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Interest in Form in Japan and the West

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In the end of the last century, Japanese wood block prints gave a great shock to European artists. This proves that the encounter between civilizations can give rise to creative activity, and that traditional interest in form of artistic subjects depends on the characteristics of culture. This will apply to science as well. A story related to the form of a candy, Kompeito, is also presented.

INTRODUCTION

It is often said that science has no border, or science is international. Of course it is so, as long as its objective character is concerned, in the sense that facts or laws which a certain scientist asserts should be capable of being proved true by any other scientists of any country, and everything subjective is to be excluded in principle. However, in selecting research themes, in the way of thinking or in experimental procedures, the personality and the environment of the scientist will play some role, which can be rather important in actual research development. Erwin Schrödinger, the famous physicist, one of the founders of quantum mechanics, once discussed several examples of actual research procedures and said that even in exact science like physics, one can not claim that science is absolutely independent of human temperament (Schrödinger: 1935). Biographers is fond of finding the relation between scientific achievement and personal character of the scientist.

The personality and the environment of a person depend much on the related tradition or culture. For example, Japan and the West have different cultures, which naturally implies differences in the ways of thinking, imagination, intuition and so on. In this context, we may expect that the Japanese would be able to contribute something unique and original to the development of human culture including science. And I hope this is true in our case of the Science on Form.

If one asks for examples of the mental activities in which

human characteristics or tradition might have played important roles, the question will be two-fold, as has been already mentioned. That is, on one side it is on a personal level, and on the other hand it is on a level of culture or civilization. In the following I would like to refer to some examples in this connection. Firstly, I draw them from the field of fine art to see the cultural difference in expressing the form or shape by painting, secondly from the scientific works of an outstanding physicist of Japan, who may be called as a great pioneer of the Science of Form, and finally from a sugar candy familiar to all the Japanese people to explain our interest in its specific form.

JAPANESE WOOD BLOCK PRINTS

As is well-known, in the last century, Japanese fine art gave a great shock to the artists in Europe. That is, Japanese wood block prints ("Ukiyoe") gave a great impact on the impressionist painters in France. These painters were Vincent van Gogh, Edouard Manet, Claude Monet, Henri de Toulouse-Lautrec and others. Also "nabis" painters such as Pierre Bonnard and Maurice Denis, and the famous glassworker Emile Gallé received direct influence from these wood block prints. In many works of these Western artists we can clearly see the influence of Japanese Ukiyoe painters, Hokusai,

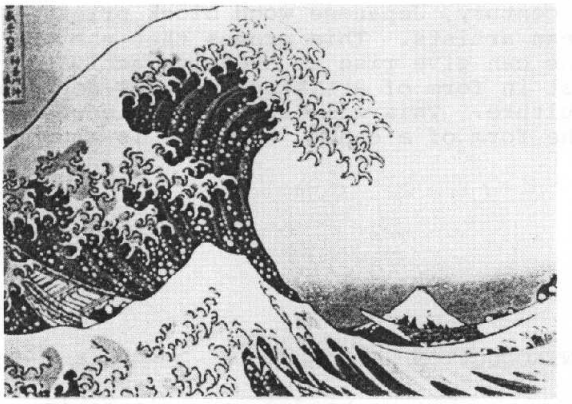

Fig. 1 Ocean waves by Hokusai

Fig. 2 "Standing Beauty"

Fig. 3 "La japonaise" by Monet

Hiroshige and others.

Fig. 1 shows a part of a Ukiyoe by Hokusai. Giantic ocean waves are expressed in a decorative way, and Mt. Fuji is at a distance. Fig. 2 is a part of a picture by a Japanese Ukiyoe painter, of a standing beauty in a casual pose favored at that time. Fig. 3 is "la japonaise" by Claude Monet, a girl wearing a Japanese dress and posing like Fig. 2. This is only one example of great many French paintings exhibiting deep influence of Japanese wood block prints.

