

# Fourth Axis®

A business unit of Relativity PL - ABN 52 002 218 993

## A new workflow for three-sided ring-cutting:

A great range of ring waxes can be manufactured using a three-pass process. In general three-sided ring-cutting, the wax blank from which the ring will be machined is mounted in three orientations. The first orientation allows side-detail and the ring's finger hole to be machined out of the middle of the wax (Side-A cut). The second orientation involves flipping the wax over and machining the detail on the ring's other side (Side-B cut). The third and final orientation involves mounting the wax for a full rotary cut of the band detail, OR mounting the wax at an index so that the mill can machine out the stone setting, OR both.

Having seen jewellers struggle with the compounding complexities of three-sided ring-cutting, we've been looking at ways to make the process more straightforward and less prone to error. The new FlipFlopWax procedure, introduced here, costs nothing and can be made to work with any quality machine.

The FlipFlopWax procedure is inherently completely repeatable, does not require intricate mounts or critical alignment of customized components, and can be used with your Fourth Axis hardware, straight out of the box -- no accessories or fixtures are required.

## Disclaimer






First we need to say that this information is provided without any kind of warranty, express or implied, including but not limited to, any implied warranty of merchantability or fitness for a particular purpose. This procedure requires a properly made and maintained mill with a rotary axis. If your mill has measurable endplay, rotary backlash or radial runout, you will need to take steps to minimize this. We are not charging you for this information.

## Acknowledgments

We admire the beautifully engineered ProtoWizard, DeskProto 123WaxRing, and TelPro fixtures, and after listening to users of this style of fixture and reading the associated forums, we wanted to find an even more trouble-free way of cutting three-sided rings. Colin Creed (Austatt Image Makers, AU) and Steve Crout (Jubilee Jewellers, NZ) deserve our deepest thanks for their expertise, test cuts and optimizations of this collaborative development.

Roland™, ProtoWizard™, DeskProto™, 123WaxRing™, TelPro™ are trademarks of their respective owners.

## Background

<b>112 090 Steel Faceplate</b> Improves accuracy in sanding (with Sanding Paper, Art. 162 242) Ideal for big faceplate-turning of wood, stone,...		Upgrade for: UNIMAT 1 CLASSIC ✓ UNIMAT 1 BASIC ✓
<b>112 090 DMI Chuck</b> For quick and easy changing of 1.0mm - 5mm tools.		Upgrade for: UNIMAT 1 CLASSIC ✓ UNIMAT 1 BASIC ✓
<b>112 430 Metal - 3-Jaw-Chuck with spare jaws polycarbonat jaws</b> This set consists of our well-tried 3-Jaw-Chuck, a second set metal jaws (these can be re-lathed to an arbitrary diameter, in order to raise the concentricity accuracy for work pieces with the same diameter) and a set of polycarbonat jaws for extra rotatory work pieces (i.e. pearls).		Upgrade for: UNIMAT 1 CLASSIC ✓ UNIMAT 1 BASIC ✓
<b>112 430 Live Center</b> Equipped with ball bearings, this accessory eliminates the need for lubrication and ensures smooth rotation of the workpiece.		Upgrade for: UNIMAT 1 CLASSIC ✓ UNIMAT 1 BASIC ✓
<b>112 430 10 Metal Collets</b> To replace the polymer collets included with the Unimat system, these metal collets ensure better accuracy and longer life. Diameters: 1mm; 1.5mm; 2mm; 2.5mm; 2.5mm; 3.175mm; 3.5mm; 4mm; 5mm; 6mm ...others on request		Upgrade for: UNIMAT 1 CLASSIC ✓ UNIMAT 1 BASIC ✓

For milling waxes which only need a single operation, workholding is not a problem for most users; oversized blank wax can account for positioning errors, and the remainder is usually discarded.

Most mill users will quickly realize, however, that it isn't straightforward to remove a milling target and reorient it reliably in a position known in software. Jigs can be made with precise locating pins, but like all custom fixtures, these are open to user error, machine flexibility, and homing repeatability.

Looking at existing workholding devices available, amongst three-jaw chucks and faceplates, we couldn't find something that would readily facilitate the flipping of waxes or reorientation into another plane. With many fixtures, jewellers are forced to cut multiple unusable "prototypes" to tweak their position and orientation, or must simplify their designs to avoid pins or hold-down screws.

