Masu Matrioshki

What's a masu? It's a small Japanese wooden box used in former times for measuring rice or beans. It's now more frequently used as a cup for drinking sake at weddings, or in restaurants and bars. It's an everyday object which can be purchased for a just few yen in hardware or kitchen stores in Japan. I have acquired for my growing masu collection a black plastic version bearing the logo of a bar, as well as some more upmarket ones, made from sweet smelling woods (fig. 1). These masu were never intended to be used for their original purpose!

The masu is not a new subject for an origami design. You are probably very familiar with the classic origami box made from a blintzed square: this is a simple fold popular with beginners and experts alike.

fig.1

fig.2

The father of 20th century creative origami, Akira Yoshizawa, included a wooden masu in a photograph of origami mice in his book Origami Hakubutsushi I (1979). This image (fig.2) lay dormant in my mind until I first saw a real wooden masu in Kyoto in 1993. I was struck then by the beauty of the simple box shape, the warmth of the wood, the elegance of the proportion and the precision of the joints. It wasn't until after my return to England, while cursing myself for not having bought one, that I resolved to try and design an origami version. My aim was to reproduce the depth of the walls with an inner layer, at the same time attempting to imitate the masu's simplicity and completeness of form.

Although I first tried to make the new masu from several sheets, intending to reproduce the finger or dovetail joints precisely, I realised that this was too difficult a task. As I have frequently experienced during these kinds of explorations, an unfulfilled challenge is better left for a while, rather than worried to destruction! So I set the problem aside. Incidentally, I have found when a particularly troublesome origami problem is encountered, it has often been possible to solve the problem immediately after a period of stress or personal difficulty. About this time, I had received an unjustified complaint against me in a quite different area of my life. To counter the complaint, I took a lot of time to compose a detailed letter stating my case and disproving the claim. That finished, within a day or so I was able to complete the first Masu box to my satisfaction. (fig.3)

Working from memory, I found that an A4 rectangle gave me the required structure. I borrowed folding ideas from Shuzo Fujimoto on the way, namely the iterative division into five equal parts, the twist lock which forms the base of the inner layer, and the final rotating lock on the outside which pays tribute to Fujimoto's masterful cube. As an aside, I found that if I made a Fujimoto cube from a 15 cm square it would fit perfectly into the A4 square masu. On a return visit to Kyoto in 1994, the following year, I did buy three masu of different sizes, and I was delighted to find that my origami version matched almost exactly the dimensions of the middle-sized one!

The pentagonal masu does not really exist outside origami, but having achieved a reasonable square result from an A4 rectangle, I soon had the idea that I could make use of the approximate pentagonal geometry of the A4 rectangle. I had dabbled with this concept before, producing a dodecahedron and various other modular constructions. Whereas it is possible to make the square masu from a rectangle other than an A4 (providing it is of roughly the same proportion!), you must use an A4 for the pentagonal masu in order to take advantage of the necessary, albeit approximate, hidden pentagonal geometries within (fig.4)

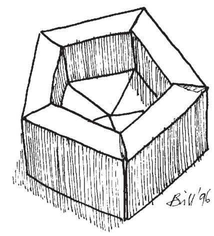
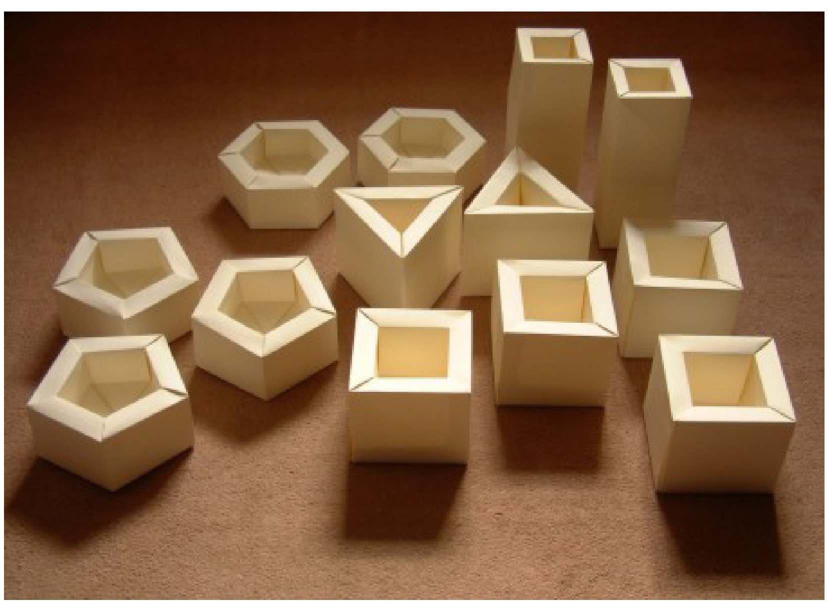


