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A NEW EDUCATION SYSTEM FOR ART AND DESIGN STUDENTS BASED ON SCIENTIFIC EXPERIENCES

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Publications and/or Exhibitions: Takaki, E. ed. (1994) Research of Pattern Formation, Scipress, x+590 pp.
Takaki, R. ed. (2004, 2006) Introduction to the theory of design, Kobe Design University, IV+54 pp.
Takaki, R. (2006) Private Exhibition "From Science to Art", Gallery ASK?, Tokyo, October 2-7, 2006.

Abstract: *A new education system for students of art and design is proposed, which has been applied in the course "Introduction to the Theory of Design" at Kobe Design University. In this course student have experiences to observe geometrical structures and natural phenomena, so that they have a rich culture and a strong motivation to art creation. In the course of one year about thirteen topics are prepared, such as Symmetry and Kaleidoscope, Folding Structures, Time and Rhythm, Crystal Growth, Flow and Vortex, etc. The class of each topic is composed of two kinds of studies; one is a lecture with exercises and experiments, and another is a creative works based on these experiences. The estimation questionnaire of the course in 2004 shows a favourable result. In this paper outline of the course and explanations of two topics, Space Packing and Crystal Growth are given.*

1 OUTLINE OF "INTRODUCTION TO THEORY OF DESIGN"

The course "Introduction to the Theory of Design" has been given by this author for the past four years in Kobe Design University. This course is aimed at encouraging graduate students of art and design to have a wide view of their environment, i.e. shapes of natural and artificial objects and processes of natural phenomena, in order to acquire a higher sense of creation. For this purpose this author prepared thirteen topics and arranged them as shown in Fig. 1, where important concepts for creative works are arranged in a hierarchy. The class of each topic is composed of two kind of activities, a lecture with exercise and experiences and a creative work. The former is to form concepts and understandings of real phenomena, while the latter is to produce real objects based on the concepts.

Coexistence of both activities within one person is expected to be a successful route to the symbiosis of art and science.

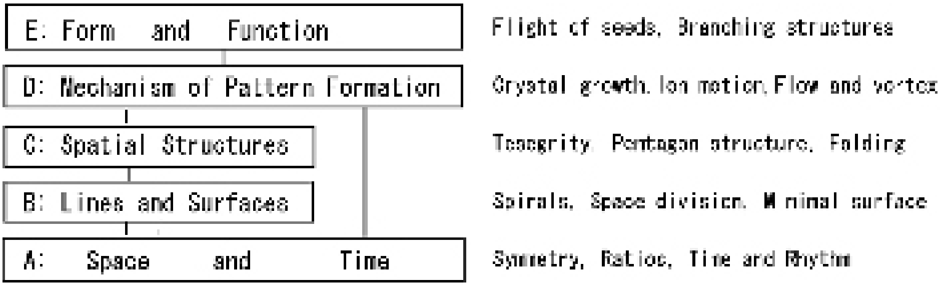

Figure 1: Hierarchy of topics in "Introduction to Theory of Design". The topics corresponding to these levels are shown in the right (Takaki, 2006).

As shown in Fig. 1, the lowest level is the basic concepts of space and time. In the course they corresponds to the topics, symmetry, ratio and periodicity. The next lowest level is concerned to basic shapes. Above this level come combinations of basic shapes, i.e. the spatial structures. The next level is the understanding of natural phenomena through experiments. Finally, at the highest level students consider about a problem, how functions of objects are supported by their shapes. In the choice of topics the most important factors are that exercises and experiments can be prepared without difficulty and that students can enjoy them.

2 AN EXAMPLE OF TOPICS - SPACE DIVISION

After some explanations of periodic tilings a random tiling based on the Collins lattice (arrangement of squares and regular triangles) and a quasi-crystal tiling are introduced. The concept of quasi-crystal is explained first by a 1D model, i.e. growth of a sequence of two characters "L" and "S" with deterministic growth rules: S→L, L→SL. Then, 2D models of quasi-crystal tiling are introduced, such as the Penrose tiling and the Watanabe's tiling (Watanabe & Soma, 1994). A students work based on the Watanabe's tiling is shown in Fig. 2.

For 3D space division those by the rhombic dodecahedron and by the Kelvin's body (truncated octahedron) are introduced. The former is closely related to the close packing of equal spheres and also to the 3D structure of honeycomb. Students make an experiment to produce a rhombic dodecahedron by pressing closely packed spheres of paper clay. After that students are suggested to measure the angle of the rhombus on the dodecahedron to confirm the Maraldi's angle 109.5 degree found in honeycomb in 17c.