Ukiyoe started with depicting lives of town people. Ukiyoe painters loved to depict elegant and beautiful women, portraits of actors, and landscapes. It may be characterized by decorative flat way of expressing things with clear colors and simplified lines ignoring shade. The European artists might have been shocked also by the fact that Ukiyoes depict beautifulness of casual gesture or form of townspeople in their daily lives. In addition, in the composition Ukiyoes almost ignore perspective and symmetry. All of these characteristics of Japanese paintings were quite different from the tradition of the Western art, which the artists of the last century were trying to surpass. So the impact by the Ukiyoe prints could give great influence to the Western art. This example shows, as the historian Arnold Toynbee (1952) pointed out, when a civilization is encountered by another, the difference in culture can give rise to a new creative activity.

PROFESSOR T. TERADA

In Japan, we often speak of Professor Torahiko Terada (1878-1935), who was a leading scientist in physics and geophysics (Terada: 1936-1939, and 1985). Since he had a unique intuition of finding scientific themes even out of phenomena very familiar to the Japanese, and derived remarkable persuading results, his way of research is referred to as "Terada physics". I think he was an outstanding pioneer in the field of the Science on Form.

Professor Terada was a professor of the University of Tokyo. In the earlier period of his career, he performed some famous studies on X-ray analysis. His subsequent works covered the fields of acoustics, magnetism, geophysics, meteorology and seismology. He had been interested in random or statistical phenomena, such as the fracture patterns of glass plates, of earth crust, and columnar convection vortices. Even the patchwork-like patterns on cat skins could not escape from his scientific themes.

He was a remarkable essayist as well; his essays are still attracting wide class of readers, and they prove that literary and scientific interests can be harmonically combined. His research themes and the way of performing experiments clearly show that the personality of scientist and his cultural background can lead to unique contributions, especially in fresh branches of science.

In a scientific essay, he wrote about a sugar candy familiar to all the Japanese. This candy is very interesting in its form, because though it is roughly spherical it has many conspicuous horns. In his essay, Professor Terada briefly describes how they make it according to the story he heard from the candy maker and adds some conjecture about the mechanism of the formation of its horns.

KOMPEITO

Fig. 4 shows some grains of the sugar candy, Kompeito. The Kompeito grains are rather small, about 1 cm in diameter, roughly spherical, but covered by many horns (from 20 to 30 horns, sometimes more).

This candy was brought to Japan for the first time by a Portuguese missionary, Luis Frois, in 1569. It was among some presents to Nobunaga, the ruler of Japan of that time. The sugar candy was kept in a bottle of glass, and was called "confeitos" in Portuguese. In Japanese, we call it "Kompeito" after the Portuguese word. It is still made in Japan, and can be obtained at stores of traditional Japanese candy or cakes.

I expected that such candy would be found in Portugal or in some other part of Europe. I have asked many Europeans in vain if such a candy with horns might exist in Europe. It seems likely that it is no more made in Europe. If you could give me any information about it, I would be much obliged to you. As you see the Portuguese word confeitos is etymologically the same to the English word comfit or confectionary. We have also the words confite in Spanish, confetti in Italian and French, Konfekt in German and so on. However these will mean simply candies or chocolates, but not the candy with such specific horns. [After my lecture, I learnt from Professor Y. Collan that "konfekt" in Finnish is a common noun for candy, used as "chokladkonfekt".]

In the sixteenth century, sugar must have been precious and sugar candies not yet well developed. Therefore, I would rather assume that the confeitos which Luis Frois brought had irregular shape. Further, I suspect that, in Europe since then, they endeavored to make confeitos perfectly spherical, while the Japanese were so interested in its irregular shape that they tried to develop pretty horns on the surface of confeitos.

As is often pointed out, symmetry involving spherical shape, is favored in the West, while lack of symmetry is felt more preferable in Japan in many cases. Such difference in taste or interest might have divided the progress of confeitos or Kompeito into European and Japanese ways.

