Functional 3D Printed Miniature Compound Bow

Instructions & Assembly Guide

By DonStickel

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1. Disclaimer

So let’s get these mandatory phrases out of the way first.

> *These instructions and associated print templates are provided as is without any guarantees or warranty. The author makes no warranties of any kind, either express or implied, including but not limited to warranties of merchantability, fitness for a particular purpose, of title, or of noninfringement of third party rights. Use of the finished product by a user is at the user’s risk.*

This was the only template I found online, I could grasp a good fraction of. But to be brief, please use common sense when building and using the attached model. The finished bow may look somewhat cute, but I assure you, in the wrong hands (or even in the right ones) it is not. I would not go as far as to call it a weapon but it certainly is no toy either. Under German law bows of all kind are treated legally as “sports equipment” or “throwing device”. And this definition meets it very well.

Never, under any circumstances, aim, draw or even shoot at live targets! A misguided arrow may inflict serious pain, puncture of skin or lead to permanent impairment or loss of vision!

And one last warning: This document has only been proofread by almighty Word autocorrect. So please overlook a non-native speaker’s attempt to swiftly put together some semiprofessional instructions for his very own work.

2. General Slicer Settings

As far as slicing software goes, I personally like [Ultimaker's Cura] best as it provides a tidy, user friendly UI produces solid G-Code quite quickly and most important is free to use. I know Slice3r, especially the Prusa edition, fulfils most of this requirements too plus is open source. Thing is I have gotten used to Cura so much, I will use its terminology for all slicer settings in the upcoming sections. As far as I know most of the terms even have become canon in the 3D printing community and largely are the same in all slicing software (few exceptions excluded like *Vase Mode*/*Spiralize*).

Quality

Not much to say about this category except my default *Layer Height* is 0,15mm. I only step up to 0,2mm for parts that will be invisible in the final assembly, have to withstand persistent mechanical stress or would take unreasonably long to print at 0,15.

Shell

Only setting of interest here is the *Wall Thickness* which should be twice the nozzle diameter – 0,8 to 1,0mm - by default. One of the most common misperceptions in 3D printing is how to generate more mechanically robust results. The number one goto solution is beefing up the infill, because solid parts have to be more rigid right? Of course they are but they also take hours to print and waste tons filament. Trick here is to leave the infill at its default – 10 to 20 % - and only increase the *Wall Thickness* as the wall of a body makes up about 90% of its structural integrity.

Since version 3.0 or so Cura provides some settings to *Hide Seams* in concave corners so they are close to invisible. So why not simply use this option.

Infill

As stated above simply leave the density at its default and the generic *Grid Infill Pattern* should do a fantastic job.

Material

Material specific settings solely depend on your choice of filament. The parts list Excel sheet contains a material recommendation for each part but you really have to test out different combinations for a bow with optimal performance.

A general advice from my side: The shop page and or packaging of the filament often state a specific hotend temperature range. The most common way is to set it up to the maximum and gradually step down until the print looks best. But in my personal experience you can simply stick to the lower end of the temperature range ± 5 Kelvin as higher temperatures lead to more stringing, smearing and an uglier print.

Speed

All settings in this category highly depend on two main factors:

- How filigree the smallest structures in the part are, how dense they are packed and whether they are part of a (kinematic) assembly thus need to perfectly fit together with other printed or even precision machined parts.
- The capabilities of your 3D printer when it comes to precision in X-Y-direction. My machine is a heavily modified and fine-tuned Anet A6 China DIY kit with the vanilla direct extruder which pretty much limits the print speed. If you have a more sophisticated high end machine with Bowden Extruder you could potentially speed up the print by a significant amount.

My default printing speed for life-size visual props that have to look perfect but are also quite large is 30mm/s. I can also print a functional M3 and 1/8" Whitworth screw and thread but have to lower speed to 15mm/s to give you some reference.

The Excel sheet parts list provided alongside this document lists the print speed I used for each part giving me optimal results. But feel free to test out for yourself and maybe cut down on printing time.

Cooling

Not much to say here besides I never run above 80% *Fan Speed* unless I want to become deaf.

Support

Now this topic is a field of science on its own but let's not waste too much time on it. For pretty much every part of the compound bow support is advised even if it may not seem so on first glimpse (IdlerWheel and CableAnchor eg. could potentially be printed without but have deep notches for the strings that need to come out perfect or they won't work).

If you happen to have a machine with multi extruder and overpriced soluble filament please move on.

For the rest of us normal mortals please stick to the default values like 50° *Overhang Angle* and *Zig Zag Pattern* but always enable the *Support Interface* in the advanced settings to get perfect surface structure where support touches the model.

Build Plate Adhesion

Boring category yet again as I use 5mm *Brim* for basically everything.

3. Part Description, Printing & Post Processing

Print Parts

Generally all parts are exported from Autodesk Fusion360 on high preset and are already oriented in a way to be printed with optimal results in respect to distribution of mechanical stress and optical appearance. If you plan on rotating any of the parts in the slicer in terms of personal experience, please keep in mind the inherent anisotropy of 3D printing. Printing in wrong orientation might lead to breakage when stretching the bow.

Riser (ID 1)

The so called riser in archery terminology is the main body of the bow which the limbs and all other parts are mounted to. Its only purpose is to be rigid but lightweight. Therefore you should use the most rigid filament you have for it as flex in the riser itself would defy this purpose. In my case cheap white PLA was just fine.

When it comes to slicing simply stick to your/my default settings and keep the recommendations in the parts list in mind. Use *Support Interface* to keep the inside of the riser's arc as smooth and beautiful as possible.
This is by far the largest part of the assembly and will take the most time to print. Nevertheless it easily fits on my 220 x 220mm print bed. For small beds try to rotate it by 45 degrees.