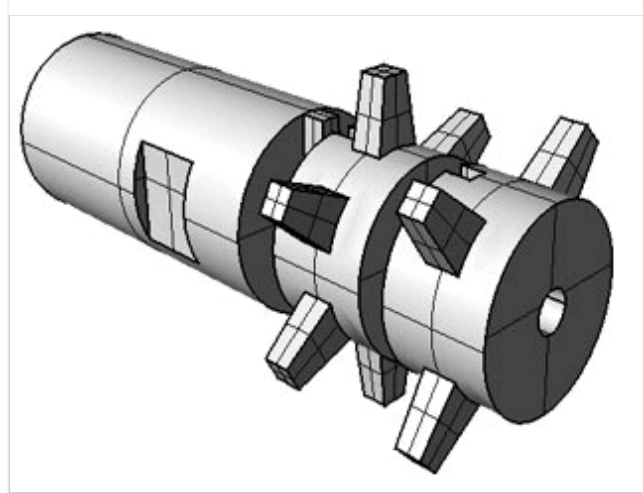
A number of ideas surfaced using parts machined from aluminium to act as waxholding receptacles, but these tended to be complex and expensive to produce, and always interfered with the wax or limited tool access.



Some of these receptacles were made as prototypes for evaluation.



and some stayed on the drawing board.



**Aluminium Mould Frames**


Specially made from aluminium alloy for best heat conduction properties and ease of handling.

Cavity dimensions for Single, Double and Quad frames all approximately 47.5mm x 73mm

**Single**  
 Ref: 41-106-000 75 x 100 x 19mm  
 Ref: 41-108-000 75 x 100 x 25mm

**Double**  
 Ref: 41-107-000 150 x 100 x 19mm  
 Ref: 41-109-000 150 x 100 x 25mm  
 For making two moulds at the same time.

**Quad**  
 Ref: 41-110-000 203 x 150 x 19mm  
 Ref: 41-111-000 203 x 150 x 25mm  
 For making four moulds at the same time.



Customized wax blanks were another option we wanted to investigate; we looked at basic shapes and profiles that were better suited to flipping, or could have mounting aids built in.



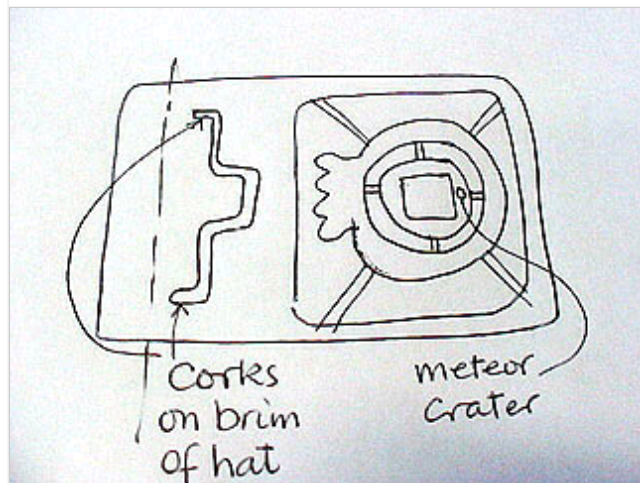
L-shaped wax biscuits proved fairly popular for three-sided cuts, but like any fixture, the holder intruded into the workspace, and the waxes could always limit the size of the ring design.



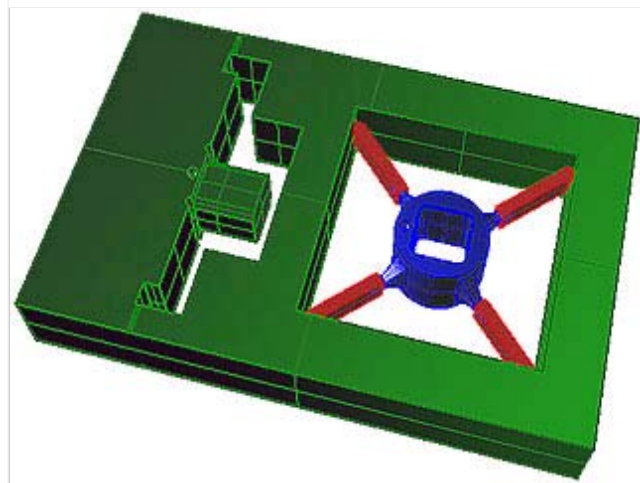
The downside to third-party waxes is that they take away the jeweller's independence; he must rely on the merchant to continue to produce and have stock of the correct blanks, and the jeweller has no control over the manufacturing tolerances.

