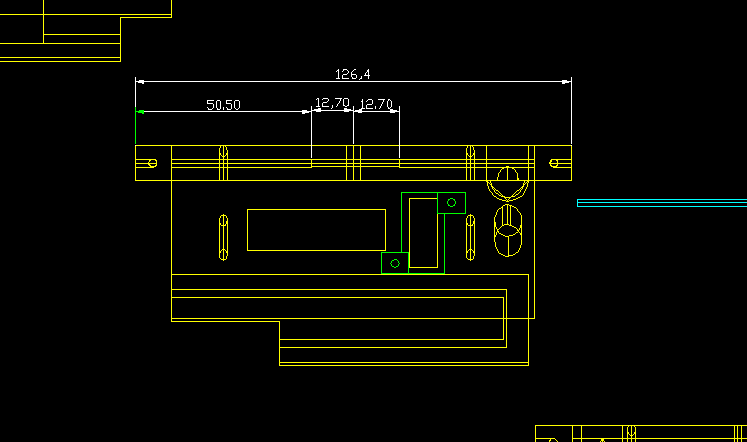
The objective of this *Instructables* is to demonstrate a few of the various basic *methods* to use discarded bicycle spokes to strengthen and stiffen 3D printed parts. Not to build the tool rack and other items, they are simply vehicles, though useful. Building the Tool Rack and Key Rack are a bonus; a ‘twofer’.

The 3D Printed Item(s) you wish to strengthen/stiffen will need to be *designed* {sometimes called modeling} with a cavity or thru-hole to accommodate the spoke-bits.

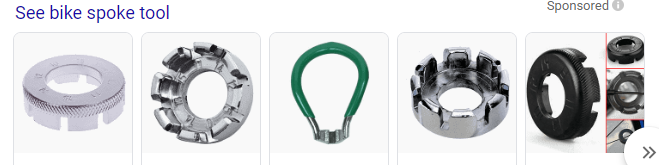
First; the bicycle spokes.

Bicycle spokes come in a variety of sizes, the most common are 1.98mm-[5/64” - 0.0785in.] Stainless Steel; though I found one ‘set’ with a 1.54mm shaft and a 2.25mm (O.D.) thread size, and one set that is manufactured flat(ovoid) not round [weirdness happens]. The most common spoke seems typically to be 290mm [11.4”] long, though this also varies. The threaded end(s) also vary from set to set. I’ve found them from 1.75mm to 2.5mm OD, with roughly 12mm of thread length {~0.5”}; this seems to have no relationship to the shaft size either. It will be best to measure your spokes and design accordingly. Allow, at least, +R0.15mm clearances for the shaft (a *very* tight fit). The holes for the ‘Alternate Threaded Attachment’ method should be designed undersized slightly, roughly -R0.10mm to insure a tight coupling. Plastic is stretchy☺ {I think that’s why they called it ‘Plastic’. [Insert sound effect: maniacal giggling]. For standard size spokes I design with R1.2 for both ‘slip fit’ and easy threading; and a loose fit dimension of R1.3 when using epoxy/glue. While it is obvious these ‘design’ numbers cannot be counted upon for tolerance purposes [because most ‘craft’ printers will only maintain +/-0.2mm tolerance}, I *consistently* achieve the desired resultsusing these numbers.

Additionally a R1.20 ‘slip fit’ for the shaft will still require *self-threading* for the entire length of the ‘slip’ when using the spoke as both reinforcement *and* attachment method {and should include glue/epoxy for maximum strength}; with the ‘center’ or attachment location design tolerance of R1.0mm; the drawing below shows the ‘attachment threading constriction’ centered within the item and a normal ‘slip fit shaft’ length for the included {printable} 3D Printer Tool Rack designs. (Dimensions in millimeters)



I found it to be *extremely* easy to obtain used/discarded/reusable bicycle spokes from the first bicycle repair shop I ask; at no charge in this case [your experience may differ☹]. Though simply removing them from an old rim yourself would serve the purpose just as well; or perhaps better as you could avoid the traffic/drive. Removing the spokes from the rim requires a special tool [image taken from google☺]



; Though the tool is inexpensive it’s not free☹ {perhaps you could arrange something with the bicycle repair shop}. Simply clipping them out is an option but the rim would be rendered more difficult to salvage or re-use as well as limiting the various uses for the spoke itself. Used/Discarded bike spokes are quite versatile when combined with 3D printing.

**Tools, Supplies & Technical Data (files included):**

1. 3DPrinter {your choice. For the purpose of this “*Instructables*” I’m guessing/assuming you have one or have access to one; or perhaps only wish you did? They are quite inexpensive these days, less than $200 in several cases; as mine was}. Also note; the 3D printed parts for this Instructable are using PETG filament; simply because that’s what’s on the spool I have loaded at the moment☺. You can probably print these items in any filament/material you like as there seem to be no related temperature concerns for the finished items that I can think of.
2. Sharpie brand marking pen or equivalent {something that will mark on stainless steel, your choice}
3. Light duty bolt cutters [image]
4. Discarded/Used bicycle spokes. [Image]
5. Calipers [image]
6. Specialty Spoke Tools 0, 1 & 2
   1. 3D printed item files: SpokeTool0-Extraction.stl, SpokeTool0-Insertion.stl, SpokeTool1.stl, SpokeTool2.stl; print these first☺}
7. Demonstration/Practice Item File(s) [3D printable ‘Demonstration’ files (*useful* items)]: 3D Printer Tools Rack w/Support Legs [multiple files] & “Pub-Edu” Wall Mount Key Rack [single file]. (Not independently useful; demo only) Up-Cycle Bike Spokes Puzzle piece, Imbedding Spokes practice print [single file].
   1. 3D printed item file(s):
      1. 3DPrinterToolsRack-A.stl
      2. 3DPrinterToolsRack-A2.stl
      3. 3DPrinterToolsRack-B.stl
      4. 3DPrinterToolsRack-B2.stl
      5. 3DPrinterToolsRack-C.stl
      6. SandingBlockCaddy.stl {optional}
      7. ScraperCaddy.stl
      8. ToolsRackLegsA.stl
      9. ToolsRackLegsB.stl
      10. Nubs.stl
   2. Print file: UpCycle-BikeSpokes-ImbeddedSpokes
   3. Print file: PubEduKeyRack.stl
8. AutoCAD .dwg files [in case you would like to modify the designs]: Nubs.dwg, Spoketools.dwg, PubEduKeyRack.dwg, 3DPrintingToolRack.dwg, and UpCycle-BikeSpokes-ImbeddedSpokes.dwg
9. Instructions: This document