The riser is housing most of the M3 Nuts and bores for M3 screws. Using support it can be pretty difficult to remove every last bit blocking these holes. For easy assembly make sure all holes are clear by sticking a thick needle in and "stirring around". This will loosen the support material which can then be pulled right out with pliers.

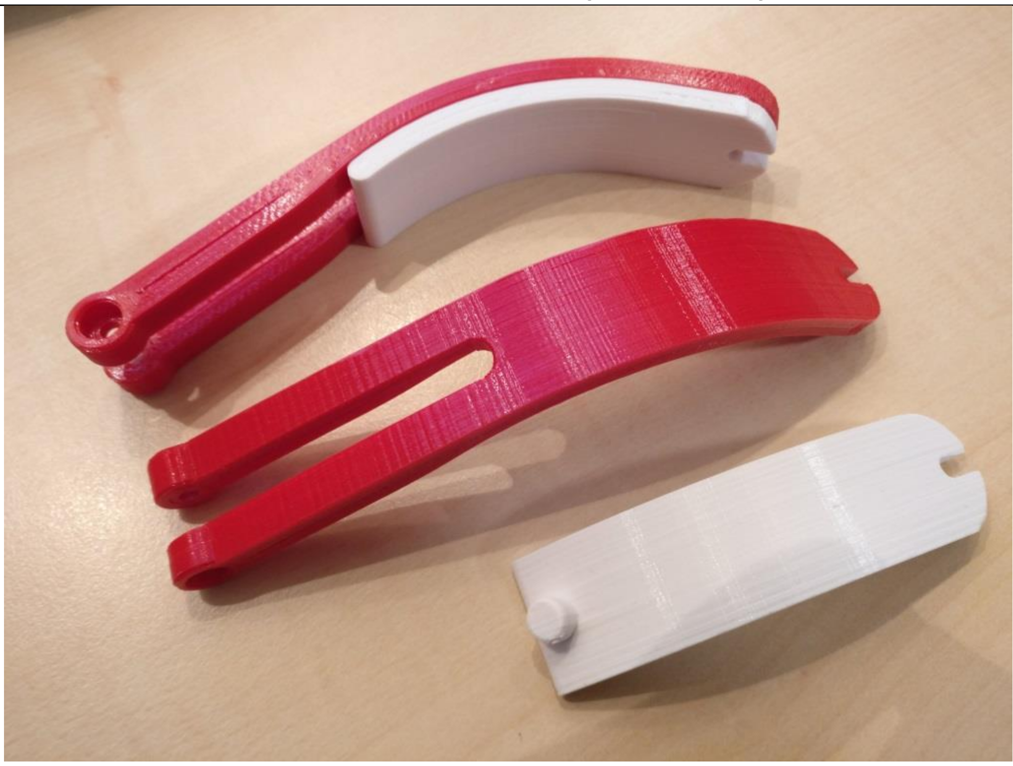
LimbPivots (ID 2a & b)

As the riser is pretty slim in profile (only 8mm) but the limbs are 20mm wide these parts serve as base and pivot points stabilizing the overall construction. There is one Hex and one Blank version of the LimbPivot and you need two of each. The former is designed to hold a M3 nut while the latter will simply carry the corresponding screw's head forming a pair for both limbs on the top and bottom of the riser.

Set the *Printing Speed* lower than usual as each part has two thin (2mm) nipples at the bottom which easily get messed up at higher speed.

Removing Build Plate Adhesion and Support be careful not break off those nipples as they are required for aligning the pivots in the riser.

Limbs & AuxLimbs (ID 3a & b)



Limbs are the two long, thin and often curved iconic parts of any bow or crossbow responsible for temporarily storing all the energy from drawing the string and then releasing in onto the arrow/bolt.
But what is an Aux (auxiliary) Limb?
As it turned out the 4,5mm PETG main Limbs were too weak for my liking shooting arrows far too lightly. So I started experimenting with different materials (see following section) and thickness. Increasing the thickness primarily went into printing time but otherwise didn't do much; changing to blue PLA immediately gave me a rigid rod with no elasticity at all. And I feared mounting and trying them out might break my precious Riser.
So what I came up with is a combination of a long primary Limb made from PETG and a shorter PLA one as booster.
The same principle is used in heavy duty leaf springs as on trains and pickups.

In terms of *Material* selection the Limbs are the most delicate parts. They need to be kind of elastic but not soft (↘ PETG, ABS) and have to be powerful enough to provide some punch (↘ PLA). So basically you are bound to experiment with what materials you have here. And if you later on should wish for a bit more power you can simply add the AuxLimbs.

Regarding slicer settings it is very important to set an extraordinaryly high *Wall Thickness* (4mm). This way the body is not filled up with infill but rather inner walls. That guarantees the required isotropy along the Limb's curve.

Proceed with extreme caution removing support material from the Limb's fork.
I accidentially split up at least two Limbs in the process (because you know one does learn from mistakes)
I found the best method to be sliding a thin blade (e.g. exacto knife) down each side of the support separating it from the Limb about half way. Then grabbing the support with long pliers and twisting it out in the plane of the print layers. This way minimum force is applied in Z-direction.

LimbCaps (ID 4)

As screwing the limbs directly to the riser might damage /split them up and from a design perspective would not be quite up to the rest of the bow these two caps come to use. They fit over the end of the limbs, provide a rounded bearing for the screw heads and distribute the load from clamping to the riser evenly.

A relatively low *Printing Speed* is required for the thin walls to turn out nicely.

When using a *Support Interface* you should get a pretty even and clean surface on the inside.

Cam (ID 5)

Besides the bow limbs this is the most important part of any compound bow. It distributes the draw force over the draw length in a way nearly zero strength is required for holding the string in end position. Furthermore the arrow is not accelerated in linear fashion but in a rather smoothed out way, giving it less disturbance and allowing a more stable trajectory. It does this by redirecting the primary string and a secondary cable to the other limb, over an idler wheel and back to itself while varying the ratio of tensile forces in all strings across the draw length. The mechanical theory in itself is quite complex and requires good understanding of kinematics. Even a M.Sc. in engineering did not provide me with enough background knowledge to fully grasp the concept. Basically I modelled a mashup of several patent drawings that magically turned out to work somehow. For further information see the [Wikipedia Article on Compound Bows](https://en.wikipedia.org/wiki/Compound_bow).

