

Universal Magic Cube: A Hands-on Workshop for Closed Cubic Kaleidoscopes with Infinite Reflections

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Abstract

Cumos, a new type of polyhedral closed box kaleidoscope with infinite reflections, was invented first in 1974 as an artistic product. The same type of cubic kaleidoscope named as Universal Magic Cube was developed later by using commercially available materials and spread out as a universal art design through the workshops all over the world. This is a hands-on workshop during which participants can enjoy to construct their own magic cubes.

It is well known that physicist David Brewster invented a new optical instrument for creating and exhibiting an infinite variety of beautiful forms and patterns in 1816 in the course of a series of experiments on the polarization of light by successive reflections between plates of mirrors and put the name of kaleidoscope derived from the Greek words *kalos*, beautiful; *eidōs*, a form; and *skopein*, to see [1]. The kaleidoscope for great use in all the ornamental arts attracted many peoples all over the world and became popular in few years even in Japan during its Edo period of isolation. Although the kaleidoscope has been treated as a toy for children for a long time in the history, the modern boom of fine kaleidoscope as a contemporary decorative art appeared as the Renaissance of kaleidoscope in the mid-1980 especially after surface-reflecting glass became commercially available for artists [2]-[3].

From a view point of geometric art, Kasper Schwabe [4] distinguished three basic kinds of kaleidoscopes (Fig. 1) based on the investigations of polyhedral kaleidoscopes by H. S. M. Coxeter [5] and others. See also J. Richter-Gebert's article on the investigation about the infinite views [6].

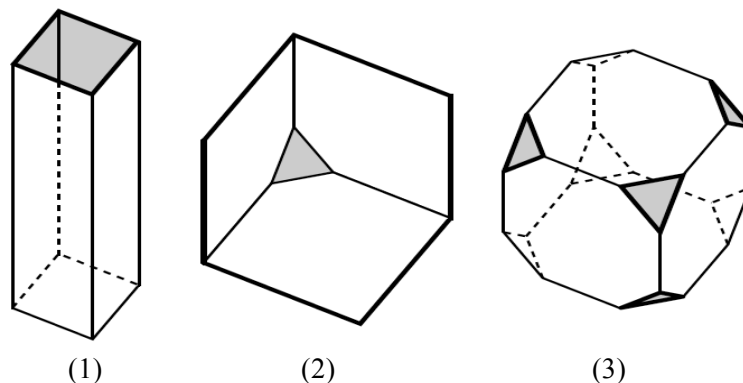


Figure 1: *The three basic kinds of kaleidoscopes*

- (1) The classic polygonal kaleidoscopes with infinite reflections
- (2) The polyhedral corner kaleidoscopes with finite reflections
- (3) The polyhedral closed box kaleidoscopes with infinite reflections

C. L. Palmer organized the workshop at Bridges 2011 about the polyhedral corner kaleidoscopes [7]. In case of the corner kaleidoscopes (2) in Fig. 1 we can see an infinite structure of objects on the inside mirrors and/or of objects behind the mirrors similar to the polygonal kaleidoscopes (1) through its corner hole. In case of the closed box kaleidoscopes (3) in Fig. 1 the mirrors inside form a closed space and reflect an infinite spatial structure. There are two ways to see the inside: to go inside the mirrors, or to peep in through holes. When objects are placed in the closed space, we can see an infinite structure of the objects reflected on the inside mirrors by light only from the opened holes. When the closed box kaleidoscopes (3) have only one hole for peeping in and the hole is almost covered by eye, then the inside of the box is so dark that we cannot see any objects put in the box without light but can see only an infinite structure of our eye peeping in the box.

On the other hand, independent from such mathematical investigations, in 1974 when Minori Yamazaki, a freshman of an art university at that time, was in a space-design lesson to make infinite designs by cubic structures, he came to an idea to scratch vacuum-sublimed aluminum mirror surface on one polyacrylate plastic plate by cutter knife to draw line-patterns on the mirror and make a closed cubic box with the scratched mirror and other five mirrors (Figs. 2-3). The infinite structure of the patterns reflected on the inside mirrors due to light in the dark box penetrated through the scratched part of the mirror could be obtained from a peeping hole on the mirror opposite to the scratched mirror (Fig. 4). Yamazaki put the name of Cumos (Cubic Cosmos) to this new type of cubic kaleidoscope and patented in 1985 [8].