Also included is a list of tools that fit the 3D Printer Tools Rack; some of which you might wish to use during the project☺. If you have a 3D printer you probably have many, if not all, of these items already; but I’m including the list just in case.

Assemblies:

#1 – 3D Printer Tools Rack

#2 – ‘GovEdu’ Keys Rack {The result of *years* of government training}

#3 – Drop-In “3-bar” Puzzle Piece [Demo item]

… And off we go.

**Methods**

**I recommend *not* cutting off the hooked end of the spoke until you are *certain* you won’t need to extract the puppy. Extraction is considerably easier with the hook intact using tool#0 than it is with a pair of plyers or channel locks☺ and once any glue you use sets all bets are off.**

**Method #1**: Spoke Insertion *Post*-*Printing*

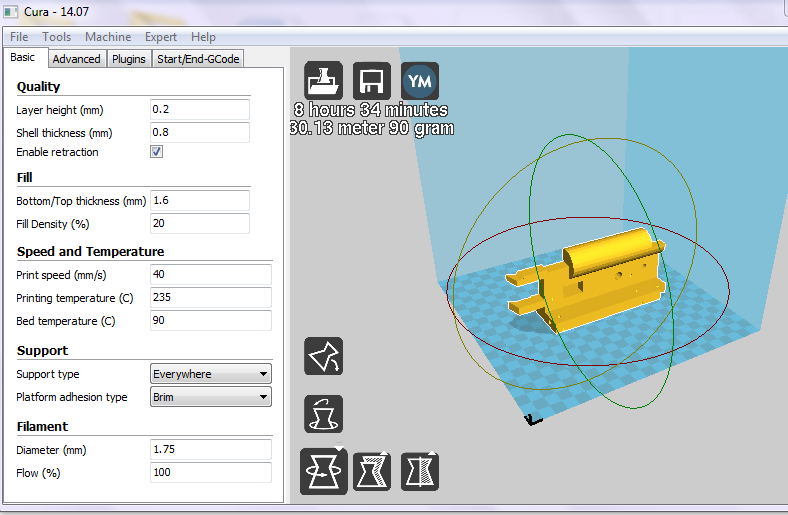
For Method #1 we will be constructing/assembling the 3DPrinter Tool Rack. {See Notes \*\*}

Total combined print time: for all the various components run {on my machine with the indicated settings} approximately 34hrs; the associated instruction steps can be completed within that time frame as well. {I let my machine run while I sleep/work/etc.; it’s not particularly exciting to watch☹} Actual assembly time is approximately 2 to 3hrs including post processing ‘clean-up’. Cost; about $10, not including tools you may need to purchase; materials only.

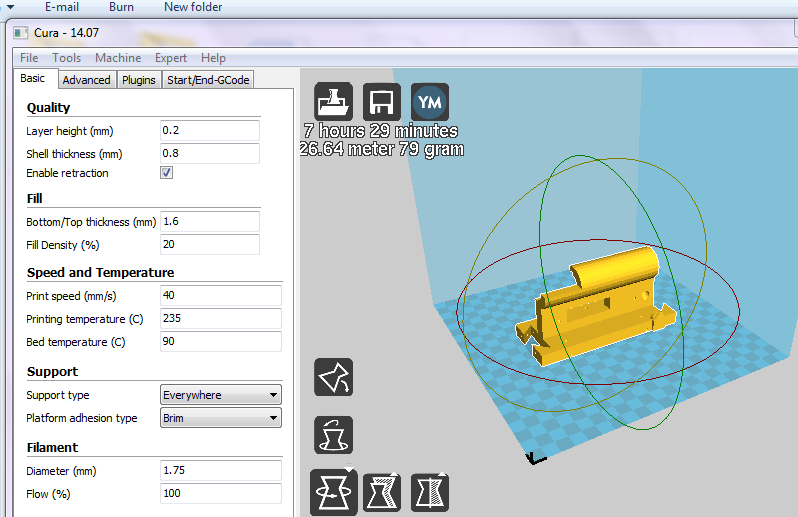
--- Design items you wish to reinforce with a ‘nominal’ R1.2mm thru-hole {use with standard spokes (Ø1.98mm)}; you can, or perhaps should, include an epoxy or glue {I recommend either *Gorilla glue* for a thicker application {when using a larger hole size compared to the shaft size}, or *Tester* plastic cement {aka: model glue} for the ‘normal’ 1.2mm thru holes; Dow’s E6000 {aka: Rubber Cement} also comes in handy for some applications but will also require a slightly larger thru hole}.