The orientation of this part should definitely be left as is and the use of *Support* is strongly advised although it will be a pain in the a** to remove later on. *WallThickness* should be increased as with all parts bearing the load of the bow's draw force (e.g. to 1,6mm or 4 times the nozzle diameter). The Cam provides 3 pivot bitts for primary and secondary string which at their thinnest only measure 3mm in diameter. But as they carry all the force they should turn out all solid.

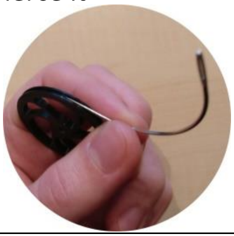
Make yourself familiar with this geometrically complex part and in case of doubt look up in your slicing software on what is support/adhesion and what not. Otherwise you could easily end up cutting/breaking off an essential portion of the part. And keep in mind although pretty small, due to its complexity it takes a considerable amount of material and time to make.
When using *Support* and *Support Interface* the string notches on the cam will most certainly be filled up and appear almost impossible to clear. Follow the hints for IdlerWheel and CableAnchor below for easy support removal.

IdlerWheel (ID 6) & CableAnchor (ID 7)

As mentioned before the IdlerWheel simply redirects the main string from one Limb/Cam to the other and back. Its neighboring CableAnchor is, well, an anchor for the loose end of the cable. More on that topic will be discussed in the assembly chapter.

Although these two parts may appear pretty straight forward like a simple extrusion body they both, like the cam explained before, have a 1,5mm deep notch for reliably guiding the strings. They require *Support* generation to be printed clean enough for fulfilling their purpose.

Depending on the slicer software used und selected *Support Pattern* the notches may come out fully filled up on the outside. Do not, I repeat DO NOT try to simply plie them out or you might split up print layers destroying the whole part. Instead take a solid sewing needle and pierce it through the support wall. Then tangentially slide it into the notch behind the wall. Finally make your way around the whole wheel/cam pulling the free end of the needle away from the center pushing the tip further into the notch. This way the support material should be pushed out leaving the notch intact. See figure for reference (granted this piece is fully cleaned up and I'm missing a third hand to capture the process accurately but you should get the point).



CableGuard (ID 8)

This curved rod is supposed to hold the Cables out of the arrow's travel as they normally would lay in the exact same plane as the main String.

The CableGuard has to be as rigid and stiff as possible to not flex and let the Cable interfere with the arrow. To achieve this definitely use PLA as *Material*. Furthermore increase the *Wall Thickness* to very high 3mm like with the Limbs.
Print Speed can be pretty high with this part as it has no fine details at all.

The end with the slot needs to slide into the round hole through the Riser. Depending on your machine's Z-accuracy the CableGuard printed laying flat might (will) not turn out perfectly round. In theory I worked sufficient tolerance in every connection between two parts. Should it not fit whatsoever, carefully sand the slotted section until it fits (P400; P150 max). Do not overdo it (like I did) or it will fit to loosely and start wobbling in its bearing.

ArrowGuide (ID 9)

Pretty proud of this sleek piece of design as it allows to easily insert an arrow from the side and reliably and accurately guides it toward the target.
It has an inner diameter/clearance of 6mm thus should be able to guide almost any arrow shaft reasonable in this scale.

The geometry theoreticall allows to print completely without *Infill*.
Support is required for the screw slot nervertheless.
I tend to increase the *Wall Thickness* to 1,6mm for parts that are going to see some wear. And this guide sure is.

Sand the front of the ring a little to achieve smooth guidance of the arrow right from the start.

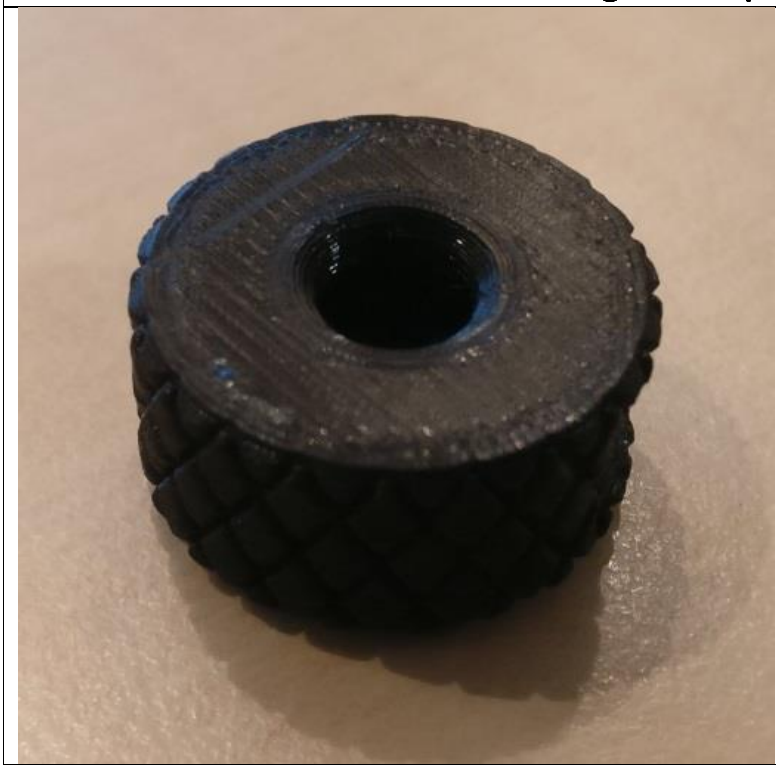
CounterWeightRod (ID 10)

This 80mm long rod horizontally sticks out from the front of the riser and is supposed to balance the bow and arrow in fully drawn position. The rod works as a mount for the actual weight described below.

