A GRAPHIC SCIENCE EDUCATION AS A PUBLIC LECTURE MAKING USE OF FREEWARE, POV-Ray.

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ABSTRACT

Until now, graphic science education was mostly taken as the entrance of design and drawing education in the areas of architecture and machinery engineering. However in a highly advanced information society, there are increasing demands for skills to graphically express complicated information in an easy-to-understand manner, and graphic science education needs to play this role in the future. Technical education to heighten such skills must be positioned as literacy education in the same way as language education and information processing education, and though students need to understand what is being taught and master the skills, what is more important would be to use those skills, and be aware of actually using them for other studies, research, and self-expression. At Osaka City University, based on these needs, we offer a lecture "Graphic Science" as a public lecture, particularly studies using computer graphics making use of freeware POV-Ray. This paper discusses the aim of this class and details of the curriculum, and then analyzes how goals are achieved based on student's works, to show the direction of future graphic science education.

1. INTRODUCTION

With the progress of computer graphics (hereafter referred to as CG), it is often the topic of debate how should CG technical skills should be introduced into graphic science education. Broadly speaking, some attempt to actively incorporate CG technology as a excellent simple way of high quality drawings expressing brightness and color, while others believe that the principle of graphic science education lies in understanding and mastering projection methods and it does not matter if the method of expression is by hand or CG (or it should be by hand, which is a more basic method of expression). We believe that apart from these disputes over hand vs CG, there exist valid reasons for actively incorporating CG in graphic science education. This stems from our strong belief of the need for graphic science education as design language education.

The Keio University Shonan Fujisawa Campus in Japan established in 1990 is known for its various innovative attempts. One such is its curriculum which organically merges liberal arts education and specialized subject education. As described in KEIO(1996), they particularly focuses on literacy education required for learning and emphasizes significance of the two education pillars of natural language (so called linguistics) and artificial language (information processing), and are producing considerable results. We are profoundly aware of the importance of these two educational pillars, but believe that in addition to these, design language education should be added as the third pillar. (See Figure 1.)

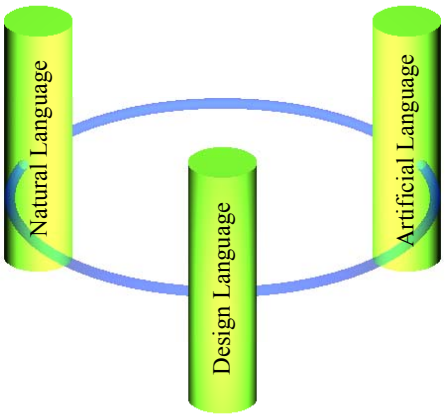

Figure 1. Three Pillars of Literacy Education

Table1. Schedule of Graphical Science II

	Content	Assignment
1st	Introduction	Impression for the submitted works by past students, and Comments and Suggestions for the Lecture
2nd	The Basis of POV-Ray	
3rd	The Description Method of Primitive Figures	Giving Small Assignment 1 (Scarecrow)
4th	Rotation, Magnification & Reduction, Translation and Repeat	Giving Small Assignment 2 (Stairs)
5th	Conditional Branch, Defined Colors, Block Pattern	
6th	CSG Model	Giving Small Assignment 3 (CSG)
7th	Behavior of Light Flow(Light Source, Reflection, Transmission)	
8th	Giving Final Assignment and Having questions regarding lectures until then	Giving Final Assignment
9th	Midterm Examination	
10th	Texture, Group, Prism, Solid of Revolution	
11st	The Others	
12nd	Review of the Final Assignment	
13rd	The Final Examination	

In the advanced information-oriented society we live in today, we are required the capacity to reorganize complicated information appropriately and express it in a clear manner. Essential for this is the skill to express clearly using appropriate drawings or pictures, in addition to information analysis skills. Presentation tools as represented by the application software "Microsoft Power Point" provide a lot of templates on drawings and various expressions and allows the user to choose from these, thus enabling expression above a particular quality regardless of the user's expression ability and drawing skills. However considering the ever-increasing progress of information processing, and future circumstances of our society shifting to a competitive one where choices are made based on the results of various presentations, there are limits to presentation tools based on selection from templates. The skills to draw appropriate figures as desired considering color scheme and tone, etc. will become significant. At the same time, without the ability to read information correctly from given expressions, objectives may not be read correctly in the flood of information available. We call the skills of communication through expression using such drawings and understanding them as design language, and believe that needs for this design language will become very high in the future.

