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Paper Review: Paper Circle vs Origamido Studio

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As origami arthropod aficionados know well, the go-to source for paper for the most challenging origami insects has ong been the Origamido Studio, home of Michael LaFosse and Richard Alexander. For years, they have specialized in making papers expressly for origami—in fact, expressly for Michael's own folding (Michael, uniquely, folds his own designs solely from his own paper). As origami designers like myself pushed the boundaries of complex design, we placed greater and greater demands on the paper: on its thinness, uniformity, crispness, foldability, and texture. Michael, and then Richard (who, nowadays, does most of the paper making and development) rose to these demands, developing what is now widely recognized as the premier paper for the most demanding supercomplex origami designs.

For my own folding, I draw upon many types of paper and many suppliers; for insects, I've used Korean hanji from ifides and kozo papers from Hiromi Paper, both of which work very well for complex wet/dry-folded designs. But when the chips are down, the folds are dense, and nothing but the best will do, I turn to Origamido. Although it's possible to commission an entire manufacturing run of paper from Origamido (which I've done a few times, and highly recommend the hands-on experience), it is not otherwise readily available; most of us have to content ourselves with the once-a-year sale at the OrigamiUSA Annual Convention where Michael and Richard bring an assortment of their stock (which, invariably, sells out entirely by the end of the second day).

I always try to keep an eye out for interesting new papers, though, and about a year ago, at the Centerfold origami convention in Columbus, Ohio, I met Barb Campagnola and the folks at the Paper Circle (PC), which bills itself as "Southeastern Ohio's Center for Paper and Book Arts." Their facilities include a studio for making handmade paper. They had brought quite a few sheets to the convention to sell, which, upon cursory examination, appeared well suited for complex origami. They gave me a couple of sheets, and before the end of the convention, I'd used one to fold my Bull Moose, opus 413, which came out quite well, as you can see in Figure 1.

Figure 1. Bull Moose, opus 413. Folded from Paper Circle paper.

The paper had a nice texture and a pleasant light mottling that complemented the lines created by the folding. It was fairly thin—the Moose is a fairly demanding fold—but had a bit of springiness that tended to push layers apart (a tendency tamed by a bit of MC). Over the subsequent weeks and months, I tried out a few more sheets and corresponded quite a bit with the PC folks as they developed their papers.

It presently turned out that Barb and the PC team were interested in a big way in becoming suppliers to the origami community (despite my frequent cautions that, business-wise, origami folks were probably not the most lucrative market to go after; we're the only people I know for whom a single sheet of paper can keep us gainfully occupied for a week.) In fact, though, not only did they want to make papers for origami in general: they wanted to shoot for the most demanding application of all: supercomplex origami, particularly insects and arthropods! I knew that would place enormous demands upon their paper-making skills. Insect paper must be thin; it must be uniform; it must be strong; and these are often conflicting objectives. You can get good uniformity and thinness by beating your pulp down to smithereens, but the strength vanishes because you've shattered all the fibers. Or you can underbeat for strength and pull thin sheets, but then the thickness will be all over the map. It's tough—which is why I rely on experts to make my paper.

Over a period of several months, Barb and the folks sent me various test sheets as they honed their recipes; I would, in turn, fold them, and give feedback on their folding properties (too springy; splits; too thick; tore when wet; etc., etc.). Finally, Barb indicated that they had their recipe down: a blend of hemp and abaca (a pair of fibers that Michael has used for some of his best papers), with associated protocols for beating, coloring, and sheet-pulling. I promised her that I would do a head-to-head folding comparison with some of my Origamido paper and report the results; and so I have below.

In order to provide a fair comparison, I felt that I should fold the exact same model from both papers, in exactly the same size; and to really test the papers to their limits, I should use a fairly demanding design to fold. When I fold an intricate design, though, it takes what seems like forever to fold even a single figure, and by the end of it, I'm usually swearing that I will never do another one of these again! In order to avoid this outcome, instead of choosing one of my most intricate designs, I created a somewhat simplified version of an intricate fold and then folded it in small size to provide some challeng. I'd recently created a hex-pleated Brown Widow spider for an article on hex pleating, so I folded each figure from a 26 cm square, which gave a finished size of about 7–8 cm for the finished model. I figured that the small size and moderate intricacy would provide a good test of the paper; the skinny legs would test how well it compresses down; and by not shooting for extreme intricacy, I could probably convince myself to fold several of them in order to carry out a fair comparison.