Increase *Wall Thickness* to 1,6mm to give this thin rod some more strength.
The modelled ISO M6 thread has a pitch of as little as 1mm. For this fine structures to turn out somewhat functional *Print Speed* has to be reduced to 25 or even 20 mm/s.

Nothing special for post processing except be careful with the thin, fragile walls.

CounterWeightHull (ID 11)



This is the actual CounterWeight that can be shifted on its rod to adjust the bow’s center of weight. As plain polymer parts provide not enough mass for this job, this part is only a hull for a steel M6 Nut.

Print with low *Speed* if you don’t want the cool looking and feeling knurling on the outside to be lost entirely.

The support material is going to be really hard to remove from inside of the hull. Try not to damage the part too much or the M6 Nut might not fit in eventually.

Non-Print Parts (Hardware)

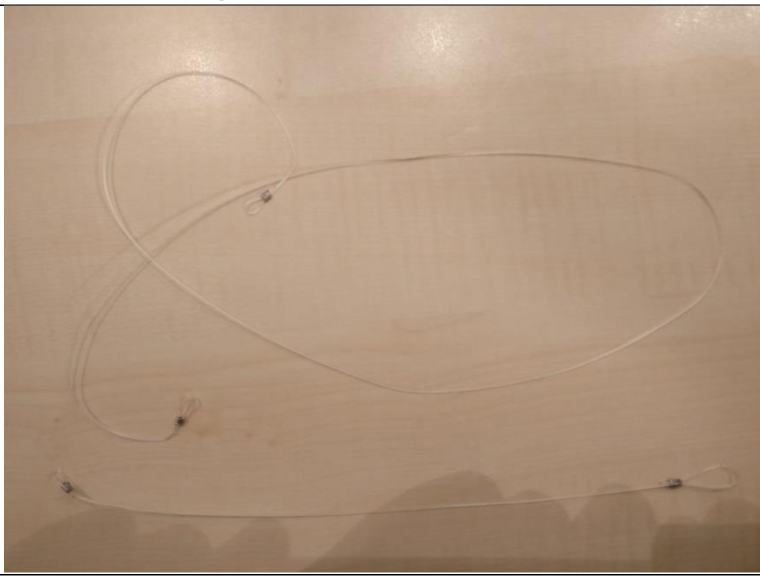
It’s hard to confess to oneself but the following parts are either impossible or unreasonably tricky to 3D print. So just get over it and buy them in a hardware store of your trust.

Screws & Nuts (ID 12 - 14)

I decided to solely use ISO M3 in the entire design as this is the smallest standard thread available in conventional hardware stores, fits the scale just right and is far strong enough.
The single M6 Nut and third M3x12 are used for the optional counter weight so leave them out should you decide you do not need one.
For those living outside the EU I’m not quite sure about the availability of ISO screws and nuts. If you are not able to get them at all, Whitworth screws might work also but you have to find out the size yourself I’m afraid.

An alle deutschsprachigen Communitymitglieder: Hierzulande sollte es niemanden vor große Schwierigkeiten stellen, M3er Schrauben zu besorgen. Als Tipp kann ich allerdings Hornbach geben. Der hat mit Abstand das beste Angebot an Eisenwaren inklusive M3 Kreuzschlitz Linsenkopf in allen Längen.

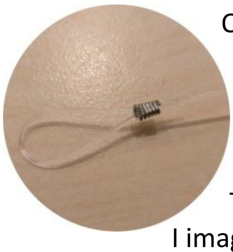
String (ID 15) & Cable (ID 16)



Finding the right type of string is kind of tricky as it has to be thin and flexible enough but must not be elastic nor tear easily. Real compound bows and crossbows use synthetic high-tech fiber like Kevlar or Aramid bundled into a single cord.

But to my knowledge none of that exists in a downscaled version suitable for the miniature bow.
The notches in Cam, IdlerWheel and CableAnchor are 1,5mm wide but in order to allow them to move freely, **Strings should be a maximum of 1,0mm in diameter**.
Personally I have tried several types of yarn which all failed me as they tend to unravel or rip on applying drawforce. To recapture, anything based on cotton or wool is doomed to failure.

What is currently in use on my bow, working quite fine but hard to see in the picture above is 0,7mm nylon string. You can find thin nylon thread in most notions departments but it is typically only 0,1/0,2 mm and far too weak for our purpose. The type I use can only be found in well sorted hardware stores or online shops.
What I later discovered and am keen to try out at some point is polyester kite string. You can get it off Amazon in 100m quantity for few bucks and in various diameters.



One problem arises from the use of thick nylon string however: It is too stiff to put on tight, lasting knots. The surface does not provide enough friction and any type of knot I tried was either too thick or would untie itself over time.
What I finally came up with is to lay a loop and wrap its base in steel (copper?) wire then crimp with pliers to fix in place.
This takes some practice until a loop finally turns out stable enough.
I imagine using real woven string and putting on knots will be a lot easier

It is very important to use String and Cable of correct length for the “compounding” in the bow to function properly as String length, Cam design and Limb spacing work hand in hand.
It is easiest to put a loop on one end of the string, fix it somewhere, measure the correct length, add enough excess string (80 – 100mm should be sufficient), cut, put on the second loop and cut excess.
The lengths indicated below are measured from **loop center to loop center, not end to end** as this might vary based on knot type or other fixture.

The main **String (ID 15)** has to be **720mm** long as it covers twice the distance between the Limbs plus half the perimeter of Cam and IdlerWheel. The loops on both ends should be the same diameter, about **6mm**.

The **Cable (ID 16)** directly connects the Limbs thus needs to be only **230 mm**. The loop for the Cam can also be **6mm** in diameter but the one for the CableAnchor should be about **15mm**. In case of doubt, try to slip it over the part and it should be quite loose.