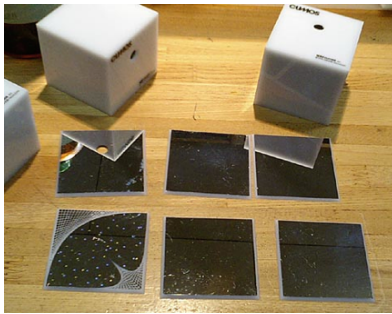


Figure 2

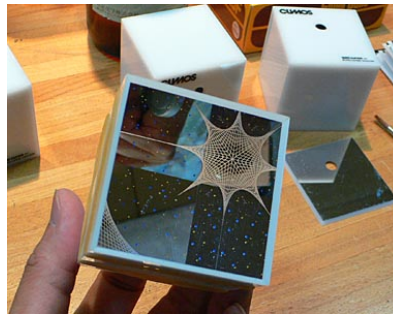


Figure 3

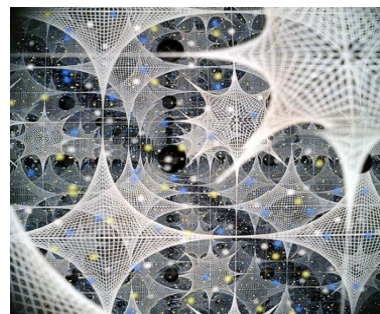


Figure 4

Before Cumos was first introduced in a Japanese public science magazine in 2006 [9], Yamazaki has prepared almost three thousands copies of Cumos by hand and opened several times the art gallery exhibitions of his Cumos works since 1974. Some of his Cumos are shown in Fig. 5 [10].

It is known that Cumos-style closed cubic kaleidoscopes with commercially available polycarbonate mirrors were designed first by a person still unknown and further expanded through summer-seminars of high school teachers of science and mathematics in Japan since 1980s before Takaaki Sonoda and his colleagues started the workshops of UAP (Universal Art Project) Owl Association (Fukuro-no-Kai in Japanese) which was established at Fukuoka in 2003 to organize the universal magic cube workshops at various community centers such as kindergartens, schools, universities, museums, and science and art festivals in order to facilitate local and global human exchange activities especially for disabled peoples under severe life conditions such as children in the hospitals and refugee camps [11]. Some workshop pictures are shown in Fig. 6. The projects of UAP Owl Association are based on an idea of universal art as a universal design attractive for any persons irrespective of their personal human factors such as age, disability, nationality, and cultural differences. The workshops for various kinds of universal magic cubes and magic-spaces were realized already in more than 50 cities and towns in 14 countries in the world to make more than 30000 magic cubes with various peoples aged from one year to 101 years in the last ten years.