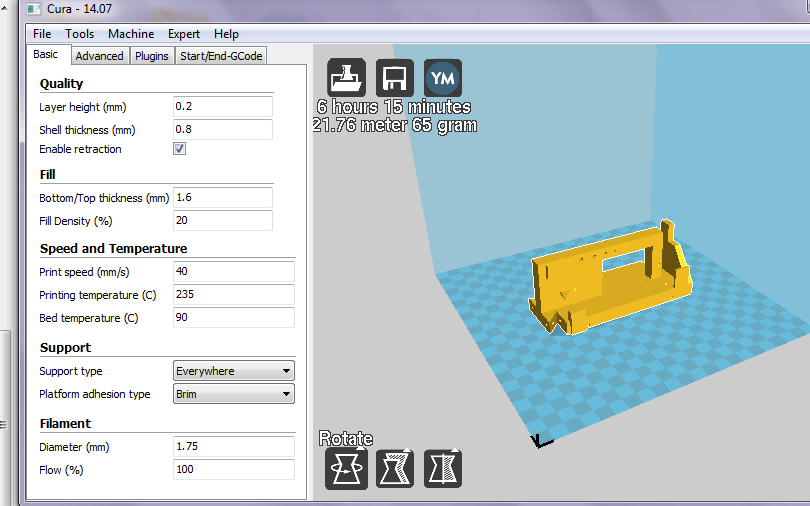
**Step 0** – Make coffee. {May not actually be necessary, but I’m not interested in finding out.}

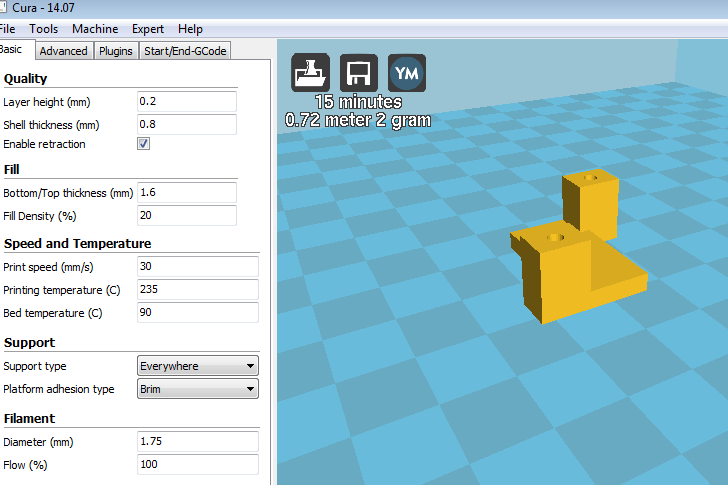
**Step #1** - Print item(s): Create the Appropriate ‘GCode’ {print file} for your 3DPrinter. I am using an Anet-A8 {with minor upgrades} and the associated Cura 14.07 software.

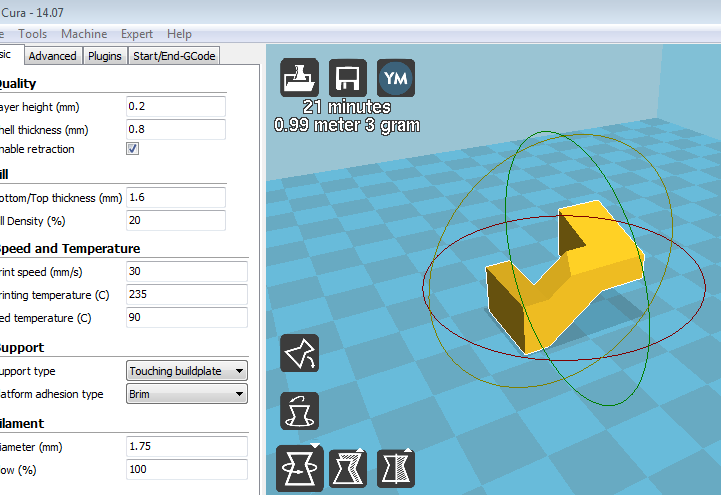
3DPrinterToolRack-RtC.stl {print position as shown}

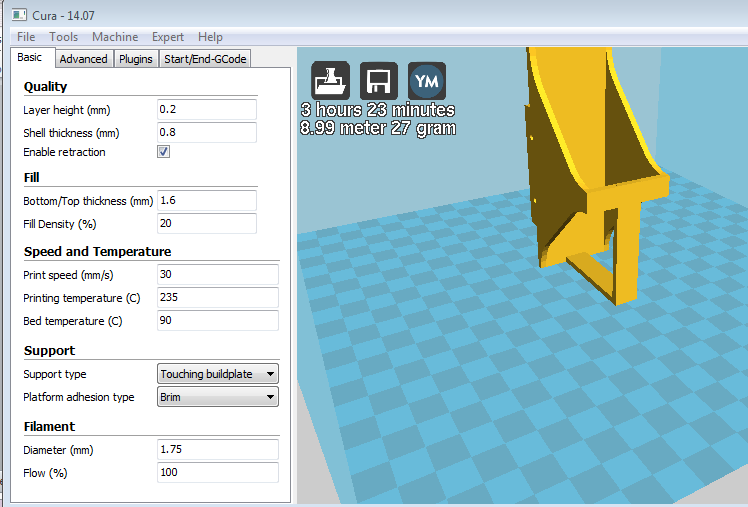
3DPrinterToolRack-RtB.stl {print position as shown}