Um wieder auf Hornbach zurück zu kommen, der führt neben den Schrauben auch Perlondraht (allgemein auch als Nylonschnur bezeichnet) der Firma mamutec. An meinem Bogen kommt momentan die Variante mit 0,7mm Durchmesser zum Einsatz. Daneben sind noch 0,4 und 1,0 mm im Angebot. 0,7 ist schon sehr steif aber funktioniert bei ausreichen Zugkraft. 1,0 wäre auf jeden Fall zu dick davon würde ich abraten. 0,4 werde ich bei Gelegenheit noch ausprobieren, das sollte immer noch genug Zugfestigkeit haben.

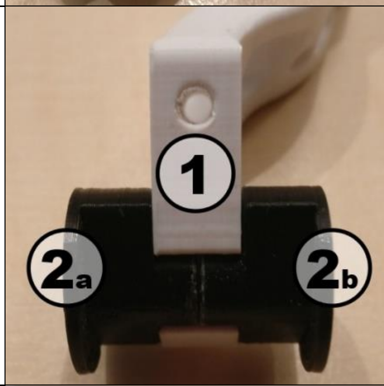
4. Assembly Guide

If you follow this foolproof step by step assembly guide, have all required parts at hand according to the parts list and listened to at least some of the advice in previous sections nothing should go wrong.

The only tools you need for assembly are a medium sized phillips drive ⊕ and your very own ungainly fingers.

1. Begin with the **Riser (ID 1)** and choose either end with a part circular opening. Put in a **LimbPivot (ID 2a/b)** so that its angled surface aligns with the Riser and the two small nipples fit into the holes on the Riser.

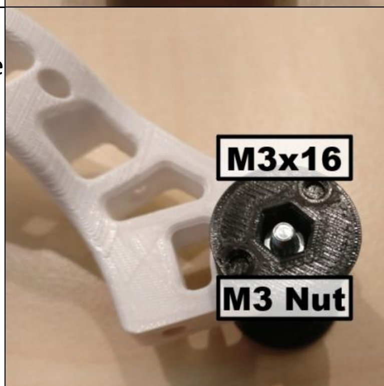
2. Put the other type Pivot (Hex/Blank) on the opposite side of the Riser.
Which type of LimbPivot you choose for which side depends on whether you want to see a screw head or nut while holding the bow.
Personally I prefer the screw heads on the left side.



3. Insert one **M3 Nut (ID 13)** in the hexagonal opening of one Pivot and one **M3x16 (ID 12b)** screw in the round opening of the other half. Tighten screw firmly but keep in mind you are dealing with plastics.

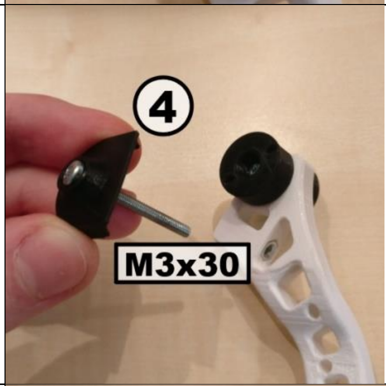
Repeat procedure for other side of the riser with same set of parts.

The result should look like below.



4. Inside the second last cutout at each end of the Riser you will find a **hexagonal opening**.
Place one **M3 Nut (ID 13)** inside

5. Take one of the two **LimbCaps (ID 4)** and stick a long **M3x30 Screw (ID 12a)** through.



6. Slide the **M3x30 Screw (ID 12a)** in the bore at the flat end of the riser and screw loosely into the Nut just placed in the hexagonal opening.

Repeat this step for the other side also.

7. Slide a **Limb (ID 3a)** between the Riser and the LimbCap onto the M3x30 Screw.

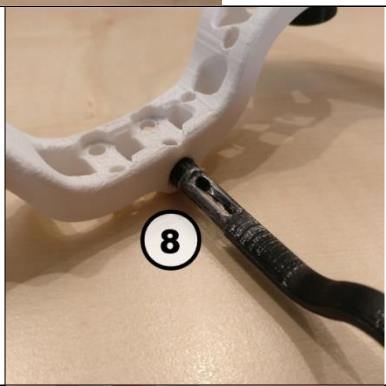
8. Tighten the M3x30 Screw until the Limb is clamped firmly between Riser and LimbCap.

If you choose to beef up the bow’s power a little, slide an **AuxLimb (ID 3b)** under the primary limb (see next figure) and clamp both in together.

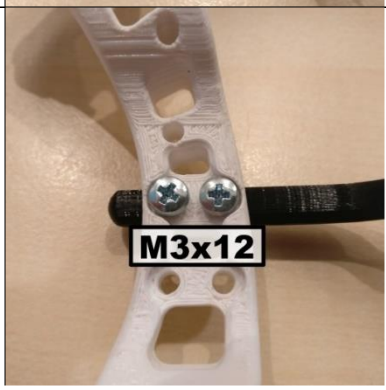
9. The final result should now already look like a real compound bow.
For the following steps we now can define the bow's local coordinate system. Holding the bow upright the limbs point towards the archer and the riser arc opens to the left (Sorry lefties but this is a right handed bow). The riser grip with the four small holes close to each other should now be at the bottom.
This way below figure shows the right side of the bow.

10. Ever wondered what the larger hole in the middle of the Riser is for? It houses the **CableGuard (ID 8)** which should slide right in from the back with the curved in part facing to the left.

Don't get distracted by the tape wrapped around the end of the Guard. I messed my one up and it fit too loosely.

