
Subject: metal test pieces and monster figurine
Posted by [dadrummond](#) on Wed, 07 Oct 2009 05:49:52 GMT
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Hi all,

While I swear I'm revving up to print my own stuff, I've been printing some items designed by others to get a sense of what the technology is capable of. Here I report that metal (bronze-infused stainless steel) prints have rather marvelous detail levels relative to, e.g., prints in white detail material. I show the results of a print of Rob Mack's (Mack Madness) test piece in metal, allowing comparison to his pictures for the other materials with the exception of White Glaze. I also printed the Chaos Elemental figurine from Chez Reno in metal and white detail for a side-by-side comparison.

First, the data.

The test piece in metal:

The figurine in metal and white detail material:

Now, observations:

- For my prints, the resolution of metal printing is comparable to white detail material; details below.
- I can see daylight through 8 of the 11 circular holes in the negative test piece (top). That's more than any other material Mack printed (WSF, white detail, transparent, cream robust), where white detail managed to hold 7 of 11 holes open and WSF only did 5. See his pictures of the test pieces printed in other materials. The smallest open hole has a diameter of ~0.5 mm on a piece with a thickness of ~1.5 mm; without the input STL file I can't say what the intended measurements are (Mack?). Only 2 of the 7 rectangular holes pass light, again better than WSF (1) and comparable to white detail (2).
- Both test pieces have a bit of warp. They do not lie perfectly flat. At most 0.2mm warp on a 58.5mm piece, so quite minimal, but perhaps important for the most demanding applications.
- The nominal rectangular size of the pieces is 10 x 60mm. The prints I received are actually 0.91 x 58.5mm. Without the STL file in hand, I'm unsure whether this is an artifact of the printing or the "nominality" of the reported dimensions.

- None of the positive (protruding) solid circle/cones that I can test fit into their corresponding holes. Close, but no. This means that if you want pieces to fit without filing/sanding, you should make them slightly (who knows, but I would guess that 0.1mm would do) smaller than the hole they must fit in. Sadly, I have not yet done a fit test. But I may, soon enough.

- Because of the polishing of the metal pieces, areas close to a protruding area tend to be rough (unpolished) compared to less-sheltered areas. The inside of the figurine's mouth, for example, has a much more crystalline look.

- More on polishing: the X's on the test piece came out well compared to the other materials. Slightly raised bits, like the logo on the back of the negative test piece, were mostly obliterated by polishing, whereas the sunken stamp-like areas look quite sharp down to a fraction of a mm. I'd be very grateful if the Shapeways folks posted more details on the exact polishing process.

- Side-by-side comparisons of the Chaos Elemental figurine (which I chose for its nooks, crannies and fine details) in metal and white detail suggest that metal is again equal to or even superior to the white detail material in resolution. For example, as the photo shows, the half-millimeter saliva/jaw-membrane connections on the metal piece are perfectly rendered, whereas on the white detail piece, both are broken (it is unclear whether they failed to print or broke after production, but visually it appears to be a printing failure). Similarly, as is apparent in the rear view, the thin dewclaw on the back left leg is sharp and intact on the metal piece, but again either broken off or misprinted on the white detail piece. The teeth are ever-so-slightly better-formed in white detail, but all are present and nearly as good-looking in metal.

(A word of caution: my white-detail print seemed to not be of the highest possible quality. The rear of the skull, for example, has obvious layering that is almost flaky. However, Mack's test pieces in white detail compare with my metal prints in virtually the same way, suggesting that our prints are representative of the material and printing properties of white detail and metal.)

- The "washed out" white look on the white-detail figurine is not a photographic artifact. I'm sure many of the skin details are present on the white-detail print, but in typical home lighting, the contrast and material properties make it almost impossible to see anything but the bulk shape. In metal, the skin looks beautifully pebbly -- the material is well-suited to the model -- and also shows details like muscles and horns to full advantage.

I hope this information is useful to y'all. A final note on the emotional side. After having my expectations set by a lovely WSF print and the white-detail pieces (which arrived in 10 days versus 21 for the metal), I was astonished by the detail on the metal pieces, and spent Monday running around accosting people in the halls of Harvard, thrusting bits of metal into their faces and saying, "Can you believe this?" For the record: no, they cannot.

Huge kudos to the Shapeways folks, and the developers of the metal printing process, for this spectacular technology. I'm still giddy and amazed that we can make things using it for a price that is accessible to mortals!

- Allan

p.s. -- The quarter is the work of the U.S. mint. They do metal printing at an enviable level of detail. I hope they open up their technology -- on a cubic centimeter basis it's much cheaper than Shapeways.

File Attachments

- 1) [testpiece-steel-top-small.png](#), downloaded 2148 times
 - 2) [chaos-elemental-front-small.png](#), downloaded 2108 times
 - 3) [chaos-elemental-back-small.png](#), downloaded 2117 times
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Subject: Re: metal test pieces and monster figurine
Posted by [huan80](#) on Wed, 07 Oct 2009 06:31:27 GMT
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Thanks!

This is exactly the type of thing I've been looking for. I'm much more confident about my current project now.

Subject: Re: metal test pieces and monster figurine
Posted by [chris89](#) on Wed, 07 Oct 2009 09:18:52 GMT
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nice! this is some good information!
I'm amazed at how well the creature came out actually.