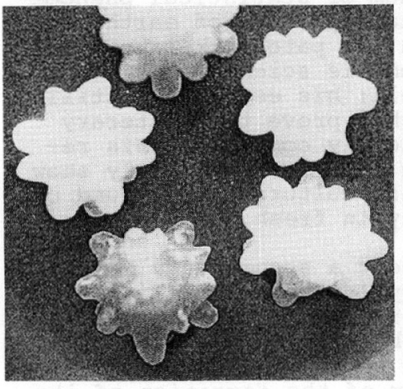

Fig. 4 Kompeito

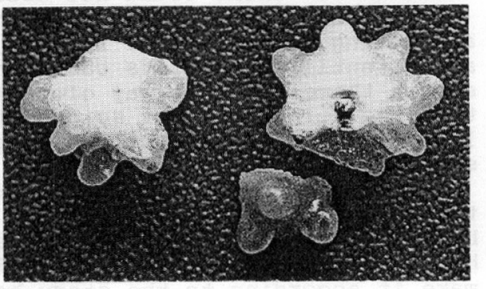

Fig. 5 Kompeito's section

KOMPEITO GROWTH

When we cut a grain of Kompeito through its center, we see a "seed" as is shown in Fig. 5. It is said that this is a poppy seed, but also that a sesame seed was used sometime. Kompeito makers are supposed to start manufacturing by attaching some sugar on each seed to have a tiny ball of sugar. But the detailed procedure of manipulation seems to belong to the secret of makers.

With the aid of some colleagues of mine in Yokohama National University, we constructed an apparatus and succeeded in making Kompeito by ourselves. The essential part of the apparatus is a flat pan, made of iron, with vertical edge at the circumference like the pan used in cooking "Sukiyaki". The apparatus and the procedure are as follows.

The pan about 40 cm in diameter is inclined by 30 angle degrees or so, being held by a central shaft, and is slowly rotated by a motor at the speed of one rotation per minute. The lowest part of the pan is heated by a gas burner. Sesame seed is used as the kernal. A handful of seeds is put in the pan. As the pan rotates the seeds crumble down, as a continuous snowslide, to the lower part of the pan to stay there as a whole.

Besides, we make thick sugar syrup, which is nearly saturated at about 70°C. By using a small spoon, the sugar syrup is dripped now and then onto the seeds, which then catch sugar and turn into grains of sugar. As the pan is inclined and rotates, the grains in the pan continuously go up a little and then tumble down. We continue dripping the sugar syrup now and then. By sampling, we can follow the process to some extent. First, each seed catches some sugar syrup. Being heated from below, water evapolates leaving sugar trace on the surface of the seed, and repeating the process of catching sugar, the grain catches more and more sugar, which ultimately develop horns.

The process may be described as follows. If a part of the surface of the grain stick out, this part catches more sugar, cools faster, and water there evaporates faster than the other part, and so it solidifies faster. Thus bumps grow leaving dents, and horns develop. Since grains continuously tumble down the pan, they mutually scrumble for sugar syrup. At the same time, tumbling motion will prevent the grains from sticking together. Thus the generation of Kompeito horns seems to be a dynamical many-body process, different from a steady growth of independent grains.

EVOLUTION PROCESS

Now, we shall turn to simple mathematical consideration. Suppose that a small sugar horn is generated. Then, as already stated, the top of the horn will be favored to catch more sugar than the lower part. Therefore we may roughly expect that the shape of a horn $y = y(x,t)$ will be subject to the equation $\partial y/\partial t \simeq ay$. However not only the top, but also each side of the horn will catch sugar and this process will have some similarity to diffusion, so that we will have a term depending on $\partial y/\partial x$ or $\partial \log y/\partial x$. Thus a possible and simple equation would be

$$\frac{\partial y}{\partial t} = ay + b\left(\frac{\partial \log y}{\partial x}\right)^2 y \ . \qquad (1)$$

This equation has a particular solution

$$y = A \exp(at - \frac{x^2}{4bt}) \qquad (2)$$

which represents a horn of Gaussian form, with the hight evolving indefinitely and the width proportional to $\sqrt{t}$. The above evolution equation is only the simplest trial. Of course, there must be a saturation effect which limits the growth of horns, which can be into consideration by more elaborate analysis.