fig.4

I published privately a small booklet containing diagrams for the square and pentagonal masu designs in advance of a visit to Israel in March 2005. There was to be a small one-man show of my work in Tel Aviv, the emphasis being on geometric designs at the request of the exhibition's curator Paul Jackson. As well as some new ideas, including a 300-piece A4 unit "pavement", I decided to resurrect the two masu boxes and I folded a number of these from A1 sheets to make about a dozen quite monumental figures. I made a tall vase variation of the square masu, folding the same creases on the horizontal sheet now turned vertically. I made two of these vases, and when photographed they gave an unintentional "9/11" look to the group! (fig 5) To give further range to this theme of the exhibition, I designed a hexagonal and a triangular masu, by changing the geometry of the corners and adjusting the number of the vertical divisions to give the right number of sides.



The masu booklet has proved popular, and from it, my friend Assia Vely folded both square and pentagonal designs. Her Russian background led her towards a series of nesting square masu in the style of the classic Russian Matrioshki dolls. When we met in Salzburg in July 2005, I was thrilled to receive her gift of a nest of five masu, each beautifully folded to the original square design, and each successive box perfectly fitting inside its larger "parent"! (fig.6 and 7)

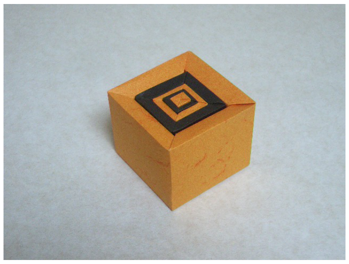


fig.6

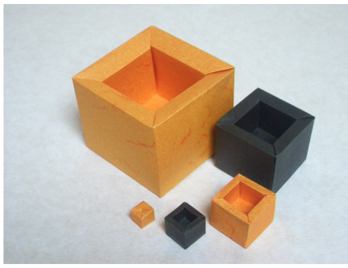


fig.7

Assia constructed her series of Masu Matrioshki by measuring the aperture of the first box in order to calculate the size of the "infant" which was to fit inside. All of the boxes are folded from 1:√2 rectangles, and the largest was A4. However the smaller ones did not comply with any recognised fraction of A international paper sizes. She arrived at a formula and a folding method to construct the exact size of the reducing rectangles. She called this progression the "VA" rectangles, though obviously they are all 1:√2 rectangles too (see Appendix 1 and 2). Later, she even made some nesting pentagonal Masu Matrioshki!

My first thought that the reducing size of each of the rectangles used in Assia's Masu Matrioshki were half the size of the former, A4, A5, A6, etc, but as shown above, that's not the case. Logic seemed to say that each successive reduction of paper size to make the next smaller box should be half the former in the classic silver rectangle reducing sequence. So a few weeks later, I decided to make a further alteration to the square masu to fulfil this requirement. The result has the benefit that the box's external side is proportioned 1:√2, so the height of the first box is the same as the width of the next box. Furthermore the width of the first is equivalent to the diagonal of the second. You can see that interesting groupings of this last masu series can be made to show their special geometrical relationship. (fig. 8 -11)

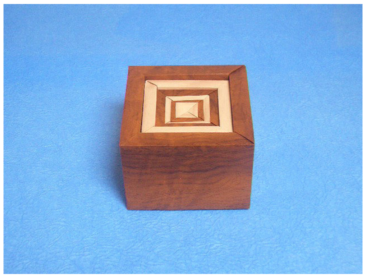


fig.8

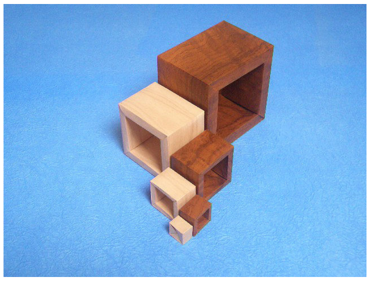


fig.9

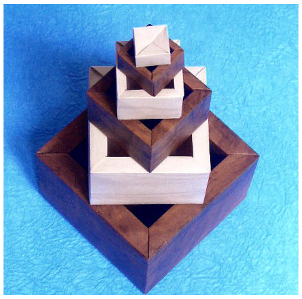


fig.10

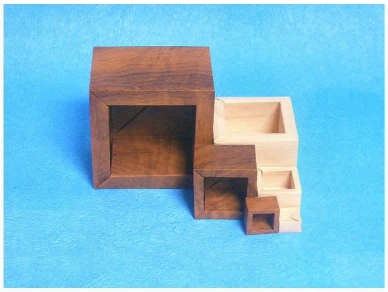


fig.11

There remains an unfulfilled challenge. The proportions of the sides of the inside of the box are not 1:√2, and so there are tiny "steps" when they are nested. I realised that if the dimensions of the external and internal box side could both be made to be 1:√2, then the steps can be eliminated. So far, I haven't succeeded.