So what are the classes which meet to such needs? We believe that graphic science should indeed answer to such needs, where graphic science is defined as the fundamentals of industrial drawing and spacious design with a curriculum centering around understanding and leaning projection methods, and is mostly taken up as a liberal arts class or public lecture historically.

Based on this idea, the Osaka City University provides graphic science class as a public lecture open to all departments, and promote use of CG in these classes. Though we are still in the process of completing it as a curriculum for realizing design language education, this paper attempts to report the curriculum based on this principle and analysis of works by students, to show the direction of graphic science education of the future.

2. DETAIL OF CURRICULUM

At Osaka City University, freshmen (some sophomores) are offered Graphic Science I class in the first term where students are taught to understand the projection methods and learn actual technique by hand. And they are also offered Graphic Science II in the latter to learn the fundamentals of CG and related information. Graphic science education by hand still remain because we believe understanding projection methods serve as the basis of design

language even in future advanced information society. In addition, the basic hand method is more suited for training for conceiving three-dimensional figures in minds. This paper discusses our Graphic Science II class. This subject is intended for students of the all departments as a public lecture. Lectures are held three times a week for about 160 students

2.1 Objectives of Graphic Science II Class

The aim of this subject lies in understanding CG technology and related information. From the perspective of design language education, we especially stress that knowledge and skill mastered in this class is helpful not only in the duration of the lectures but also after the course. In our lectures, we repeatedly explain possible application of CG in the future such as drawings in reports of other lectures, perspective and isometric drawings in design subjects, graduation papers, etc. Like linguistics and information processing education, we stress that it is something which will serve useful throughout a person's life, and we set continued use by the student a major goal in the lectures.

2.2 Details of Lecture and Assignments

Table 1 shows the lecture schedule of our Graphic Science II class. We hold eleven lectures and two tests in half a term. Assignments include three small assignments; “Scarecrow” for mastering the combination of primitive figure, “Stairs” targeting comprehension of repeat procedure, and “CSG” aiming at the understanding of the concept of Constructive Solid Geometry (CSG), and the “Final Assignment” for applying all that was learnt to tackle a high level task. Though the lectures do not differ greatly in content from general CG education, we particularly focus on several topics considering the perspective of design language education. The topics are “the behavior of light and its effects” (specular reflection and diffuse reflection, optical characteristics of general materials, types of lighting methods, adaptation brightness and psychological effects), “color and its effects” (color expression method and psychological effects), “visual point and visual field” (using analogy of camera lens), etc. Particularly for visual field, we also demonstrate, using examples, that a totally different impression can be given according to the visual point and visual field for the same three-dimensional figures.

2.3 The Application Used

We use the CG application POV-Ray(Persistence of Vision Ray Tracer). This application is continuously being developed by users all over the world based on the application software for ray tracing called DKBTrace which was developed by David K. Buck. The detail of POV-Ray can be seen at POV-Ray official web page. (See http://www.povray.org/.) We selected POV-Ray due to such reasons as; it is a freeware, it does not restrict the platform of computer, and is able to run on Microsoft, MacOS and Linux, it produces high quality CG images, it is easy to visualize numerically calculated results with flexible data interface, etc. All of these reasons take into account the aim of “continued use” described in 2.1.