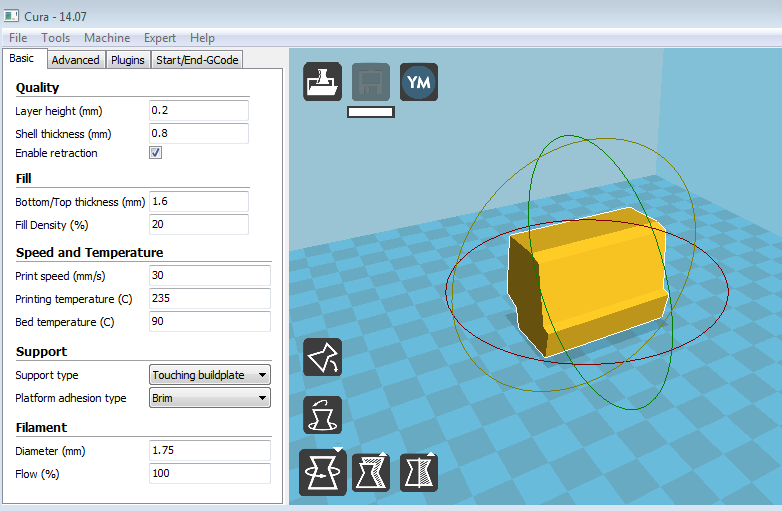


3D Printer Tools rack Rt-A {print position as shown}

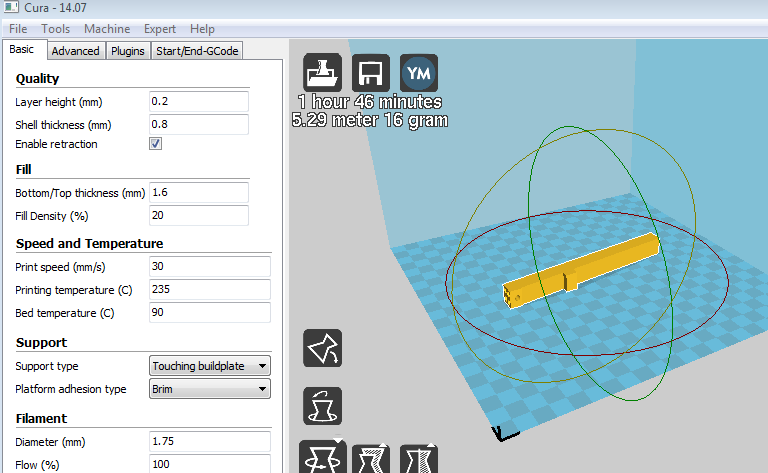
3DPrinterToolsRack-B2 

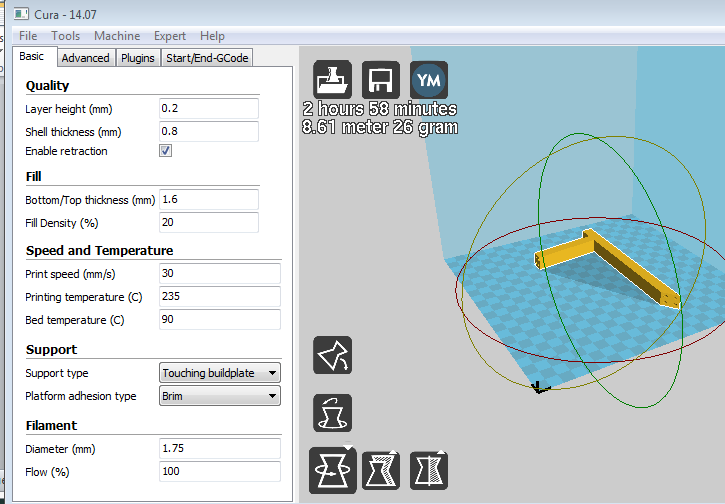
3DPrinterToolsRack-Rt-A2 {print position as shown]

Sanding Block Cady {optional: print position as shown}

Scraper Cady [print position as shown (face down)] 

**Notice;** You will require **3 sets** of legs [A&B]; assembly instructions for the legs below [step XX].

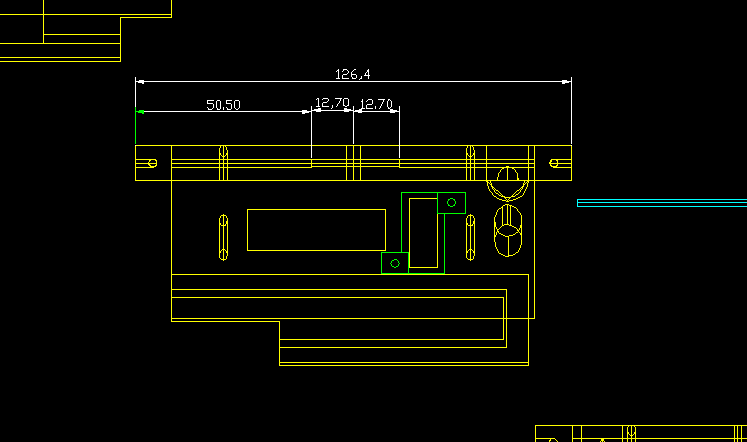
ToolsRackLegsA {all 3 can be printed at once} 

ToolsRackLegsB (print position optionally facing up can be printed all at once, but not recommended) 

**Step 2:** Assemble Units A, B & C. ‘puzzle pieces’. … [I didn’t get an image of this, sorry, didn’t think it was necessary. ☹, my bad.]

**Method - 1A** – Parts Reinforcement *with/including* Self Threading Component Attachment

Leave the screw threads intact and spin-in/self-thread the entire shaft. While this is not as quick as a basic ‘press-fit’ it allows attachment to a second piece / different separate component to be more secure, taking advantage of the spoke screw threads (apx. equivalent to a 2M or #2-56 screw).

The Parts/3Dprinted items have been designed with a fairly loose fit for the shaft [R1.2mm], and a tighter fit [R1.0mm or R0.98mm] for the screw thread(s). Allow at least 12.7mm {1/2”} constriction [reduced internal section] within the printed items for threading purposes: 

**Step 3:** Self-Threading the spoke into place using tool-0



Lay the unit on a flat surface and clamp in place is the easiest method; but you can simply hold the unit and the tool in opposite hands and spin the tool. The spoke will self-thread and draw itself into the unit. It’s a bit slow without clamping, but quit functional. Masking tape would also give the desired effect. Once you’ve clamped the unit, hold the tool/shaft combination generally/basically as shown below and spin the tool with your finger while stabilizing the shaft with thumb and forefinger of the opposite hand until the spoke seats. It does not require much pressure on the tool end to spin the shaft, in most cases. {I did make one ‘diameter-test-bore’ very tight, but was still able to get the shaft seated properly at R0.97, but I do not recommend this as I can’t think of any good reason to do the extra work}. It would also be possible to use a ‘power tool’ such as a drill or Dremmel tool, but that seems a bit of overkill.



