

How it is made

Hanayama *Cast Twist*

by Oskar van Deventer

Introduction

Hanayama cast puzzles are among the most coveted mechanical puzzles in the world, famous for their perfection in all aspects. Initial production batches are typically sold out within a couple of days, and many collectors worldwide maintain a complete collection. This summer (2013), George Miller, Roxanne Wong, José and I made a factory tour through China, visiting many factories and offices around Shenzhen, Guangzhou and Hong Kong. Kyoo Wong of Hanayama spent a full day to show us the Hanayama facilities. This article provides an impression of the many steps that it takes to produce a Hanayama Cast Puzzle taking the youngest of the series, *Cast Twist*, as example.

The puzzle design

A puzzle design starts with an idea. After seeing my *Oskar's Disks* puzzle [1] from 1986, Wil Strijbos suggested that the two disks should go through each other all the way. Hanayama *Cast Disk* [2] from 2000 was one of the spin-offs of that suggestion. In 2004, shortly after George Miller introduced me to 3D-printing, I designed the *Snake Ball* (see Figure 1), which George prototyped on his machine [3]. We considered the puzzle impossible to mass produce at that time, so we abandoned the project. Early 2012, Brett Rothstein asked me for a sample, which I delivered via Shapeways [4]. I also provided a sample to Teddy Sakamoto and Takeshi Onishi of Hanayama at IPP 2012. They would check whether Kyoo Wong could find a solution to produce the puzzle.

Hand samples

The first thing Hanayama does for a new puzzle is producing hand samples (Figure 3). These hand samples are machined from brass and serve to check all production details of the puzzle. When a prototype is delivered in physical form, like Akio Yamamoto's organically shaped puzzles, they are 3D-scanned so they can be handled by CAD software. As the *Snake Ball* was already available in electronic form, this step could be skipped. Kyoo, together with a Chinese CAD specialist, found a way to split the *Snake Ball* rings into three separate castable parts.



Figure 1. *Snake Ball* prototype after use by Hanayama

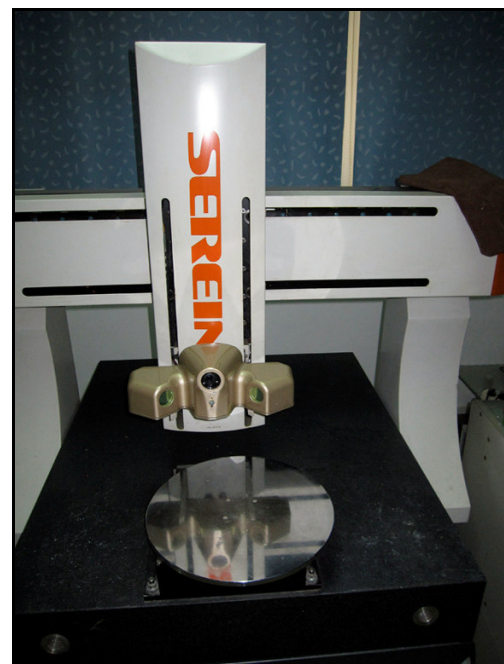


Figure 2. Hanayama's 3D-scanner



Figure 3. First hand sample of *Cast Twist*

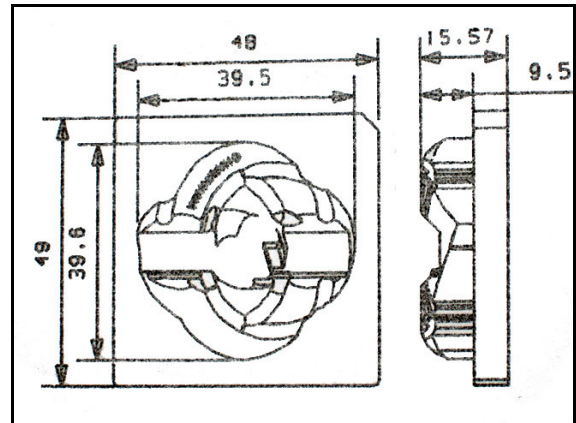


Figure 4. Mould design

Mould making

Once the hand samples are approved, the mould-making process starts. Moulds are also designed using CAD, see Figure 4. Special care is taken to make sure that the pieces can be extracted from the mould. First a negative of the mould cavity is machined in copper (figures 5 and 6). Actually, there are multiple negatives as the mould is made in multiple steps. The mould is made using a process called spark erosion [5]. The copper negative is kept onto a steel slab that will become the mould, and a high current is put through the system. As a result, the steel is eroded away spark by spark, and the minuscule sparks are washed away by a steady water stream, see Figure 7. The process proceeds at a glacial speed.