As a postscript, I was intrigued to discover that the roots of Russian Matrioshki dolls are in Japan. Nesting Fukuruma dolls appeared in Japan at the latter part of the 19th century: Fukuruma was a benevolent wise man, and the dolls contained within were younger versions of same character. So you can see that there are stong parallels with the journey of this origami Masu Matrioshki. The subject is Japanese, this origami counterpart has travelled via England and Russia, and so, to complete this circlar journey, we are pleased to dedicate this model to the home of origami, Japan.

David Brill
Poynton March 2006

Appendix 1

Progression of VA dimensions

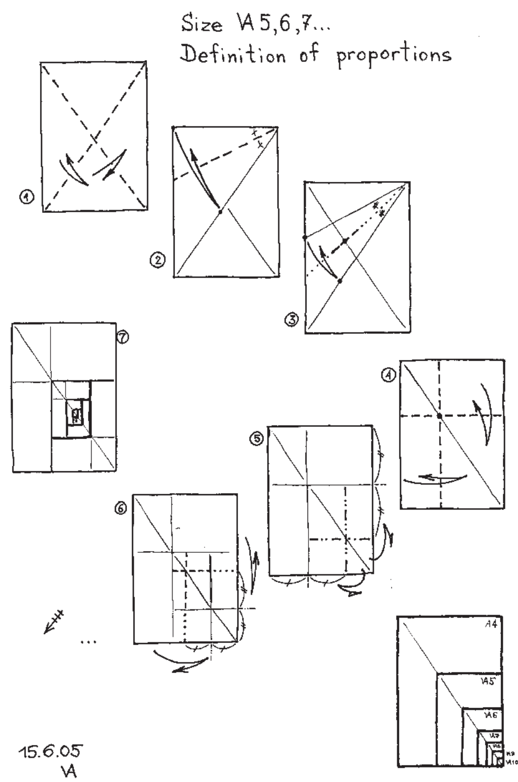
	round off dimensions (mm)	exact proportion $a\sqrt{2}$ × a (mm)
VA 0	2034 × 1440	2036,6 × 1440
VA 1	1257 × 890	1258,7 × 890
VA 2	777 × 550	777,86 × 550
VA 3	480 × 340	480,8 × 340
A4	**297 × 210**	296,96 × 210
VA 5	184 × 130	183,86 × 130
VA 6	113 × 80	113,1 × 80
VA 7	71 × 50	70,7 × 50
VA 8	42 × 30	42,4 × 30
VA 9	28 × 20	28,3 × 20
VA 10	14 × 10	14,14 × 10
VA10=VA11 STOP	14 × 10	14,14 × 10

The Rule (formula):

VA4 = VA5 + VA6, that is $VA_n = VA_{n-1} + VA_{n-2}$

15.6.05
VA

Definition of VA proportions



Appendix 2

VA size story

The size of the first box in the series was A4 (297 x 210mm), also known as "Silver Rectangle" with the correlation of sides a√2 : a, where a - the width, a√2 = b - the length. When I measured the dimensions of the next paper sizes in the sequence (187 x 130mm) and (113 x 80mm), I noticed that in total they are equal to A4:

	187	130	
plus	<u>113</u>	<u>80</u>	
	297	210	= A4!

So to calculate the dimensions of the next paper sizes we need to find the difference between the two previous ones. Verifying for the width, for example:

	210	130	80	50	30	20	10
less	<u>130</u>	<u>80</u>	<u>50</u>	<u>30</u>	<u>20</u>	<u>10</u>	<u>10</u>
	80	50	30	20	10	10	0 !

But after the seventh subtraction the decreasing progression is finished. Why? We can see on the paper which we are folding that the smaller dimensions do exist! *

For the width "a" the progression VA is ideal, but for the length "b" there is a little error (for example VA7) because of the irrationality of the number √2. After A4 we can continue the progression to another side to increase the formats infinitely.

Assia Vely
Pforzheim June 2005

*We have now been shown that this is explained by the principle of the Fibonacci sequence! DB, AV