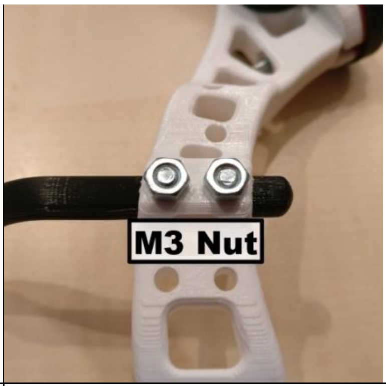


11. Align the slot in the CableGuard with the two bores in the riser and put two **M3x12 Screws (ID 12c)** through from the left.

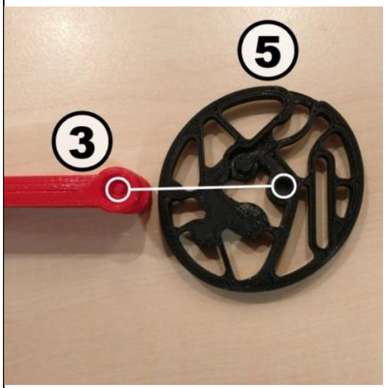


12. Turn the bow around and screw on two **M3 Nuts (ID 13)**. Tighten with the phillips drive while holding the nuts with your hand.

This design might not appear optimal and indeed I first planned on adding hexagonal housings for the nuts. But I decided attachments like a quiver for arrows may be mounted here later on.

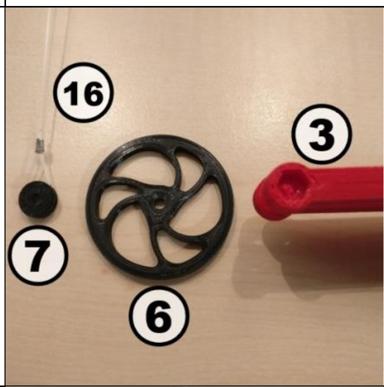


13. Turn the bow looking at the left side again.
The bow’s most complex component, the **Cam (ID 5)**, is mounted into the fork of the lower Limb. Looking at the Cam only one stud/holding point for the string should be visible as well as a vertical slot on the right.
Place the Cam inside the limb aligning the small center hole with the one at the Limb’s end.
Place a **M3Nut (ID 13)** inside the hexagonal hole on one side of the Limb an screw a **M3x16 (ID 12b)** through the other side.
Tighten until the Cam does not move anymore and then loosen by half a turn. The Cam should now be able to move freely.



14. Now onto the opposite Limb which will hold the **IdlerWheel (ID 6)** and **CableAnchor (ID 7)**.

Before you continue put the larger loop of the **Cable (ID 16)** (should be the shorter one) over its Anchor!
Proceed as with the Cam before but this time you have to align IdlerWheel and CableAnchor simultaneously.

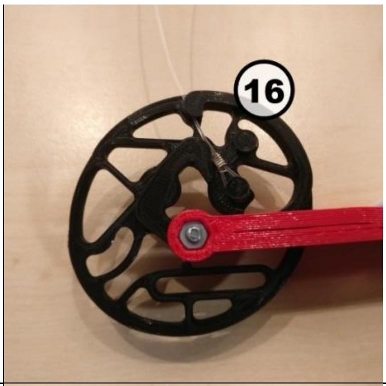


15. Looking at the left side the Anchor has to be at the bottom (hidden by the IdlerWheel). Or holding the bow upright it has to be to the right of the IdlerWheel.

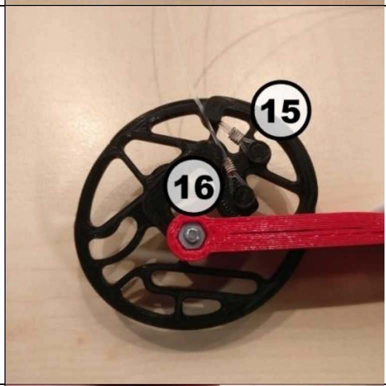
The IdlerWheel by the way does not have a specific directional, so simply choose a direction you like better.

Now comes the trickiest part of the whole assembly: Correctly stringing the bow.
If you, like me, ever tried to look up instructions on a certain type of knot (e.g. the bowline aka “Palstek”). And after 5 minutes of looking at dazzling images of ropes going $\rightarrow\downarrow\leftarrow\leftrightarrow\rightarrow\nwarrow\searrow E = mc^2$ and DONE thought to yourself – well f*** this I will stick to a basic knot – you will not like this process.
Nevertheless I tried my best to make it perfectly clear and visual. So let’s begin.

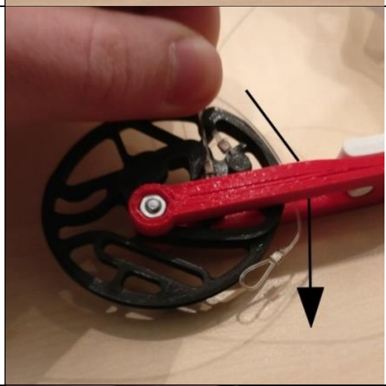
16. Turn the bow looking at its right, lower Limb + Cam toward you. Remember the vertical slot in Cam? Turn it 90° counter clockwise so the slot is horizontal. You should see two of the string studs on the top.
Place the free looped end of the Cable just attached on the lower stud closer to the rotation center. The Cable should run over the CableGuard.



17. Next pick up the **String (ID 15)** and put one looped end on the second free stud.



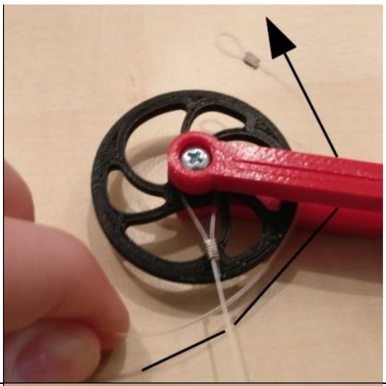
18. Grab the other loose end of the String and stick it through the fork of the limb right next to the Cam.



19. As you may have noticed the Cam consists of two layers – a larger layer that is now on the bottom and a smaller layer on the top – the one of interest right now.