A lot of Kelvin's bodies are constructed by students by the use of paper to confirm that the bodies fill the space without gap with small interfacial area. The recent finding by Weaire (Weaire, 1996; Weaire & Phelan, 1994) of another type of packing with less interfacial area is explained, but no exercise is made for this case. A students' creative work concerned to 3D space division is shown in Fig. 3, which is a combination of three elements made of paper imitating the space packing by Kelvin's body..

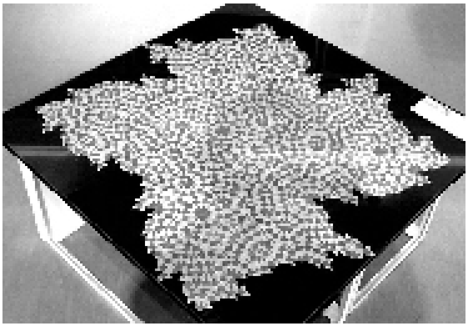

Figure 2: Watanabe’s tiling .

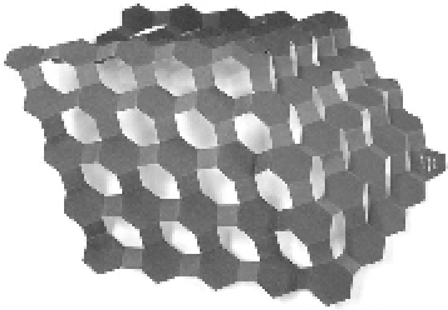

Figure 3: Artwork by Y. Wada

3 AN EXAMPLE OF TOPICS - SNOW CRYSTAL GROWTH

Three types of growth forms are observed in the class, the viscous fingering (the dendritic formation of the air while penetrating into a viscous fluid), the diffusion limited aggregation (the dendritic formation of deposition from metal ions) and the snow crystal, each by simple experiments. In the class students make a manual (not computer) simulation of crystal growth on a 2D oblique section paper, and create artworks based on its results.

Variety of shapes of snow crystal is understood by the so-called Nakaya diagram, where one growth mode is chosen from those, thin rod, hexagonal plate, dendrite, etc., according to the two parameters, the atmospheric temperature and the degree of over-saturation of vapor. While a snow flake falls down, it encounters variety of climates randomly, hence the flake grows in respective modes. In the simulation an initial crystal shape is given and a die is thrown repeatedly to choose one of growth modes according to the following rules:

For pips of die [1],[2] extension of all tips of crystal by one mesh of section paper, for pips of die [3],[4] extension of all tips of crystal and addition of side branches, and for pips of die [5],[6] covering the present crystal by a one layer of ice.
The crystal grows step by step, and after some steps one can get a grown crystal shape. One example of the results is shown in Fig. 4, and an arrangement of these results is shown in Fig. 5, which was exhibited within the university.

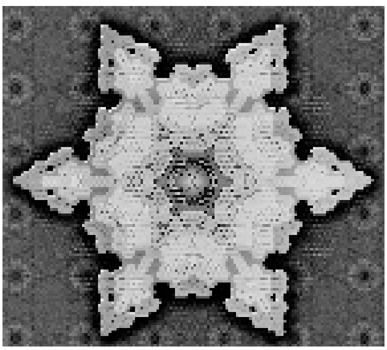

Figure 4: Simulation by Y.-P. Ren

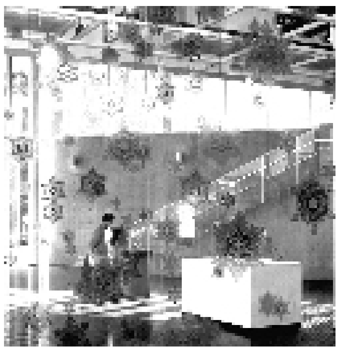

Figure 5: Artwork of falling snow.

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4 CONCLUDING REMARKS

The activity of this author can be looked upon as a trial to establish a new education system to provide a certain kind of culture to students of art and design. It is similar to the conventional field, Science of Design Studies. In this field linkages to various scientific fields are promoted, but not to the natural science such as physics, chemistry or biology. This author came to believe that experiences of natural science assures a rich basis to create artworks. The estimation research made in the end of 2004 shows that this course is supported by all students (Takaki, 2004). However, this trial is still under development, and advices and criticisms are asked. In addition, this author will be very glad if he can cooperate with aggressive educators or have successors of this activity.

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References

Takaki, R. ed. (2004, 2006) *Introduction to the Theory of Design,* Kobe Design University

Watanabe, Y. and Soma, T. (1994) Art of Quasi-Periodic Tilings,: *FORMA,*, 9, No. 3 (Watanabe, Y., Takaki, R. and Ogawa, T. eds., Special Issue , *The World of Scientific* Art), 217-224

Weaire, D. (1996) *The Kelvin Problem,* Taylor and Francis, London.

Weaire, D. and Phelan, R. (1994) -, 70, 345-350