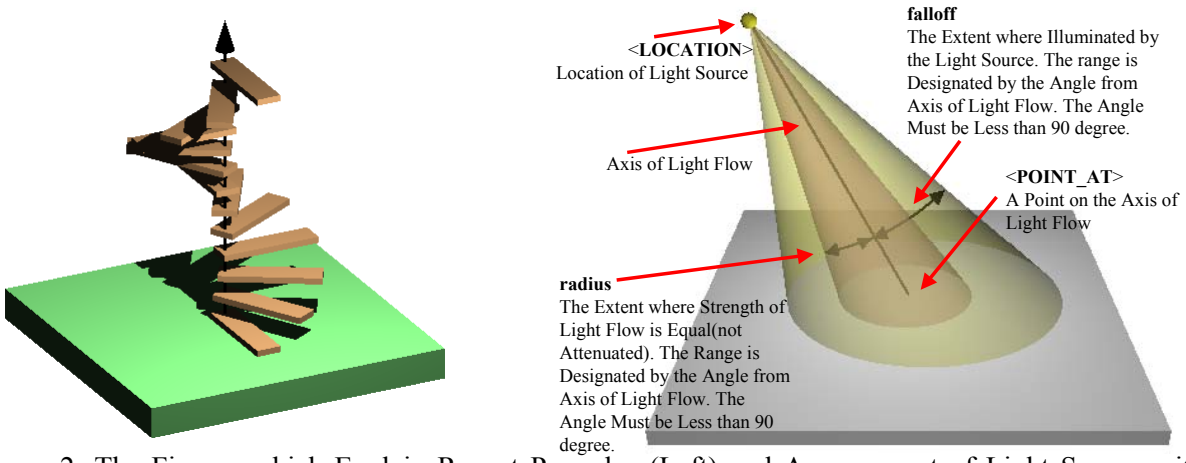

Figure 2: The Figures which Explain Repeat Procedure(Left) and Arrangement of Light Source with Directional Characteristics(Right) Described in the Textbook(SUZUKI(2001)) Used in the Lecture.

2.4 Details of Lecture and Assignments

Due to campus facilities, this class is held in a room which does not allow practice on computers. Only lectures are given in a normal classroom according to the contents of Table 1 using the textbook, SUZUKI(2001). Practice is done by the students themselves outside class hours by; (1)lending them the CD-ROM for them to install in their personal computers, (2)making use of distribution services of images of rendering results using WWW CGI function by entering scene files which are information describing the figures into Web form. Since this class is open to all faculties, the information processing skills of the students vary considerably, so we have made an attempt to avoid use of technical terms in the textbook as much as possible, and use graphical drawings instead for a more intuitive understanding. For these drawings (See Figure 2), we try to rouse the interest of the students and enhance their learning desire using POV-Ray as a practice use of design language.

2.5 Final Assignment

We only give the students “Unique Shape” as the main theme of final assignment and do not set down any other restrictions in particular. However, because some students have a hard time selecting their themes without a single clue, we give them the following seven categories;(1)Surrounding small objects, (2)Interior perspective drawings, (3)Landscape, (4)Two-dimensional architectural drawings, (5)Whatever you wish you had (imaginary objects), (6)Origami (folded papers) architectures and (7)Others. Since we have incorporated “Others”, the theme is free practically. However to make sure the students address their assignment enthusiastically, we ask them to take account of following 2 aspects as much as possible.

- *Ardent attachment for the theme*
- *Benefit for actual life given by the theme*

For both the small assignments and final assignment, we ask the students to send scene files describing figure information by e-mail. After checking scene file grammar, we render CG image with the file and open it through web page. (See http://zugaku.mae.osaka-cu.ac.jp/.) We allow resubmissions of the final assignment before the deadline. Many students often resubmit improved versions of their work two or three times after being enormously influenced by the work of others on the web.