**Step 4:** Trim the spoke, as close to the unit as possible using the light duty bolt cutters. {a ‘flush cut’ bolt cutter is nice if you’ve got one for this application.}

-- A bit of ‘filing down’ of the end of the spoke may be necessary; or cover the exposed end with one of the ‘Nubs’ from the included files using epoxy [gorilla glue].

Notes 1:

Files: {Nubs.dwg, Nub.stl} are included and contains ‘end nubs’ for covering the exposed bits if you don’t wish to file them down.

I didn’t use any glue or epoxy on mine; … it’s just a demo. My ‘stuff’ will end up scattered “all over hells half acre” regardless of any ‘organizers’ and ‘racks’ I have in convenient locations; my ‘neatness gene’ apparently got snipped in some sort of early CRYSPR experiment, or something.

Once you file the ends of the spoke you will have no ‘easy’ method of separating components A, B & C.

**Step 5:**

**Method 1B**: Press fit for mechanical strength and rigidity

This method is perhaps the most useful, and occasionally necessary, as well as the easiest and simplest. Many 3D printed parts have ‘rather thin’ protrusions/arms which can easily be snapped off; such as the micro-drills case holder on component A at the far right end of image.



Including [designing in] a cavity/shaft or thru hole to allow insertion of a spoke-bit will significantly strengthen and stiffen the ‘arm’. In this case I have used a thru hole and use the feature for a dual purpose. Both to strengthen the support arm itself, this step, and for attachment of Component A2 in the next set of steps. This design is an R1.05mm Press Fit thru hole; as the length is of a ‘medium’ length and does not require a large amount of force {easily handled manually with no actual ‘press machine’ required] , the feature ‘arm’, again in this case, is designed at 4.87mm wide and measures out at 5.1mm wide on my machine. Some experimentation may/will be necessary in different applications or materials.

**Step 6:** Clip off the spoke threads {no image}

**Step 7:** Insert the spoke into the hole and *Press Fit* the spoke into the cavity to the desired depth {approximately 32mm} using Spoke Tool #2.

 Tool #2

**Step 8:** Clip/Cut to length



**Step 9:**

Tap in the remaining exposed length with a small hammer until the spoke-end is flush with the rear surface of component A. {You can also include glue or epoxy in the process; though it is probably not necessary.}

*Ta-Da*: You’ve just created a nice strong feature that won’t be easily snapped off. And you used ‘the trash’ to do it, so it didn’t cost a cent☺.

**Step 10:**

Attach component A2 {micro-drill case restraint}

Here we use the threads, again self-threading the spoke(s) (as in method 1A above), to attach the spokes to component A2; then clip the spokes as shown. Roughly at 5mm and 12mm respectively, top and bottom (or right and left, depending on how you want to see it).



Then mount part A2 to the front of the tool rack by simply pushing/sliding the protruding spoke-bits into the matching holes on the front of component A. Component A2 will now be able to slide in and out slightly, allowing for different sized micro-drill cases. … Or at least that’s the idea☺.



**Step 11:**

Install the Scraper Caddy with box wrench slot/holder.



The scraper caddy {with a slot to hold the hot-end box wrench that is usually supplied with ‘kit’ printers} does not actually require a ‘hard’ connection to the rack. The designs used here do provide for a press fit shaft however. If you would like; cut two short shaft lengths of spoke (approximately 20mm ea.) and tap them in with a small hammer until flush, epoxy/glue is also an option. Else simply press the caddy into place, the ‘rear’ of the caddy should be flush with the top surface of component A. If you don’t use the ‘shaft attach’ method you *might* decide to remove the caddy and install some other useful component.



**Step 12:**

Install component B2 (USB caddy) onto the bottom of component B in a similar fashion to that used with components A and A2; self-threading the spokes into component B2 and press-fit onto component B. {sorry, but I didn’t add the USB caddy until after I’d finished making the ‘prototype’ used here.}

**Method - 1C**

Angles Support Braces

Some 3D Printer applications may require angled supports/braces for overhanging features that experience stress or force during use.

--- Strictly speaking the angled supports underneath the tools tray on the 3D printer tools rack are not necessary in this application; and are included as a ‘methods’ demonstration only. You can always use the extra holes for holding incense sticks or something if you don’t want to try/practice the method.

**Step 13**

Cut 6 lengths of spoke at 42mm each, no threads. {No image}

**Step 14**

Slide the pre-cut length of spoke approximately halfway in. (as shown)



**Step 15**

Apply a coating of glue/epoxy in two locations as shown {basically top and bottom portions of the spoke piece that will end up ‘inside’ the unit}.

**Step 16**

Use a pair of needle noes plyers to move/slide the spoke-section into place.



 Ta-Da

**Step 16**

Repeat for all 6 locations [Or however many your application needs]. I also recommend using a piece of wax paper, or other protective/disposable covering with a non-stick surface {Teflon pipe tape also works well I’ve found}, under the unit while the glue dries.



**Step 17**

Attach Sanding Block Caddy

The Sanding Block Caddy attaches to the side of component A, and is an optional component; the side of unit A has recessed cavities to accommodate installing end-nubs the same as the sanding block caddy has. These following steps are for attaching the caddy; if you do not wish to install the caddy the steps to complete the attachment of component A are similar to steps 3, 4 and 5 {above}.