Subject: Re: metal test pieces and monster figurine
Posted by [Eeppium](#) on Wed, 07 Oct 2009 14:51:27 GMT
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wow nice results
and thanks for the info, you answered all of my questions about metal printing

Subject: Re: metal test pieces and monster figurine
Posted by [Youknowwho4eva](#) on Wed, 07 Oct 2009 14:58:49 GMT
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I still have one more question, well 2
What is the weight, and volume of the prints?

Subject: Re: metal test pieces and monster figurine
Posted by [dadrummond](#) on Wed, 07 Oct 2009 18:07:53 GMT
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My volume estimates are pretty crappy, but I can do weight well.

The mass of the figurine is 27.22g and I measure its volume to be 3.2 cm³ by water displacement; that's plus or minus about 0.2.

$27.22\text{g} / 3.2\text{cm}^3 = 8.51 \text{ g/cm}^3$.

The density of 420 stainless steel is 7.75 g/cm³. The density of bronze varies widely depending on its alloy composition, with a range of something like 7.7 to 8.7 g/cm³.

Let's guess that the final material is 60% steel, 40% bronze. Working backward would give us a bronze density of 9.65 g/cm³, which is far too high. If my volume measurement is too low, and the real number is more like 3.4cm³, then we get 8.39 g/cm³, which is quite reasonable.

Shapeways' estimate for the volume is informative, although it's unclear how well the printed volume should relate to the nominal volume; they charged me \$36.40, or 3.64 cm³ at \$10/cm³. That would give a bronze density of 7.07 g/cm³, which is definitely too low. So the 3.4 cm³ number is probably closer to the truth.

So: final estimate, following a few somewhat unreliable lines of evidence, is that the volume of the figurine is about 3.4 cm³, its mass is definitely 27.22g, and the density of the bronze-infused stainless steel material in this print is about 8.0 g/cm³.

Shapeways folks -- what kind of bronze do you use? And what's your estimate for the proportion of steel to bronze?

Subject: Re: metal test pieces and monster figurine
Posted by [dadrummond](#) on Thu, 08 Oct 2009 00:44:20 GMT

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Thanks for the kind comments, btw -- it's nice to know this stuff is helpful!

A brief thought on the apparent mismatch between my volume measurement (3.2 cm³) and that derived from Shapeways' pricing (3.64 cm³). I was surprised that those numbers were so far apart. But it's quite possible, and sensible, that Reno is charging some markup. (Like the blinkered academic I am, I completely forgot about profit...) Without knowing what the markup is, all we can say is that the volume is less than or equal to 3.64 cm³. The discrepancy between my measurement and the price-derived volume is hopefully buying Reno an espresso right about now.

Subject: Re: metal test pieces and monster figurine
Posted by [gibell](#) on Thu, 08 Oct 2009 04:03:37 GMT
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From the pricing on that monster I deduced that it has a volume of 3.54 cm³ and the markup is exactly \$1.

Subject: Re: metal test pieces and monster figurine
Posted by [Magic](#) on Thu, 08 Oct 2009 06:37:18 GMT
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Yes, the markups are not secret as long as the item is available at least into 2 materials with different prices.

For instance, if P1 is the price in WSF and P2 is the price in Stainless Steel (including taxes), assuming V is the volume and M the markup, you will have:

$$P1 = (1.5 + 1.5xV + M)x1.19$$

$$P2 = (10 V + M)x1.19$$

And this gives:

$$V = [(P2 - P1)/1.19 + 1.5]/8.5$$

$$M = [(10xP1 - 1.5xP2)/1.19 - 15]/8.5$$

A solution - that some of you are already using - if you want to keep the markup (and the volume) secret is to have an item available only into a single material. And if you want two materials to be available for one object, you just list this object in those materials as separate items, with different markups.

By the way, even if that does not solve the "problem" of secret markups, having the markup being a percentage of the manufacturing price, would be nice: I think it has already been suggested though...

Subject: Re: metal test pieces and monster figurine
Posted by [dadrummond](#) on Fri, 09 Oct 2009 03:50:57 GMT
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Hmm -- didn't really want to start a thread on markup inference, but, well, behold the power of math. At any rate, I'm interested to see volume measurements on larger objects to see what the correlation is between nominal and actual printed volume under conditions where the volume measurement isn't so noisy.

Shapeways folks -- could you shed any light on the particular bronze alloy being used? Saying "420 stainless steel + bronze" is like saying "Pantone 17-4015 TPX and blue"...

Subject: Re: metal test pieces and monster figurine
Posted by [madox](#) on Sat, 24 Oct 2009 10:10:43 GMT
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Thanks for the information, very very useful...

Subject: Re: metal test pieces and monster figurine
Posted by [GHP](#) on Sat, 24 Oct 2009 12:50:21 GMT
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Shapeways sums the volumes of object meshes in the file to get the total volume. If these objects intersect each other (e.g. two cylinders crossing in the middle), the total volume computed will be greater than the actual volume of the printed object.

Subject: Re: metal test pieces and monster figurine
Posted by [chaitanyak](#) on Mon, 05 Jul 2010 05:14:08 GMT
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thanks, this helps.. as i do mostly character models.. was wondering about what the relation would

be between scale and detail..

anyway i already sent a few prints.. will have to see how they turn out.