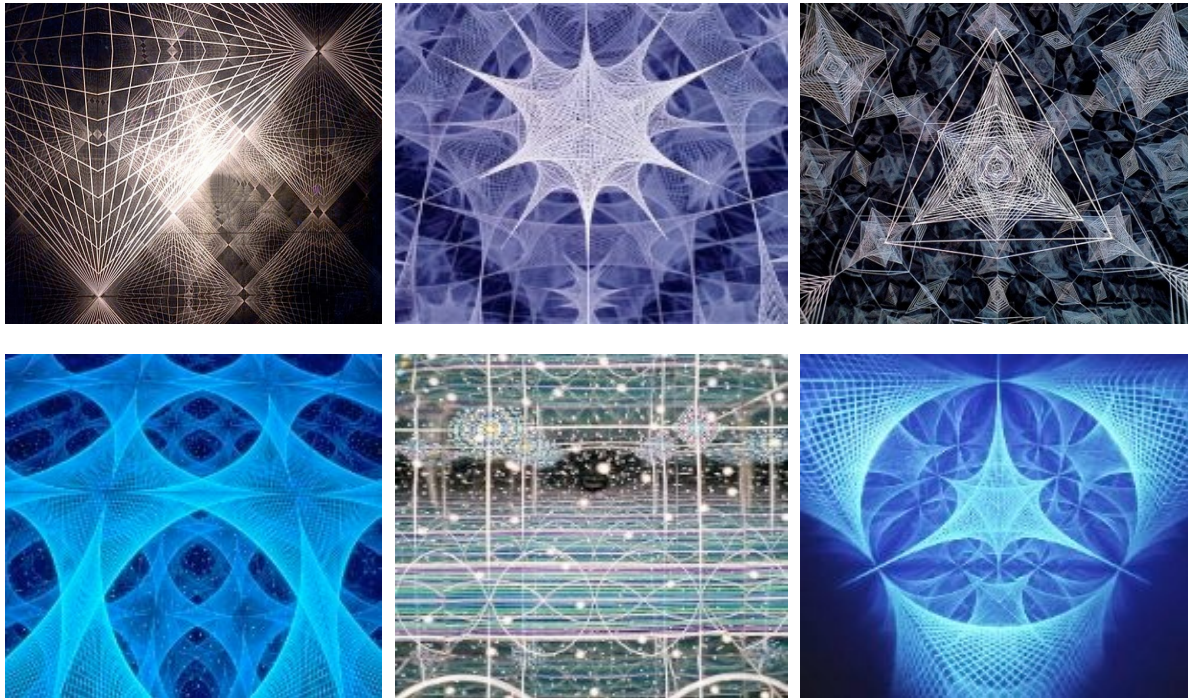


Figure 5: Some Cumos works by Yamazaki



Figure 6: Some workshops of the universal magic cubes in the hospitals by UAP Owl Association

In this universal magic cube workshop [12], we use six commercially available polycarbonate plastic mirrors squared with 10 x 10 cm size and 0.5 mm thick, twelve book-binding black tapes with 10 cm length, and six half transparent cutting sheets with different colors (Fig. 7). The polycarbonate mirror is covered by protecting film (Fig. 8) which is removed later before two half-made cubes are connected to make a closed cubic box (see below).

First step is to make a half cube with a peeping hole (Fig. 9). To cut the edges of three mirrors by scissors is easier for polycarbonate mirror with 0.5 mm thick without sharp mirror edge compared with polyacrylate mirror which is stiffer but gives more sharp and more dangerous mirror edge (Fig. 10). After peeling white cover paper off the black tape (Fig. 11), put the blue part of the mirror on the glue part of the black tape under the mirror where adjusting the corners of two mirrors is important to make good shaped cubic box (Fig. 12). To keep 1 mm space between two mirrors with 0.5 mm thick in a parallel way is important to make good shaped cubic box with right angles (Fig. 13). To rub the book-binding tape strongly on the mirrors by nail or by the edge of pencil is also very important to make solid cubic box (Fig. 14). After cutting the edge of tape (Fig. 15) by scissors, peel protective films off three mirrors (Fig. 16) to complete a half cube with a peeping hole (Fig. 17).

Second step is to draw appropriate pictures freely on two of three mirrors by pencil (Fig. 18). To scratch protective paint layer covered over aluminum mirror layer on the transparent plastic layer, a router with

spinning drill controlled by two batteries inside, which is now commercially available at most of big coin-shops in Asian and European countries, is valuable even for disabled peoples to scratch the protective cover paint layer smoothly and safely together with middle aluminum mirror layer on the transparent plastic plate (Fig. 19). In case without rooter the cover paint layer can be scratched for a line-shaped patten by cutter knife or even by toothpick when the cover paint layer becomes soft in few seconds after small amount of nail polish remover containing acetone solvent is placed on the cover paint by cotton buds(swabs) (Fig. 20). The middle aluminum mirror layer can be removed by scrubbing with cotton buds containing small amount of nail polish remover liquid to leave clear transparent plastic plate (Fig. 21). Cutting sheets with different colors cut by scissors (Fig. 22) are put on the scratched parts of the mirrors (Fig. 23). It is important to cut a part of black tape which covers the scratched mirror part to make light come through the plastic plate (Fig. 24).

Dynamic combination and graduation of different color patters with infinite reflections can be realized by changing the direction and strength of light penetrated into the cubic box (Figs. 25-27). Different styles of scratching the mirrors with different design give totally different artistic worlds in the universal magic cubes (Figs. 28-29). In this universal magic cube workshop it is important for participants to enjoy totally different artistic 3D spaces by exchanging their hand-made magic cubes with each other (Fig. 30).