Using an intact spoke including threads; thread the spoke into the center constriction of component B, thru component A and the Caddy, until the spoke seats using tool 0.  []

**Step 18**. Mark Cut/Snip locations on the spoke(s) Flush with the outside surface of the caddy.



**Step 19**. Slide the Caddy away from component A to expose the marked cut location.



**Step 20**. By sliding the caddy off/away from the cut-mark you can snip/cut just below the mark, allowing a more uniform surface for the finished item. Make the cuts. {no image}.

**Step 21**. Slid the caddy back onto the spoke/shafts and install nubs to cover the ends using a bit of glue and a small hammer to tap the nubs into place.



TaDA



**Step 22** Assemble 3 sets of Legs w/ Feet {A&B}

The easiest method for the Stand/Legs is to self-thread a spoke onto the bottom section [feet] first, allowing maximum strength for the intersection between the ‘foot’ and the ‘leg’; then ‘measure twice, cut once’ to use a slip fit shaft with glue and end nub for the top portion of the leg. The upper leg dimension, from top of foot to top of leg, is 124.5mm {cut length after self-threading operation}.

**Step 23**. Self-Thread 4 spokes, one at a time, into Leg component B (sorry; the image sucks)



**Step 24:** Mark and clip/cut the spoke shafts to 124mm above the top of component Leg section B.

**Step 25:** Repeat 15a and 15b for each of the four spokes.

**Step 26:** align the spoke shafts using tool 1. [Sorry, but I designed the tool after doing the alignment manually; it wasn’t too hard even without the tool, but the tool should make it easier. Snap the four shafts into the corners just below the top of the shaft; then push the Leg-A down onto the shaft/ tool combination. Once the shafts are “all in”, twist or rotate the tool top to bottom and remove.]

 Tool#1 

**Step 27** Repeat for all three legs. [Note: I got a bit ‘rambunctious’ here and didn’t take photos☺; you’ll have to write it off as: ‘needs better meds’]. Fortunately it isn’t rocket science.

**Step 28** Insert 4 spokes each into the feet/foot sections, from the front, for additional strength, rigidity and weight. Clip off the screw threads, and then use a ‘press-fit’ method and tool #2 {if necessary}.

**Step 29** Attach the legs to the rack using some convenient screws {#8 wood screws?}, maybe a bit of glue if you like, I used Rubber Cement [Dow E6000].

**Step 30** Attach the cross member bar [another spoke]; self-thread thru two legs and into the third {the hole is located on the back end of the foot/feet; you can see the cross-member on the image below}.

Ta-Da, finished: hang some tools in the rack … make more coffee ☺

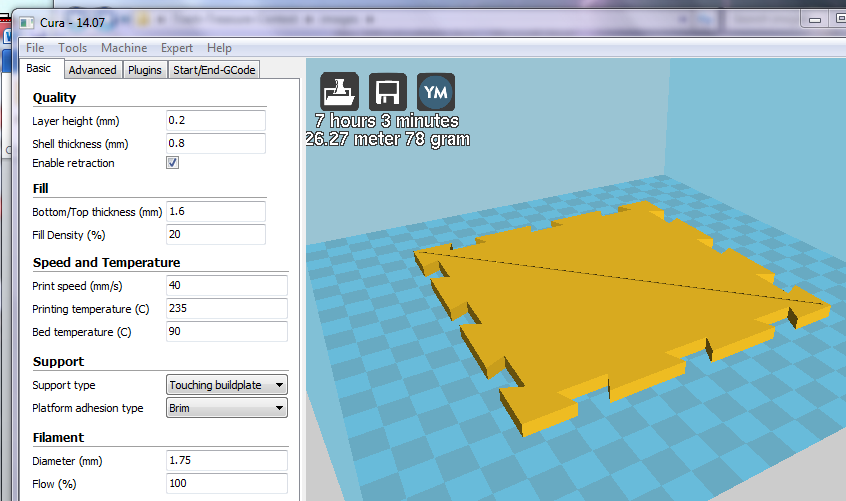
**Method #2**

Spoke Encapsulation During Print:

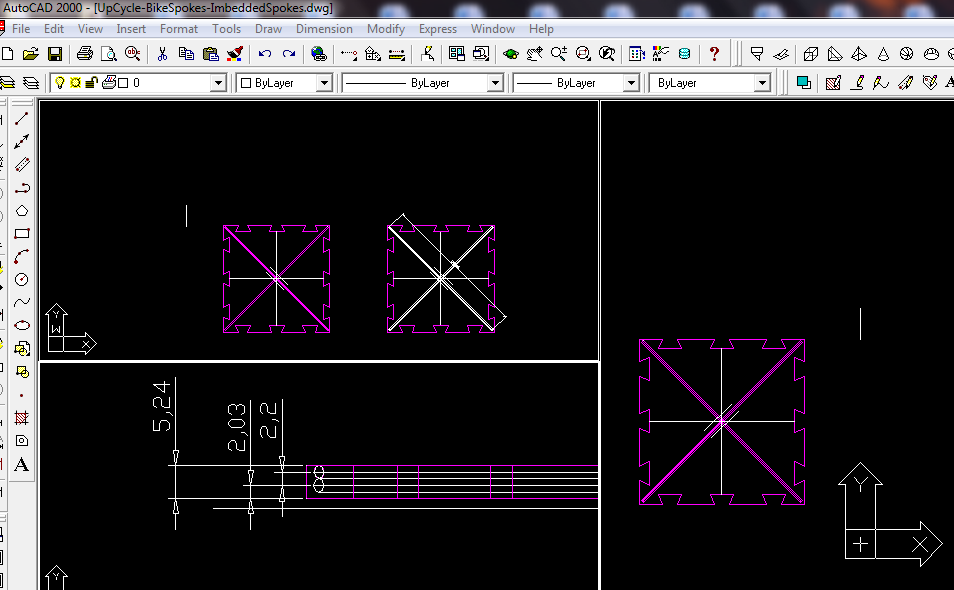
This method is a bit more involved. In some cases, depending on what the component you wish to strengthen are like {shape and size, etc.}, you may need to *Pause\** the print at the appropriate point during printing the feature and lay or slide the pre-cut length of spoke into the partially completed slot or opening; then resume printing, which can be an issue all in itself due to head re-positioning becoming off-set {the head returning to the wrong spot}. There may be a bit of experimentation involved, or perhaps ‘custome-GCode’ to be written. The cavity will need to be *Designed-In,* and a D shape may also be necessary to eliminate some headaches for the printer {the nozzle tends to collide with the spoke using a ‘standard round slot’ in some cases; which seems to be a function of the slicing software}. Encapsulation of components is an ‘art’ all in itself, and quite a bit beyond the scope of this *Instructable*, but an extremely fun and useful feature of/for 3DPrinted items. Binky Lights, electric motors, fiber optics, trapped nuts {another component attachment method}, and more☺