If your machine has home-position differences or offsets that vary from mill to mill, it is difficult to account for these in any attachments you mount in the machine. The only component that becomes oblivious to these offsets is the wax! If a block of wax is not mounted perfectly on-centre when you mill it, the surface that you create will still be correct; any eccentricity expressed through solid wax is no different from mounting a 'perfectly concentric' block of wax with a lump on one side!

There is no problem so long as the correct polar origin is used in your CAM software and endplay, rotary backlash or radial runout are properly controlled.



Though this sketch seems comical in retrospect, it illustrates the main concept of FlipFlopWax: a fresh, standard wax spigot is machined as part of the ring artwork, inherently independent of the position of any fixtures. The spigot stays mounted in the rotary throughout the whole process, guaranteeing perfect concentricity and an X-position known and referenced in software.

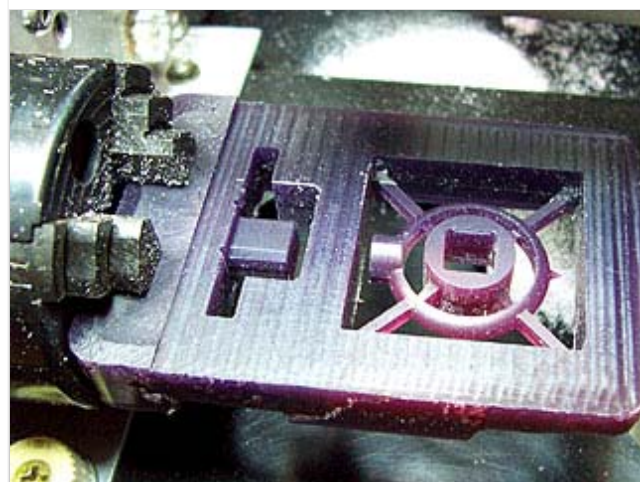


We provide the carefully-designed templates you may need in the [Resources](#) section of this article. They include a number of well-conceived features to help you get usable wax results the first time you try.

## Explanation

By now you will understand regular three-sided ring-cutting operations. The FlipFlopWax workflow is best explained in two steps, and you may compare regular three-sided ring-cutting if it helps make sense.

First, your wax is mounted in your four-jaw chuck. You machine Side-A of both the spigot and the ring, then, FLIP, the rotary is instructed to rotate 180 degrees, and you machine Side-B of both the spigot and the ring.



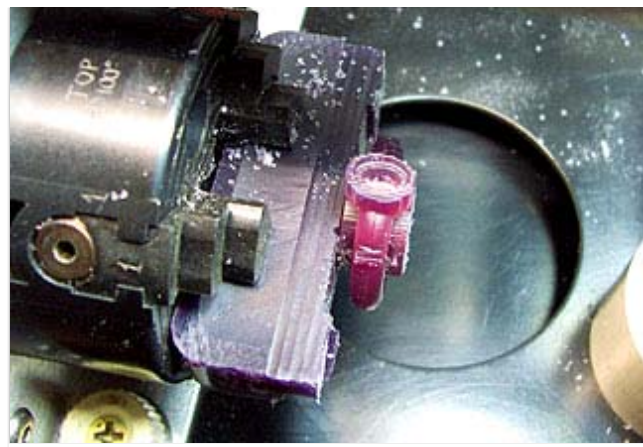
The FlipFlopWax template has the appropriate clearances for tools and shanks where required, counterbores and chamfers around seating/interfaces edges, radii and slopes to allow access, and orientation markings to assist you remounting the ring correctly. Any roughing of the template and spigot can be done with a 1mm / 0.04" ball mill.

The 'meteor crater' on the hub reminds you which face is the A-cut face of the ring. The 'meteor crater' on the spigot reminds you which is its correct up orientation. The conical pip on the bottom of the ring is a sprue attachment.

Now, leaving the wax mounted, we physically disconnect the ring and the 'crust' around it, from the block, using either a saw or a soldering iron to break through the material on both sides of the spigot. You can control how much material needs to be cut by modifying your template according to the size of wax blank you prefer to use.