You can try this for yourself: the crease pattern is given below.

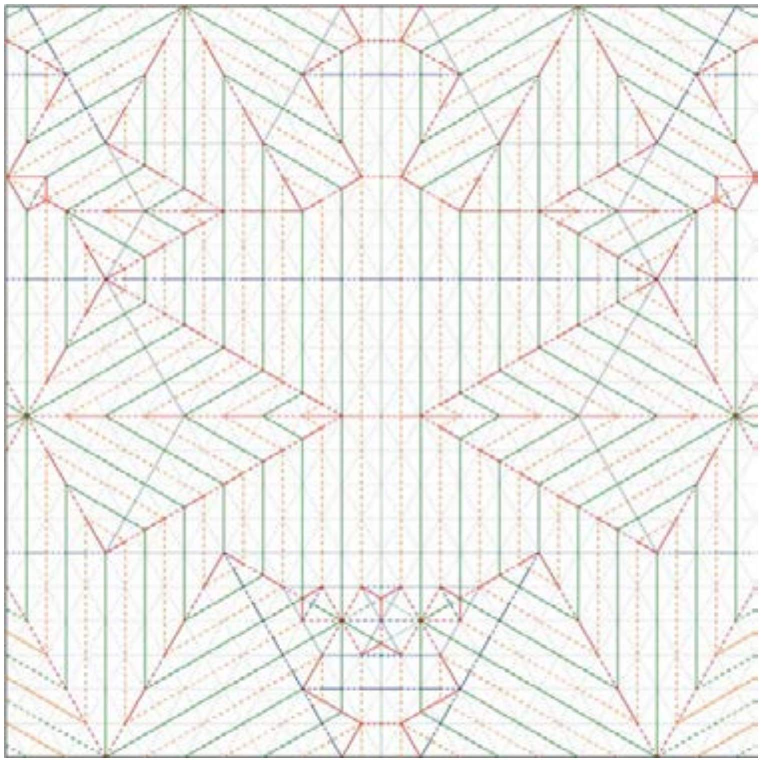

Figure 2. Crease pattern for a hex pleated Brown Widow Spider. Click the image to download a PDF.

The project started, as my insect folds often do, by sizing the paper. Sizing adds crispness to the paper when dry and, if you dampen the sized paper and let it dry, the sizing helps the paper retain its shape. I generally use the material CMC as my sizing agent. It is dissolved into water and then painted onto the surface of the paper. CMC is naturally sticky (it is basically a water-soluble glue), and so the dampened paper gets stuck down to a sheet of glass to dry. Once it is dry, the sheet can be peeled off of the glass and then is ready to cut to square and fold. See Figure 3.

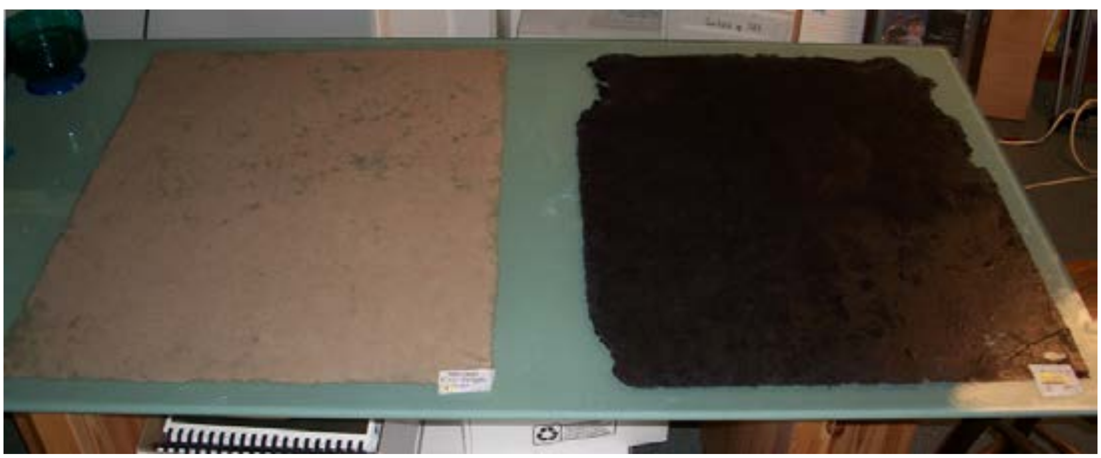

Figure 3. Two sheets of PC paper, drying on the glass. Each sheet is about 53 x 70 cm.