The following is a simple example and functions for components in need of cross-member supports or reinforcements, ‘big puzzle pieces’ so to speak; enabling the creation of fairly large completed objects with a superior degree of rigidity and strength. Using Trash! ☺

For this application, during the print cycle, you can ‘simply’ drop in the ‘3Bar’ to place the spoke pieces [reinforcement] where designed. This method uses file: UpCycle-BikeSpokes-ImbeddedSpokes.stl to generate the print file.



Designing criteria: Two sections of spoke are imbedded within the component; one completely encapsulated within the unit and one ‘just at the surface’ to add a ‘decorative’ aspect. The spoke pieces are/were cut to 175mm, though it could have been 178mm as the cavity feature was 178mm ‘long’. The component thickness, in this case, is 5.24mm. With the ‘Stop Points’ at ~2.0 and ~2.2 respectively.



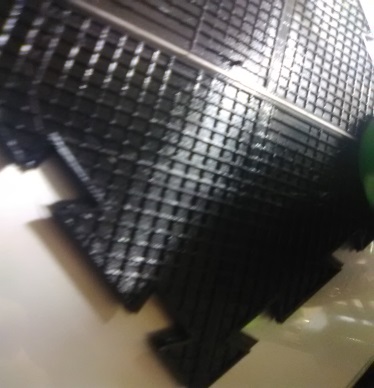
You will need to determine an approximate ‘height’ stopping point. My printer has a ‘height’; aka Layer, display I can easily use to cause the printer to stop or pause if desired; which I did not use for this demonstration.

--- Note: Straighten the spoke piece till it looks straight; there is some tolerance in the process, but it won’t hurt ☺. Lay the spoke on a table and roll it back and forth a bit to see if the ends come off the table. Bend the spoke in the opposite direction if you see any large gaps.

**Step 1:** Start the print

**Step 2:** Wait for it … After the “halfway point” in the shaft dimension [~1mm] has been printed onto the feature [a bit more won’t hurt] defining the 3Bar[☺] location. [From the above drawing you can see the first spokes halfway point is ~2.03mm ‘up’ from the bottom of the print (first layer). You can simply watch till it ‘seems’ to be past the halfway point, but I like numbers and digital displays; feels safer.

**Step 3A:** Drop in the first of the pre-cut [175-178mm], shafts. {You many need to move fairly quickly, but I’m old and slow and can’t see worth a damn anymore, so I’m sure you can manage it☺}

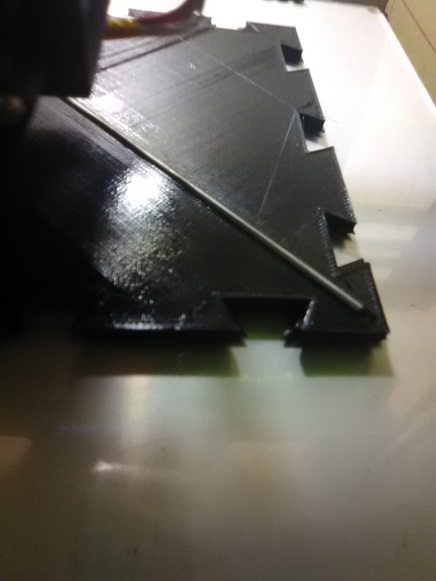


Note: ‘watch for errors’, the puppy may get nudged out of place by the print head; put it back☺

I use a metal Emory nail file for such task {see tools list}, they’re nice and thin and flexible. Don’t burn your fingers … unless you want to?

I’ve gotten this to work first time, every time, that I‘ve tried it; so it isn’t particularly difficult.

**Step 3B:** Wait for it. … Drop in the second precut spoke-bit.



Allow the print to finish:

Ta-Da

Using the ‘Hooked’ ends {example}: *Public Education* wall mounted key rack. Inspired by a line from the movie MIB {1997} by actor Rip Torn who said {and here I paraphrase a bit}, “Exactly what we’ve come to expect from years of public education”. [*GovEdu\_KeyHanger*.stl]