After sticking the String through, wrap it around the contour of the upper layer placing it conveniently in the Cam's upper notch.

20. Keeping the String somewhat tightened now concentrate on the IdlerWheel on the upper Limb.
Slide the String's end in your hand under the Cable and through the fork next to the IdlerWheel similar to the Cam before.



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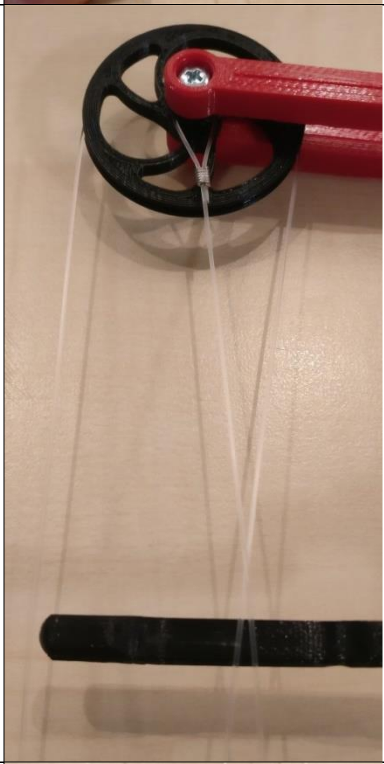
21. Wrap the String around the IdlerWheel placing it in the notch.
When tightened by pulling downward it should cross with the Cable just above the Cable guard



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22. Now let's destroy what you just build!
Turn the bow on its shooting axis so the left faces you, down is up and up is down.
Put the String down from the IdlerWheel and let it rest on the Limb fork as seen in the figure.

Might appear unintuitive now but helps the next steps a lot.

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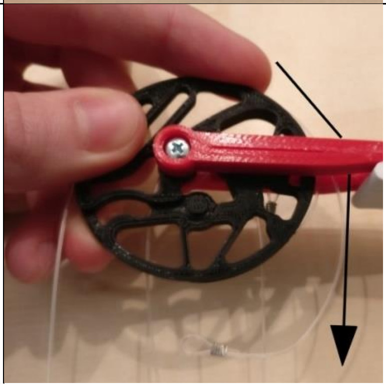
23. Move back to the Cam which should be on the top now.
You are now dealing with the larger layer of the Cam, so again place the String in the notch in a clockwise manner.
As done twice put the String through the Limb's fork leaving it dangling down.



24. Pick the loose end up on the other side and put its loop on the last remaining stud.

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25. Slide the last bit of the String over into the notch – it should now run almost 360° around the larger top layer of the Cam.

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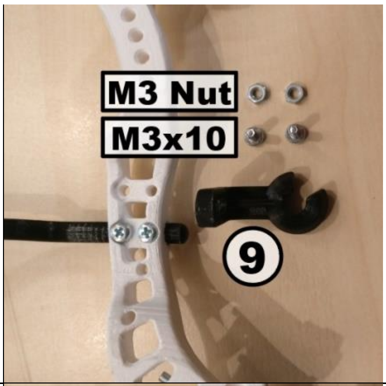
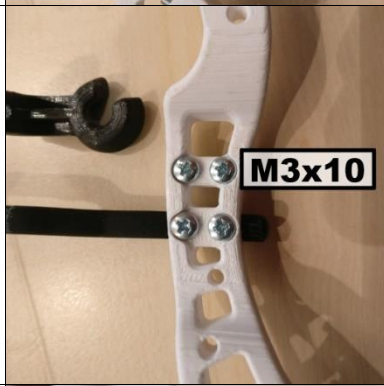
26. Finalize your effort by putting the String, rested on the Limb before, back in the IderlWheel's notch.
Ever changed the tire on a bicycle? This feels very similar.
This will already put some tension on String and Cable so depending on your Limbs' performance you might have to compress the bow a little.

And there you go, you just finished stringin your bow. It now not only looks like a real one but actually could shoot things – not accurately but it shoots.
At least you can test its draw force now by pulling the string.
But please keep in mind: Never DRYFIRE any bow or crossbow as it can and will BREAK over time! Most certainly the String will jump out of its notches and you are the happy one to redo all of the steps above!

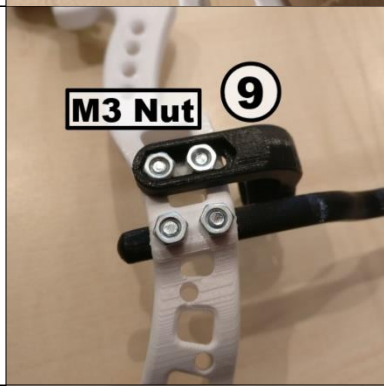
27. From the martyrdom that was stringing let's move on to something more pleasant: Mounting the **ArrowGuide (ID 9)** to actually start shooting accurately.



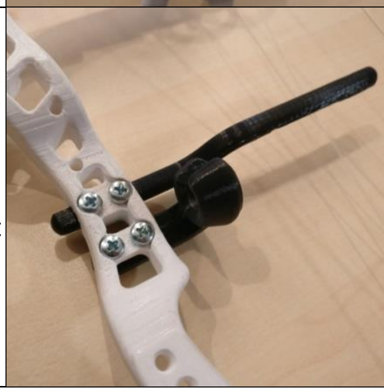
28. Start by inserting two **M3x10 Screws (ID 12d)** into the free holes next to where the CableGuard is fixed.



29. Turn the bow around holding the screws in with one finger. Put the **ArrowGuide (ID 9)** on with the ring towards the back and place two **M3 Nuts (ID 13)** in the hexagonal slot.



30. Turn back around and tighten the screws lightly. As you may have noticed the slot in the ArrowGuide is a bit longer than the spacing of the screws. This way former can be adjusted back and forth compensating for different arrow lengths.
Choose a position and tighten screws.