The ring is carefully cut free from the 'spokes' that connect it to the crust, then,

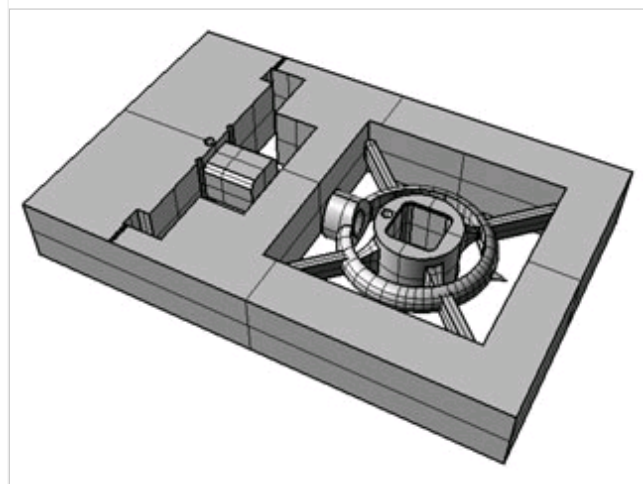


FLOP, the wax hub is a perfect fit onto the spigot, and can now be secured using either a soldering iron or electrothermal 'wax pen' to prevent the tiniest movement. You need not worry about the outer spokes protruding from the ring; these will be machined down in your rotary pass.

## Before you start

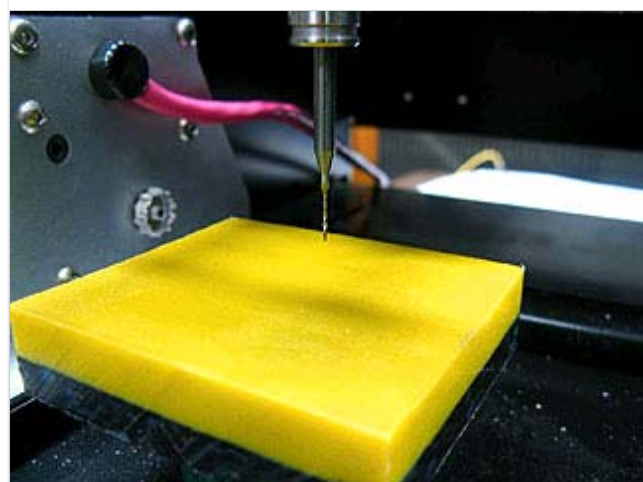
From the [Resources](#) section of this article, you can download the spigot template and a selection of central hubs to use in your ring design. You will need to save a version of your ring fitted into the template, and a version of your ring in rotary orientation without the template. We have made available the Modela Player 4 project files of a simple ring design which you may use if you want to cut wax right away!

It is important that you have obtained the appropriate Y-setback and Z-bottom values for your MDX machine, before using your Fourth Axis. We recommend perfecting both your Y-setback and Z-bottom values before you do three-sided work to correct any inaccuracies that could be introduced by your Roland host machine.



You can mount your wax slab in the four-jaw chuck now. Fit the roughing tool you intend to use. It is not critical for the wax to be perfectly level in your rotary. It is not critical for the wax to be perfectly centred in the chuck, just tight!

## Side-A - facing operation

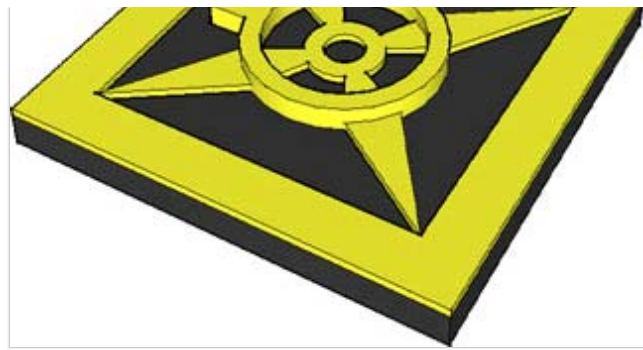


If you know the size and dimensions of your wax, it may not be necessary to face it, but this operation means there is less risk of snapping tools or gouging deeper than the cutter can handle.

## Side-A - rough cut of ring and spigot



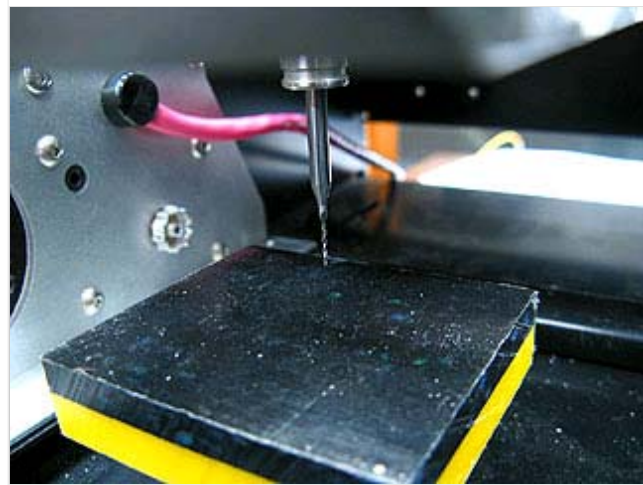
Now we do a rough cut of a single side of the ring and spigot. This operation can all be done in one toolpath, but you may separate the spigot region out if you want to insert it into other projects in FARM without recalculating the toolpath.