**‘PubEdu’ Key Rack**:

Print Time: 1:57 {machine and settings dependent}

File: **GovEdu\_KeyHanger.stl**

Assembly Time: approximately 15min. {probably less}

**Items List**

Spoke hooked ends: 5

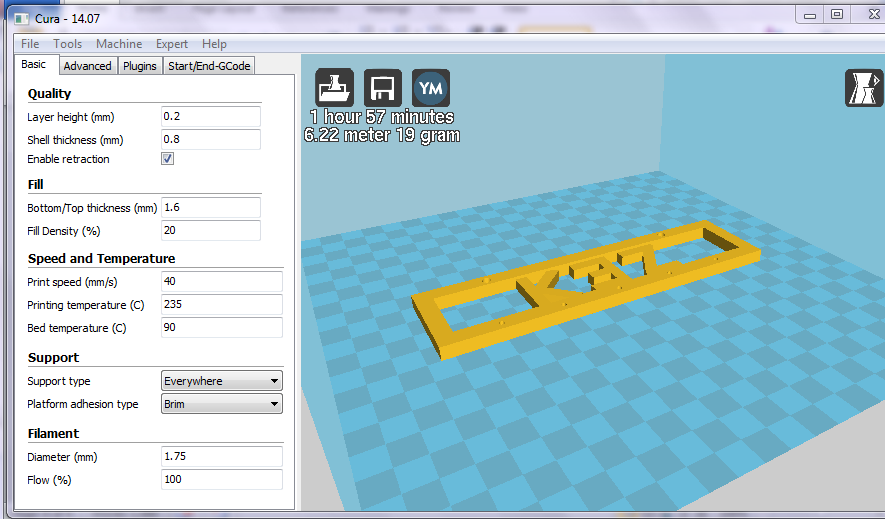
Epoxy/Glue: Gorilla Glue, *E6000* , or equivalent. {Something thick}

Filament [Your Choice]: ~6.2m

Procedure

1. Print the key rack back plate and perform any desired/necessary post processing.
2. Trim Spoke Ends to: approximately 22mm/0.86in. … Maybe a bit shorter, your choice.
3. Apply a dab of glue to the insertion end; cover about 3-4mm of shaft length liberally with glue, and insert the spoke-ends into the 5 small holes at the bottom of the back plate with the hooked end protruding from the front {recessed} side. Also insure the hook/bent ends are facing ‘up’ {assembly image}; lay the unit on a piece of wax paper to cure. Allow 24 hrs cure time.

Settings image



Assembly image



You could also paint the letters; I’m just lazy☺, Nail polish works well.

Notes:

Not all 3D printers are the same. Your specific printer may require you to experiment a bit to get these methods to function as desired. I use the Anet-A8, a RepRap i3 single print head ‘knock-off’ which I obtained as a kit; very inexpensive, required a small amount of upgrading to function well [as viewed from my thoroughly biased AR engineers mindset ☺] but generally quite a nice 3D printer. You will need to put the A8 in a box to print well in ABS. Send me an email and I’ll give you plans [open source, no charge] to build a ‘cheap’ enclosure for yourself; mine cost zip, I ‘dumpster dived’ all the bits and pieces ☺ {insert sound effect: maniacal giggling.}.

As always; removing the support structures created during printing, if you’re not using a dual head printer and PLC water soluble supports, can be a *giant* pain in the backside. Use needle noes plyers; and remember that most “industrial accidents” are the result of using razor-knives {sometimes called an Exact-O blade; ‘cause that’s what the O stands for: O-Sh\_\_ I’ve cut my fracking finger off. So *please* be careful}.

It does take a bit of pressure to cut the spokes; beware of flying objects. ☺

Turpentine is good for cleaning the spokes; it is also ‘very nasty’ and cleanup is an environmental concern. Caution is advised. Fumes happen. Read and follow all safety instructions.

The Spoke Tool(s) [SpokeTool0.stl, SpokeTool1.stl and Spoke tool2.stl] should be printed with 100% fill {solid fill}. Initially tool 0 will be rather tight {spoke butt end}, and using a small hammer to seat the spoke(s) may/will be necessary. It will loosen with use. This *is* intentional {call it a safety feature}. There are two .stl files; one for Insertion {rt} one for Extraction {lt}, though you can probably use a single version for either purpose; I do.

\* I’ve found that most of the available printers have some method to pause the print then resume once you have completed the spoke/reinforcement insertion step; though getting the print head ‘out of the way’, or simply working around it, may be something of an issue. The printer I use is the Anet A8, it’s nice and cheap and works well once you’ve ‘upgraded’ just a bit; you can use the base unit to upgrade itself; so it’s a ‘no brainer’. I have found however, that there is a 2mm offset on resume. … Custome GCode seems to be the answer.

\*\* As with all 3D printed items, the option for customization is an *awesome* feature. The included Tools Rack can be wall mounted as well as using the stand and therefore, with a simple mirroring of the furnished AutoCAD design, create a left or right handed item. Allowing mounting best suited to the individual and/or the location where you wish to use it. You can also easily include additional features accommodating specialty tools for you personally; and even attach a name-tag or print in your favorite color for decorative flavor.

I recommend printing the Nubs with a Raft, as it will solve adhesion issues and the small parts are quite easy to remove from the raft, regardless of the material of choice {ABS, PLA etc.}. Print time is very quick.

Additionally: I use the bottoms of plastic bottles as mixing cups for epoxy and glues. Simply slice off the bottom of the plastic container as shown. They make excellent mixing trays/cups and cost zip. …

There are other uses for the containers as well. … it’s not ‘trash’, it’s Materials. I also wash and re-use the separator sheets from pre-made burger packs for ‘wax paper safety sheets’ … bit over the top, perhaps, but what the heck. If you’re going to do something, like save the planet, you might as well go all out. I do seem to be saving quite a bit of coin in the process …. hummmm.

**List of Tools** that fit the Rack. {Note, I lifted these images from google}

* Needle Noes Plyers
* Philips screwdriver(s), one each: small and medium
* Hammer (5in1 – I can’t give you the manufactures name, but you can email for the info if you wish)
* Small Manual Sanding Block
* Small Round and Triangle files
* Razor scraper
* Razor knife {again no names}
* Nozzle cleaning micro-drills [with case]
* Emory nail file
* Allen wrenches (Tools Rack fits 4 - metric)
* 3D printer Hot-End mini Box Wrench



*From the mind of* … Oh … Wait; do I have one of those?