Taking a sheet of paper with the thickness of tissue paper and then thoroughly dampening it is a fairly delicate operation. I started out with two of the thinnest sheets from the PC collection (labeled "1/4c", meaning each had been made with 1/4 cup of pulp) in colors "antique gold" and "black". Ostensibly they were the same recipe, but I found that while the antique gold sheet could be easily lifted up and laid back down when wet to clear out bubbles and wrinkles, the black sheet tore easily around the edges, indicating some differences in how the fibers bonded in the two sheets. Nevertheless, I was able to successfully size and dry them both, and the tears did not extend very far into the paper, would would allow me to get two good 26 cm squares out of each.

To provide a proper comparison and reduce the confounding effects of training—I usually do a better job the second time I fold something, independent of the paper—I folded two spiders separately, one each from PC and Origamido paper, for practice, and then folded two more, this time, as nearly simultaneously as I could: again, one each from PC and Origamido paper.

After I'd cut each square, I scored and then precreased every fold in the base. Precreasing is always the most tedious step of any complex uniaxial base: every crease gets folded by hand as mountain or valley fold, as appropriate. Much folding resulted in the precreased crease pattern like that shown in Figure 4.

Figure 4. A precreased crease pattern, with the black PC paper.

Precreasing is the place where one first sees evidence of thickness nonuniformity, and the PC paper had a noticeable variation across the sheet. I could detect this as I'd flatten a crease along its intended line. As I ran my finger along the fold to set the sharpness of the crease, I could feel thicker regions of the paper "pushing back at me." The scale of variation makes a difference in the effect of the nonuniformity; if the thickness varies quickly, then a change of thickness can pull a crease off of its intended line as the crease will want to follow the line of least resistance, i.e., wander into a thinner region. If the thickness varies slowly, then there's not much pull, but one has to vary the pressure applied along the crease to achieve a consistent level of sharpness, and that's what I had to do with the PC paper. The nonuniformity required extra attention to accommodate it, but it wasn't so great as to impede a clean job of precreasing.

By contrast, one of the strengths of Origamido paper is that it is quite uniform even at relatively thin weights; although one can sometimes see thin spots in the thinnest sheets before cutting to square, it's usually possible to get one or two uniform squares that avoid the thin spots, and my test sheets had no discernable variation in thickness.

After the precreasing comes the collapse, the moment when all of the creases have to come together. If one is lucky (or careful) in the design, the creases fall naturally into isolated groups so that different portions of the crease pattern can be collapsed independently. If one is unlucky (or the designer did not strive for independent regions—I usually don't, nowadays), then the pattern exhibits "irreducible complexity"; all of the creases have to be brought together at once. My spider design was irreducibly complex, and so the collapse needed to happen all at once, or nearly so. In this case, I could start gathering the pleats at the tips of all eight legs, then slowly work my way inward toward the body of the beast, bringing the legs, and then the body, together.

An irreducibly complex collapse is also a good test of paper uniformity. When there are a hundred creases that all have to come together at once, there is no way that one can physically manipulate them all by touch. Instead, what you have to do is get some of the pleats going the right direction, and then carefully poke all of the vertices to point up or down, as appropriate, and then slowly bring the pattern together on hte large scale. As you push the model together, the forces set up by straight creases and the springiness of the paper can bring most of the folds into the right place by themselves on the small scale. Making this type of collapse work underscores the importance of a clean precreasing; you want creases in exactly the right place, going exactly the right direction, so that the natural rigidity of straight creases and the natural flexibility of folds creates a mechanism that moves most of the paper where you want it to go.