The process seems to have something to do with what is called the diffusion limited aggregation (DLA), which will be one of the themes of the next talk by Professor L.M. Sander.

We may have some sort of computer experiment to simulate the growth of Kompeito horns in a way similar to DLA, but with certain appropriately modified rules. The Computer simulated version of Kompeito may be called "Computo", or so.

REMARKS

(1) It has been pointed out that, in some cases, gallstone and renal-calculus with irregular shape somewhat similar to Kompeito are found. In this connection also, elucidation of the mechanism of Kompeito horns seems to be of some value.

(2) If we could make Kompeito-like grains of other materials such as ice, plastics, metals or so, we may utilize them in many ways.

ADDENDUM

After finish writing the manuscript the author received a mail from Professor Alan L. Mackay of the University of London. In it I found two grains of sugar candy of ellipsoidal shape. The grain is much larger than a Japanese Kompeito grain. It is covered with small horns, which are not so well developed, so that it looks rather like a young pine cone or large seed of some other tree. According to Professor Mackay, it is from the town Pisaia and widely on sale in Italy. I cut it through the shorter diameter, and found a kernel seed at its center, which is surrounded by some layer structure (see Fig. 6).

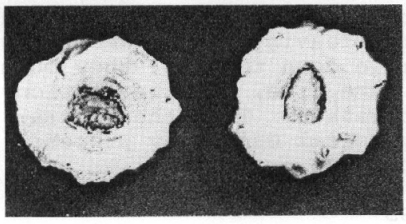

Fig. 6

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O-1
Q: Professor Toda alluded to differing artistic styles (and style interactions between continents). At school most of us are taught to write according to a given standard style ("copper plate"), but finish up by developing our own distinctive writing styles - hence the use of signatures on credit cards etc. Does Prof. Toda think that differing artistic styles are akin to differing writing styles? (R. Miles)

A: Differences in artistic styles are deeply rooted in the traditional cultures, the education, the way of living, environment and climate. These have something to do with the artistic styles. It will have some relation to writing styles. But the influence of the heredity of the family may be more important. And the network of the brain developed by training and experience may change writing styles, I think.

Q: Is it possible that metal objects patterned on "horned" spherical candy might be used as interlocking three-dimensional gear wheels? (R. Miles)

A: Kompeito-horns are very irregular; some are long and some are short. So the candy would not work as three-dimensional gear wheels in the usual sense. If we could have similar horns with metal or other material, application might develop. Shellfish and other living things with horns indicate this possibility.

Q: Are you sure that all your sweets have got a sesame seed in the centre? I have to admit to having eaten two, and one of them didn't seem to have a seed in it. Perhaps those horns get snapped off if they grow too long and thin and then these little fractured pieces can act as a focus for a new 'sweet'?
(V. Howard)

A: The kompeito you tasted is a commercial one. It contains poppy seed, while the kompeito we made has sesame seed. I think every grain has a seed. If you cut it through the center using a knife, you will find the seed. But, as you point out there is a possibility of the 'sweet' without a seed: We can develop kompeito from granulated sugar. Very small sugar crystals can act the role of seeds.

Q: I believe that kompeito is probably an example of Diffusion-Limited Aggregation as Prof. Toda suggested, provided that the amount of sugar in the syrup is rather small. Also, it would be interesting to see the effects of the size of the seed.
(L. Sander)

A: In the process of developing horns, kompeito grains in the pan compete with each other in getting sugar. We drop very small quantity of the syrup each time onto the seeds or the grains after they are developed, so that the syrup does not stick to the pan (if it sticks it will form caramel, then it must be removed), and it is distributed widely among the seeds, or grains. The

concentration and the temperature of the syrup seem to be also determining factors. The syrup must be caught by the seeds or grains before going to the pan, so the syrup should be rather thick. But if it is too thick, the seeds or grains will stick together. Commercially, poppy seeds are used, while we used sesame seeds. The size and shape of seeds have apparently no important effects after kompeito has well developed. Some kind of "shaping" will be present.