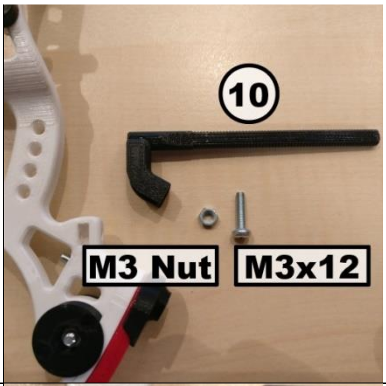


This concludes the mandatory part of the compound bow assembly. You now have a fully functional miniature bow including arrow guide – but are still missing fitting arrows. So you might as well head on to the Arrows Section, craft some projectiles and start shooting.

Optional Counter Weight

The following part of the guide deals with the optional attachment of a counter weight. If you do not want it/have not printed Rod and Hull simply skip this portion.
For the rest I cannot guarantee the practical use of a counter weight on a miniature bow. Well to be honest I'm pretty sure it has close to zero effect in this scale – But it sure looks cool and tactical AF.

31. First the **CounterWeightRod (ID 10)** needs to me mounted to the Riser with an **M3 Nut (ID 13)** and **M3 Screw**. I used a leftover M3x12 but anything from 10 to about 20 mm will do.



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32. On the right side just above the lower LimbPivot the Riser provides a slot that takes an **M3 Nut**.

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33. Place the **CounterWeightRod**'s opening over this section of the Riser and firmly screw in the **M3 Screw** from the front.

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34. In this last steps the **CounterWeightHull (ID 10)** and one **M6 Nut (ID 14)** is required.

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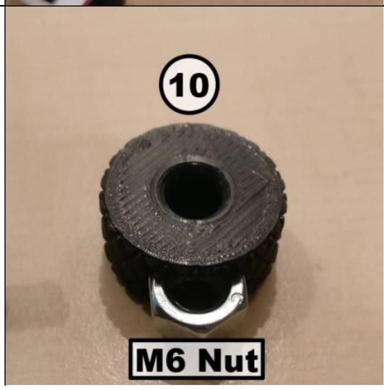
35. Slide the M6 Nut into the side of the Hull and align the holes watching through.



36. Screw the Hull and contained Nut onto the Rod balancing the bows center of weight by moving the CounterWeight back and forth. Be careful screwing the Nut on straight or you may damage the printed thread.

If you feel one Nut is not enough mass, simply print more Hulls and fill with M6 Nuts.

And there you go. Now you have a fully functional bow with possibly working, professional looking counter weight.

5. Arrows

I like to use conventional skewers as arrow, typically made from bamboo or some other wood. Most types are about 300mm in length, perfectly fitted to completely use the bow's draw length, 2.5 to 3.5mm in diameter, weight 1.3 to 2.0g and are already quite pointy.

When buying a package of skewers, sort out the ones visibly bend or otherwise misshapen which can be an impressive fraction.

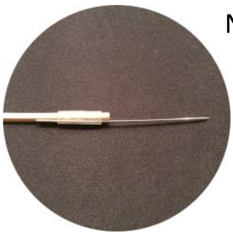
Take a sharp knife and cut al little notch (does not need to be deeper than 1mm) into the flat end of the skewer.

In this state the arrows are practically ready to use and in fact I myself still use a lot of them in this form. They stick perfectly well in cardboard boxes and paper targets as well as pieces of Styrofoam (e.g. from old packaging). If you do not plan on shooting above, say 3 – 5m, plain skewers should fly sufficiently stable (given that they are reasonably straight). Saying stable, do not expect a 1 inch group – more like a 10+ inch group.

To extend the arrows' stable trajectory and enhance accuracy there are two methods I checked out so far:

Tip

Adding a tip to an arrow or bolt shifts its center of weight, making it more front heavy. The basic skewer is of consistent density and thickness, meaning the center of mass is about the middle. Any disturbance on the trajectory immediately leads to instability and makes the arrow tumble and finally topple over. More mass on the front means less sensitivity to escalation of instability. So far the theory.



Naturally a real arrow tip won't fit the miniature version of an arrow. So what I do is I tape a thick, long needle to the side of the skewer's front (see image to the left). Make sure to wrap the tape very tight or the needle might shift back on impact (will eventually happen over time, especially when hitting something hard).

Arrows tipped with a needle like this tend to fly more stable in my experience. It furthermore expands the spectrum of possible targets by pillows, beverage cans, wooden boards or basically everything softer than the steel of the needle. So please keep this in mind when shooting indoors as furniture, room decoration, TV screens and alike seemingly has a strong magnetic field attracting rogue arrows. Not to mention live subjects – a misguided skewer probably won't kill anything but it sure puts a sting.

Fletching

I started experimenting with fletching just recently and carried out correctly it appears to be promising. For those not too much into the terminology of archery, fletching is the tiny, soft wings at the end of an arrow, stabilizing its flight furthermore.

As tape was used to fix the tip of the arrows already, it might as well be used for the other end too. On the right you can see different kinds of fletching I tried out and they all appear to work to some point. The easiest way is to cut two 30 – 40mm strips of tape, stick one to the arrow about 10mm from the end and put on the other one as precise as possible from the opposite side. Roll between fingers for optimal adhesion to the wood. Finally cut a bevel at the front of each side.

It is important to cut down the width of the wings to about 8 – 10mm. Less will reduce the stabilizing effect but more may interfere with the inner diameter (6mm) of the ArrowGuide. Cutting the fletching diagonally will further soften it up so it won't result in too much friction.

CAUTION: After adding fletching to the arrows start by shooting at a save target from close range. Then gradually increase distance and carefully observe the trajectory. If the skewer was not sufficiently straight, adding wings dramatically amplifies the drift, sending the arrow anywhere but the target.

This concludes my instructions. Have fun and always be safe.
Best regards

DonStickel.