Figure 7



Figure 8

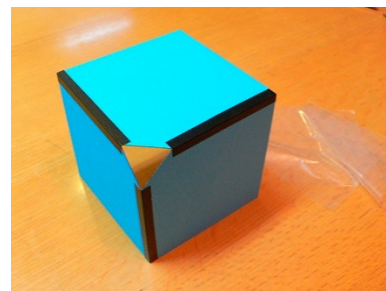


Figure 9



Figure 10

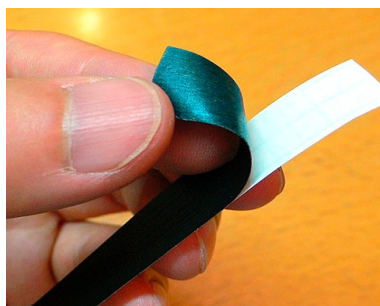


Figure 11

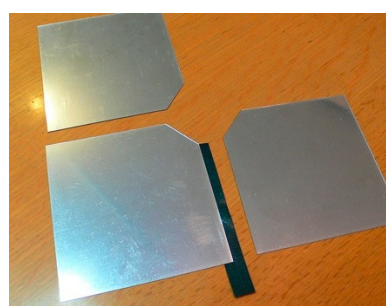


Figure 12

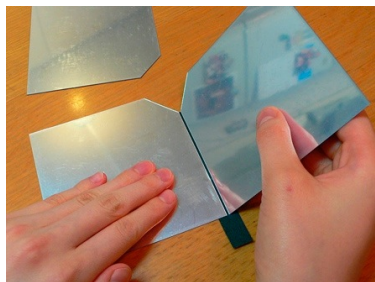


Figure 13

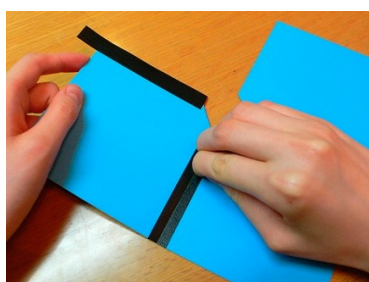


Figure 14



Figure 15

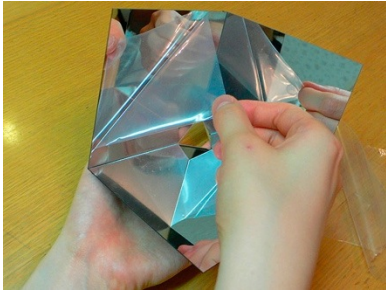


Figure 16

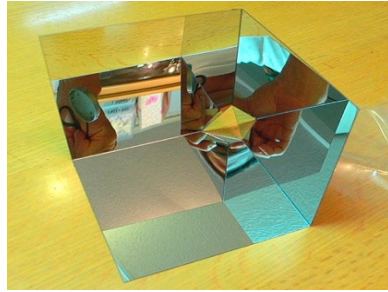


Figure 17



Figure 18

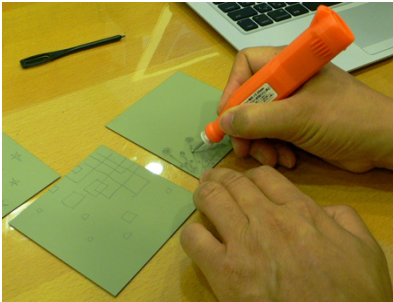


Figure 19

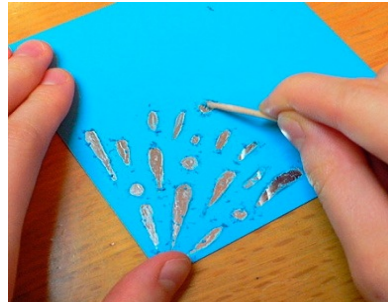


Figure 20



Figure 21



Figure 22



Figure 23

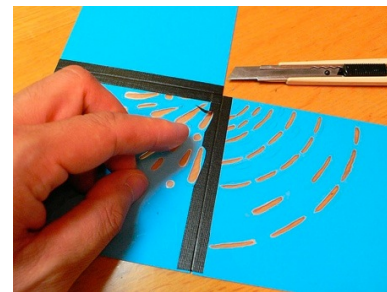


Figure 24



Figure 25



Figure 26



Figure 27



Figure 28

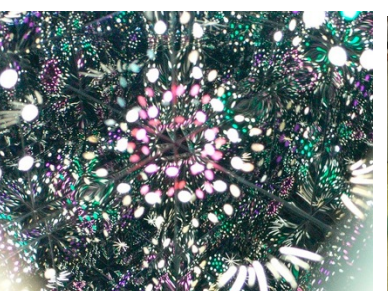


Figure 29



Figure 30

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- [12] Detail English manuals for making universal magic cube can be obtained from the following website <http://cumos.jp/work/page8/page8E.html> as well as manuals in several different languages such as Japanese, German, Chinese, Korean, Polish, Czech, Argentine-Spanish, and Brazil-Portugese at present.