## Turn ring over in FARM to Side B

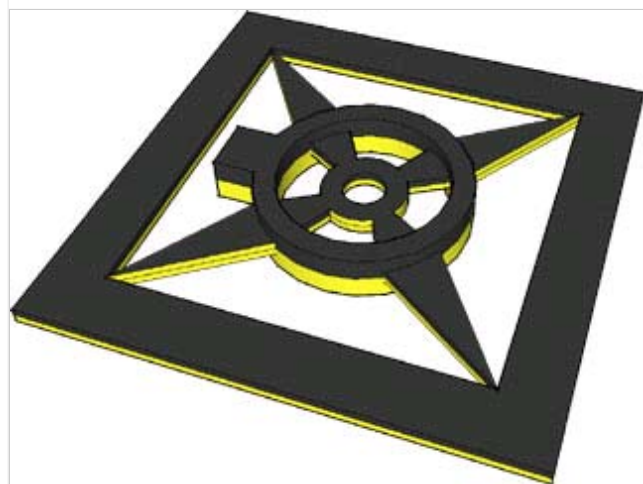
After completing the first facing and roughing operations, you can use FARM and your interface box to rotate your Fourth Axis 180 degrees for the next operation. Remember that in this case we are switching between X-Rotary-Z for flipping the wax, and XYZ for cutting it.

## Side-B - facing operation



Again, if you have a stock of identical wax blanks, if you are confident about their size and your mounting of them, you may not need to perform this facing operation. We face the block so that the roughing pass is fast and predictable with no gouging.

## Side-B - rough cut of ring and spigot



With perfect Z-bottom settings, you will be able to see 'daylight' through the wax after doing a rough cut of the second side of the ring and spigot. At this stage you should inspect the surface of the wax and check that your Y-setback settings were correct.

## Tool change, finishing cutter

If your finishing passes do not require a tool change, you could omit a few steps and do these processes after each respective roughing process. Otherwise, now is the time to change your tool. FARM gives you this opportunity in between processes, and you will be prompted to set the Z-height of your tool. You can use the same Z-gauge setting as last time to do this.

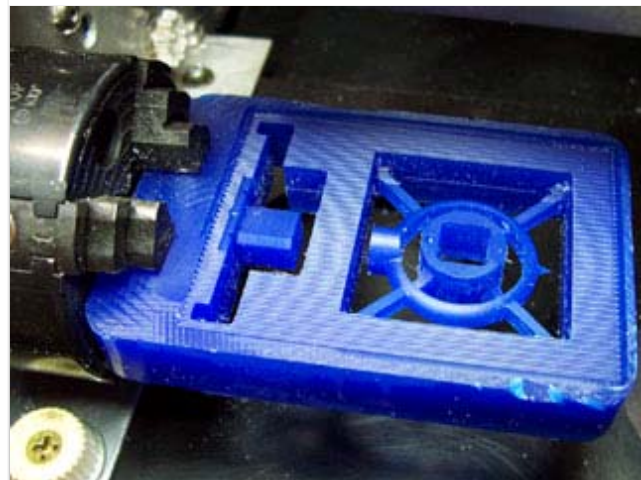
## Side-B - fine cut of ring

Now your finishing tool is fitted, FARM can send the Side-B final pass to the MDX.

## Turn ring over in FARM to Side A

Again, you will need to use FARM and your interface box to rotate your Fourth Axis 180 degrees for the final operation.

## Side-A - fine cut of ring



At this stage, all Side-A and Side-B work is complete. Your rotary cutting, or index cutting toolpath should be next in FARM's process list.

## Separate crust region from spigot



Leaving the wax mounted, with the use of a hot-air knife, a soldering iron, or a small saw, you can now physically separate the crust (including the ring) from the spigot.

The two tiny slots pointing towards the chuck provided a location where you separate the crust without accidentally striking the spigot or its back face. It is important to keep the spigot and the back face clean for proper seating of the hub when you FLOP. This surface is sloped in the final template to lessen any risk of it interfering.