Figure 5. The beginnings of the collapse, using the antique gold PC paper.

During such a collapse, you are relying implicitly on small differences in the stiffness and rigidity of the paper to make everything go where you want, and so thin spots in the paper can short-circuit your careful network of force transmission: the paper can buckle. Thick spots with partial folds running through them can resist further closure, and nearby thin spots can absorb the force, forming a buckle that then impedes further closure. Once again, I noticed a small amount of nonuniformity in the PC paper that required a bit of extra care during the collapse to avoid such buckles, but once again, with that little bit of extra care, I was able to perform the full collapse with no serious issues.

For my two near-simultaneous foldings, I collapsed one of the PC bases immediately after collapsing an Origamido base so that I could compare their feel. The PC paper felt noticeably stiffer overall (despite the occasional thin spot), and so I suspected that, overall, it was a bit thicker than the Origamido sheet. Once the base is collapsed and compressed to minimum thickness, any systematic difference in thickness is going to show up because you've now got several tens of layers all stacked up. I was surprised to find no discernible difference in the thickness of the stacked base, however. Figure 6 shows the two bases compressed and held together by a single band (which insures that they're under the same amount of compressive force). Their apparent thickness is the same. That means that for a given thickness, the PC paper is actually a bit stiffer (which can a good thing)—aside from the occasional thin spot, that is.

Figure 6. Comparison of the collapsed bases. Black (top) = Origamido, light (bottom) = PC.

Note: the photo makes it looks like the Origamido paper might be a hair thinner. When fully compressed, it isn't! In fact, the Origamido base was slightly thicker. Just to be sure, I measured the base thickness with calipers at precisely the same spot in the base, across the thickest part. The PC paper repeatably came out between 5.30 and 5.40 mm thick. The Origamido paper was perceptably squishier; if I really compressed the caliper blades, I could get it down to 5.30 mm, but with only moderate pressure, it was more like 6.00 mm, as you can see in Figure 7.

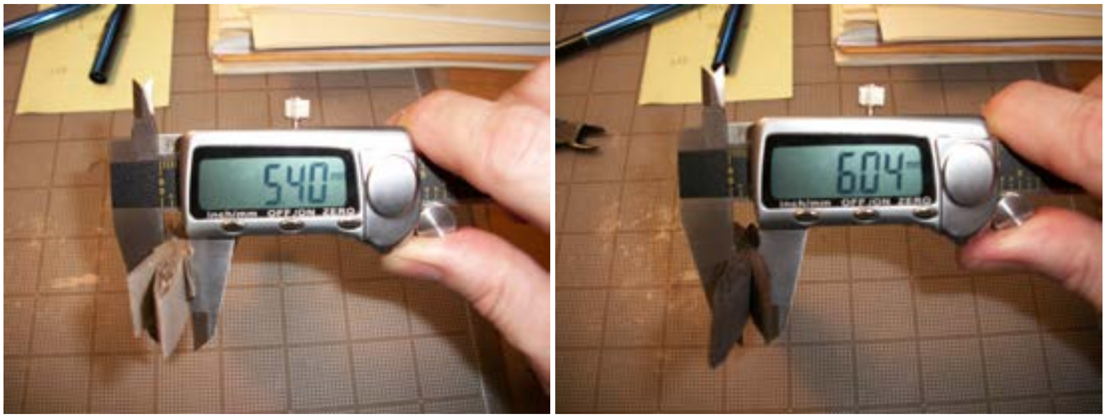

Figure 7. Caliper measurements of the two bases' thicknesses. Left: PC base. Right: Origamido base.

Keep in mind that the difference between these two numbers is a couple of hairsbreadths (human hair is typically about 0.1 mm diameter); the two papers were basically the same thickness, for all intents and purposes. This was the biggest surprise, because the PC paper definitely *felt* stiffer and heavier.

The next step after the collapse is the shaping. This spider is a model that must be wet-shaped, dampening flaps with either pure water or, as I did here, water with a bit of CMC dissolved in it. Wet shaping is by far the most challenging step, in part, because there is a time element. Once you've dampened a region, it starts to dry, and you have to adjust all of the parts while they're at the appropriate stage of moisture. Too wet, and the paper mushes; too dry, and you can't get sufficient compression or curved shaping. Matters are further complicated by the fact that some parts must be shaped in relation to others, so you need to pay attention to the dryness of all of the parts you're working on.

