# Digital Sangaku

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## Abstract

This presentation focuses on the visual component of a geometry problem extracted from a 18th century Japanese Sangaku woodcarving. It combines information of a scientific nature with digital visualization practices to create an esthetically appealing statement. It is part of a larger narrative submitted to the Bridges 2012 conference along with 3 original Sangaku for the Art exhibition and a related animated film for the Short Movie Festival.

## Introduction

In the world of English mathematician John Rigby *"Sangaku, were hand-carved wooden blocks, containing collections of problems and accompanied by beautiful coloured figures"*. [1]

This presentation focuses on the process of assessing in visual terms universal principles of Euclidian geometry as depicted in Japanese 18th century Wasan geometry and reconstructs in a significant artistic statement scientific concerns such as the area of circles, length of circular arcs, volume of intersecting solids and other surface parameters that artists use in their environment. The methodology I follow for this purpose conforms to fundamental principles of visualization in terms of shape building, contours, form, color selection and other technical parameters to build illusion of depth and perspective on a two dimensional surface.

## Data Collection

Sangaku or San Gaku (算額) lit. mathematical tablets, are geometrical problems engraved on wooden tablets. They were very popular in Japan during the Edo period, years 1603-1867. Sangaku problems are found to be very similar to Pythagorean and Euclidean geometry on areas and volumes. Dr Tony Rothman and Fukagawa Hidetoshi [2] are among the foremost experts in the field today. Their work constitutes the source from which I selected several significant Sangaku for a larger project this example is taken from.

The illustration shown here *(Figure 1)* comes from a 1803 Sangaku tablet found in the Gunma Prefecture in central Japan. The Sangaku was selected based on the simplicity-complexity of the problem, on its line dynamic and on its narrative potential. According to professor Walter Whiteley: *"Abstract and applied mathematics can be intensely visual, combining a very high level of reasoning with a solid grounding in the senses"*. [3]

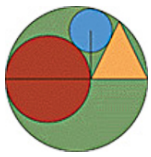

**Figure 1**. *1803 Sangaku, Gunma prefecture.*

The mathematical problem on the plate reads as follow: the base of an isosceles triangle sits on a

diameter of the large circle. This diameter also bisects the circle on the left, which is inscribed so that it just touches the inside of the container circle and one vertex of the triangle. The top circle is inscribed so that it touches the outsides of both the left circle and the triangle, as well as the inside of the container circle. A line segment connects the center of the top circle and the intersection point between the left circle and the triangle. Show that this line segment is perpendicular to the drawn diameter of the container circle.

## Image manipulation

I laid the visualization groundwork by preparing an exact calculation of shapes, contours and positioning in an electronic spreadsheet program. I created in a graphic editor program a vector outline based on the numerical data to insure the exactness of the reproduction. The resulting outline was then converted into a black and white bitmat document to visually underscore and expand the dynamic of the representation. Volumes and shapes were built using the graphic editor program's transformation tools, filter galleries, multiple image adjustment extensions and various other optional layer styles. Color was added to the composition at the last stage. According to Itten [4] the juxtaposition of colors changes the perception of volume. Each complementary color was calibrated according to the light and reflection on the black and white forms before the final composition came together in a satisfying manner *(Figure 2)*.

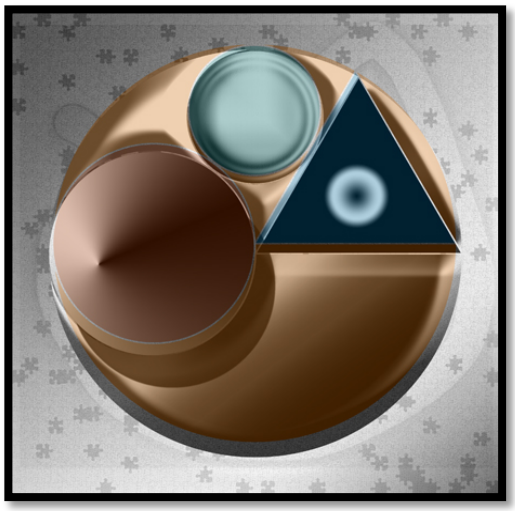

**Figure 2.** *Final Composition - Digital Sangaku*

## Conclusion

Visual communication methodologies relating to shape, color, form and even sound help assimilate problems of a scientific nature. The computerized environment nurtures a fecund and creative approach to visualization that benefit and reinforce scientific propositions. Future research based on collaborative effort between mathematics, applied sciences and communication technologies will without doubt continue to enrich further the reach and extent of multidisciplinary approaches to knowledge.

## References

[1] John Rigby, *Traditional Japanese geometry*, University of Liverpool Maths Club, 2002.
[2] F. Hidetoshi F. & T. Rothman, *Japanese Temple Geometry*, Princeton University Press, 2008.
[3] W. Whiteley, *Visualization in Mathematics*, York University, CND, 2004.
[4] J. Itten, *The Elements of Color*, DE. Wiley, 1970.