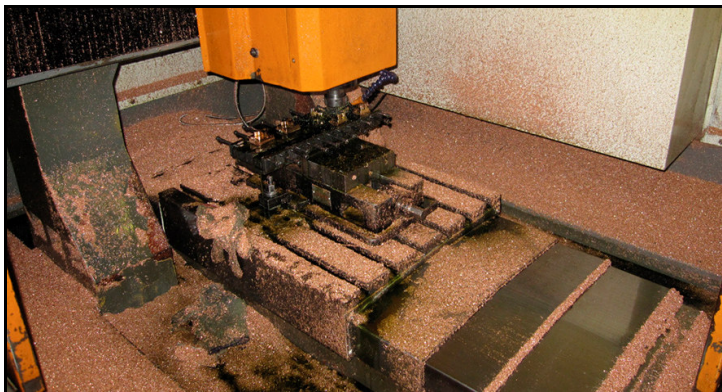


Figure 5. Machining mould negatives in copper



Figure 6. Copper negatives



Figure 7. Spark erosion

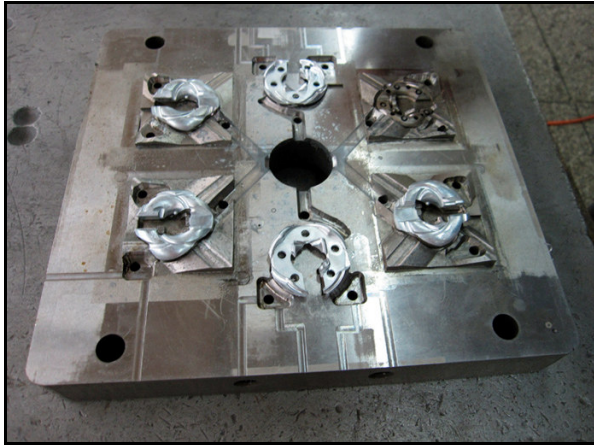


Figure 8. Resulting mould



Figure 9. Kyoo, George and Oskar checking the mould

Die casting

Once the mould is ready, a small zero-series production run is performed to test the mould. The moulding process is called die casting. A special molten zinc alloy (Figure 10) is pressed into the cavity of the mould, the zinc solidifies in the water-cooled mould, a robot arm grabs the still hot cast and puts it on a slowly-moving conveyer belt (Figure 12) to cool down. Once cooled down, the sprue [6] is broken off and recycled (Figure 13).

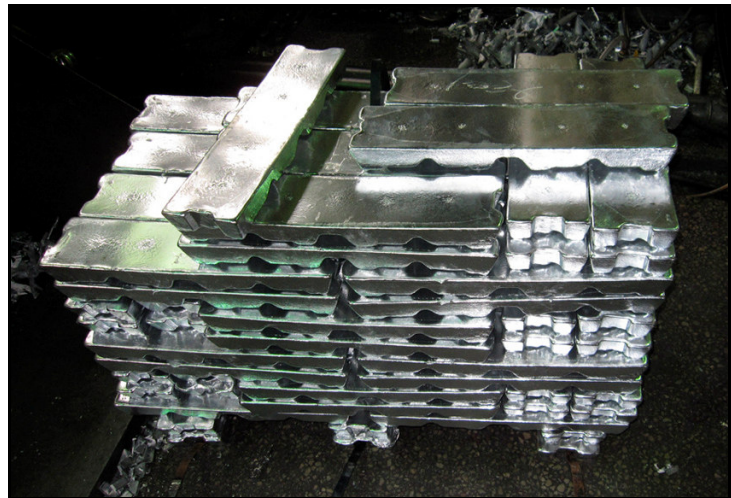


Figure 10. Special zinc alloy



Figure 11. Molten zinc in hot die-casting machine



Figure 12. Die-casting machine with robot arm and conveyer belt



Figure 13. Cast parts on their sprue



Figure 14. Buffing of the pieces

Post-processing

A lot of post-processing is needed on the cast pieces. Hanayama use special machines to cut off excess flesh from the cast pieces, cut thread, bend parts and more. The pieces are buffed [8] to remove any sharp edges (see Figure 14). After some manual checks, the pieces are polished in a vibratory tumbler [9], see Figure 16.



Figure 15. Kyoo sanding metal parts.



Figure 16. Vibratory tumbler to give the metal parts a smooth polish

Metal plating

The next step is metal plating [10]. Hanayama has many different plating types available with different looks and properties (Figure 17). Some platings are extremely scratch resistant, whereas other platings provide a nice antique look. Pieces from the zero series are tested with different platings, and a marketing decision is made what plating will be used for production. A complication is that different platings may have

different thickness, depending on the number of layers used. In some cases, the moulds need to be corrected to compensate for the change of thickness for a different plating choice. The accuracy is measured in micrometers here, and these differences do matter in an ultra-high-quality product.



Figure 17. Testing different metal platings



Figure 18. Oskar, José and George holding freshly-plated metal parts (photographer Kyoo is making a funny face)

Assembly and packaging

A lot of manual work goes into the assembly and packaging of the puzzles. Whereas workers are trained to quickly assemble a puzzle, they have no clue how to take it apart. Special care is taken during transport and assembly to ensure that the pieces do not scratch against each other, by individually packaging each part and assembly in its own little bag. Next, the assembled puzzles are strapped into their boxes (Figure 19), the boxes are put together and put into larger boxes, which are collected on pallets and moved into sea containers for shipping (Figure 20).



Figure 19. Packaging the puzzles



Figure 20. Shipping container filled with Hanayama puzzles

Marketing, sales, toy fairs, distribution, shops, collectors

The final step in the process is promotion and sales, which includes presenting the puzzles at many toy fairs around the world (Figure 21). The puzzles are distributed to the shops and sold to the collectors, who can then start solving the puzzles.



Figure 21. Hirano demonstrating Hanayama puzzles at Tokyo Toy Fair



Figure 22. Special multi-colour sample for Oskar

Hanayama, happy 30th anniversary!

References

- [1] Oskar's Disks, <http://www.gamepuzzles.com/prpuzzls.htm#OD>.
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