## Separate ring from crust

Again, we have successfully used a Portasol hot air nozzle, a 25-watt solder iron, and an Olfa 9045 sawblade in the Olfa 9164 Precision Art Knife. From experience, we recommend the solder iron for the very gentle way it treats the wax. You can now separate the ring (cut the **outer** spokes) from the crust. **Don't cut the hub out of the centre, we need to mount this on the spigot!**

## Mount on spigot and secure

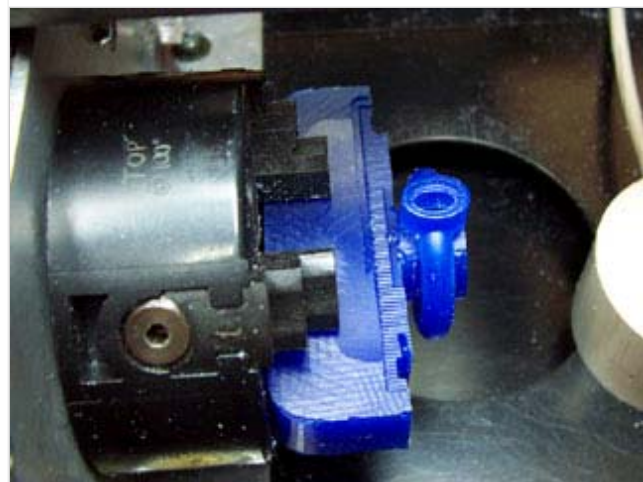


Your machined hub should be a tight fit over the spigot. We recommend the use of a soldering iron to carefully secure the hub and spigot together in a few places, as this kind of joint is unlikely to fracture with tool vibrations.

Also, the absence of screws and metal spigots keeps your tooling safer in case of accidental cutting.



## Rotary - fine cut



Now you only need to complete a finishing cut on the rotary axis. This pass will neatly remove the protrusions where the outer spokes were used to support the ring.

## Finished result



Now all machining is complete, the final ring can be removed by carefully cutting the inner spokes, and leaving the hub behind on the spigot.

## Resources



Template for RHINO users:  
[flipflopwax-rhino-template.zip \(68kB\)](#)



5-spoke ring hub for RHINO users:  
[flipflopwax-5spoke-hub.zip \(62kB\)](#)



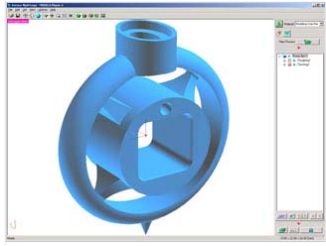
6-spoke ring hub for RHINO users:  
[flipflopwax-6spoke-hub.zip \(68kB\)](#)



Modela Player 4 project files demonstrating setup of example ring:



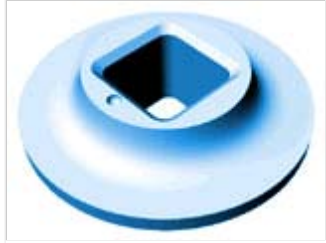
[flipflopwax-mp4.zip \(12.7MB\)](#)



Discus ring hub for RHINO users:



[flipflopwax-discus-hub.zip \(67kB\)](#)



More challenging test ring for RHINO users:



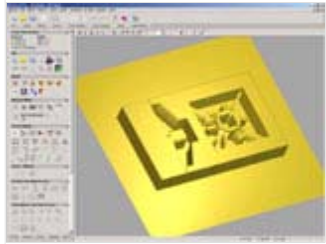
[flipflopwax-cunning-demo-ring.zip \(1127kB\)](#)



Pack for ARTCAM users, courtesy Tom Kimbrough:



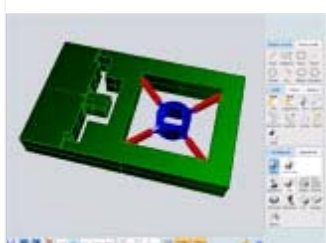
[flipflopwax-artcam-pack.zip \(504kB\)](#)



Pack for MOI users, courtesy Colin Creed:



[flipflopwax-MOI-pack.zip \(709kB\)](#)



Pack for JewelCAD users, courtesy Shane Stewart:



[flipflopwax-jewelcad-pack.zip \(121kB\)](#)



Pack for 3Design users, courtesy Paul Bierker:



[flipflopwax-3design-pack.zip \(666kB\)](#)



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