Adding to the challenge is a hazard unique to thin sized paper. When you size a paper and dry it on glass, the paper attempts to shrink while it dries, and so it ends up drying under tension. That tension is frozen into the paper (or rather, dried into the paper), and it takes very little to release the tension. So if, while you're dampening something long and skinny, you let a bit of water land on a flat, smooth surface (or soak through from the underside), the paper will develop a ripple there and, depending on the size of the ripple (and your tolerance for same), put all of your careful folding up to that point for naught.

Because of this sensitivity, I took few photos during the shaping. Once I start shaping a model, I need to be wholly focused on that, and don't feel comfortable stopping to take photographs. However, once I'd gotten the legs narrowed and all pointing upward, I took one comparison photograph, which you can see in Figure 8.

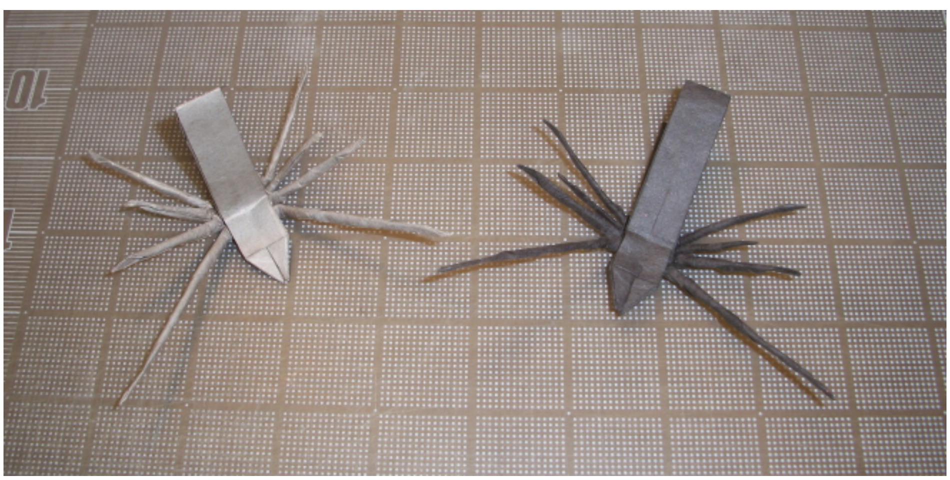

Figure 8. Bases with legs from the PC paper (left) and Origamido paper (right).

It's worth observing here that the legs, which have all been compressed into roundness, are essentially the same diameter from one paper to the other—yet more evidence that, for all intents and purposes, the two papers were the same thickness. Nevertheless, the Origamido paper was softer and more manipulable for forming curves.

Differences like this between two papers cannot be simply classified as "good" or "bad." The extra stiffness of the PC paper was a boon when I was shaping the legs; the "squishiness" of the Origamido paper meant I had to work harder to keep the legs' diameter uniform as I was compressing them down; if I wasn't careful, compression at one point would cause an unsightly bulge a bit farther along. The stiffer PC paper meant that this was less of an issue.

Conversely, though, when I was shaping the abdomen—about the size and shape of a grape—the softer Origamido formed easily into a smoothly rounded bulb, while the slightly stiffer PC paper developed some wrinkles that I was unable to fully smooth out. One can't say that the differences in springiness make one paper uniformly better or worse than the other; one can only note the differences, and the take those into account as the model is folded.

In the end, both papers folded very well. I can't say that one is absolutely better than the other, which is saying something fairly impressive about the PC paper. I did have to take a bit more care with my folding of the PC paper to accommodate the nonuniformity and extra springiness, but I could imagine that some people might actually prefer the extra springiness—in fact, I might, depending on the model. The final outcome is that both papers work very well for supercomplex designs, and we, as origami designers, are fortunate to have such wonderful materials to work with when we create our art.

Figure 9. The finished pair. Left: Origamido paper. Right: PC paper.