Figure 3. Submitted Work-Cello

Figure 4. Submitted Work-A New Plan of Own Room

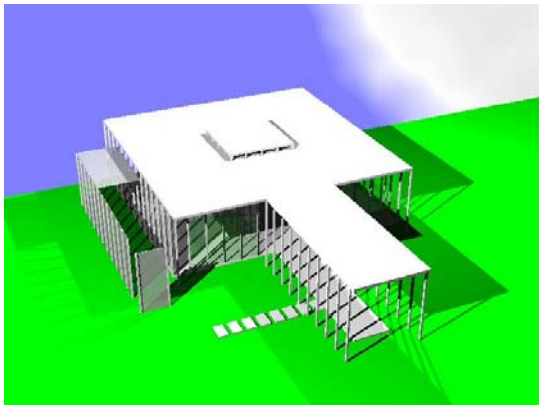

Figure 5. Submitted Work-Akashi Kaikyo Bridge, Kobe Figure 6. Submitted Work-A Study House

3. SUBMITTED WORKS

The students have about one month including their winter holidays to work on their final assignment. Though the quality of most works are very high, here we will just introduce four pieces due to limitation of paper space in Figures 3 to 6, to indicate the trends of submitted works.

Figure 3 shows a submitted work "Cello" by a freshman of Department of Architecture, Faculty of Engineering. According to above-mentioned categorization, this would belong to "Surrounding small objects" and "Ardent attachment". Like this example, many students select musical instruments as theme, such as electric guitar, mandolin, trumpet, piano, drums, etc. The shape of instruments are composed of complicated curves and surfaces, and CSG modeling takes considerable time and efforts to construct them. But this is compensated by the "affection" the students feel towards their theme and quality of works regarding instruments are therefore very high. This work is composed of basic figures only and described by a scene file consisting of about 450 lines including visual points and light source settings.

Figure 4 shows the work "A New Plan of Own Room" by a freshman of Department of Architecture, Faculty of Engineering. This work examine harmony of own room by arranging lightings and furniture selected from magazines. It is described by a scene file composed of about 600 lines. This work would belong under the category of "Interior perspective drawings" and "Benefit for actual life". Examples of indoor perspective often submitted

include the room of the students, kitchen, toilet, Japanese tatami mat room, inside of a famous architecture, etc. As the actual size can be used for these works, they are very real. In addition, as most parts are composed of straight lines and planes, modeling itself is quite easy. In the case of interior perspective drawings, as the position of the visual point is restricted, the more the visual field is broadened, the more will distortion of the perspective increase, resulting in something which is quite different from the actual impression. To prevent the distortion from increasing while keeping sufficient visual field, most work place considerable study on visual point position and visual field.

Figure 5 is a work "Akashi Kaikyo Bridge" by a freshman of Department of Architecture, Faculty of Engineering. It is described by a scene file consisting of about 400 lines. This work would belong under "Landscape" and "Ardent attachment". Bridges are often selected as a theme of landscapes. In particular, due to the location of the Osaka City University, the Akashi Kaikyo Bridge is often picked as a theme. In addition to the beautiful form of the bridge, the different expressions it carries between day and night are also very interesting, so students put in a lot of effort in studying the position of sunlight, and position and color of the light source used to light up the bridge.

Figure 6 is a "A Study House" by a freshman of Department of Environmental Design, Faculty of Human Life Science, which the student actually designed for another class. This would come under "Surrounding small objects" and "Benefit for actual life". This work is described by a scene file consisting of about 100 lines. Attempts to express works designed by themselves by CG are common among students who belong to the departments which offer design classes. CG enables students to study something which cannot be easily done using models, for example, understanding of changes in impression when materials of object change or comparison of sunlight conditions in summer and winter. Themes like these would be expected the largest contribution to education system in university.

4. SUMMARY

This paper discussed the need for design language education, introduced the "Graphical Science II" class given at the Osaka City University (open to all departments) as an example of design language education class, and introduced works submitted by students. Considering that no practice is done using computers in this class, the level of the final work submitted is considerably high. Though the students do not yet have a complete understanding of the need for design language, explanations based on the concept of design language serve for heightening the incentive of students at least. And since many of the students say that they would like to continue using POV-Ray in various ways, this shows that our goal of directing the course of design language has been achieved to a certain extent. We will continue these efforts and make further improvements, review our curriculum, and strive to establish it as a design language education.

5. REFERENCES

KEIO University, 1996, "*UNIVERSITY GUIDE BOOK KEIO*", Keio University

SUZUKI H. and MIKI N., 2001, "*The Textbook of Graphic Science* □□", Osaka City University.