

A CASE STUDY ABOUT IMPROVING THE CIVIL ENGINEERS' ABILITY OF AESTHETIC DESIGN

BY DESIGN COMPETITION FOR BRIDGES OVER CHEONGGYECHEON

ABSTRACT:

Engineers designing public facilities such as bridges must take into consideration Efficiency, Economy and Aesthetics. Nevertheless, many civil engineers are challenged to learn Aesthetics. The research group to which we belong decided to participate in bridge design competitions to practice improving ability of aesthetic design.

Our aims through these challenges are summarized below: 1) To master perspective drawing techniques as a tool to consider. 2) To get interested in various things on a regular basis and store ideas. 3) To gain experience in refining form by participating in competitions and working on practice exercises. 4) To improve presentation techniques so that viewers can imagine an attractive use of a bridge.

KEYWORDS:

Aesthetic Design, Civil Engineer, Design Competition

1. INTRODUCTION

It takes a long time for public facilities such as bridges to become a part of the local landscape. Therefore, civil engineers must pursue Aesthetics in addition to Efficiency and Economy. However, civil engineering departments in Japanese universities tend to place more importance on Efficiency and Economy than on Aesthetics in their educational curriculum [1]. In companies, a specialized landscape examination team designs for any facilities which will play an important role. In contrast, however, engineers without enough knowledge of landscape are forced to engage in designing through studying guidelines and manuals by themselves for other facilities

Currently, we belong to "The Subcommittee of 3E in bridge design of JSBEA, Japan Steel Bridge Engineering Association" [2] consisting of young practical engineers. Only 4 out of 22 group members have had practical experience in aesthetic design. As a result, we felt the need to study at both the theoretical and practical level.

To improve each member's ability of aesthetic design, we participated in the design competition for bridges over Cheonggyecheon sponsored by Seoul Metropolitan Government.

The present paper discusses important points for engineers to improve ability of aesthetic design as well as future issues which we have learned as a result of: creating entries for this competition, a questionnaire survey conducted with members, and our analysis of the outcome of this competition as well as two subsequently competitions.

2. OUTLINE OF THE IDEA COMPETITION FOR CHEONGGYECHEON BRIDGE COMPETITION

A part of the river was covered up with concrete for six kilometers and used as a road. Additionally, an elevated highway was built above this road. This place became the most heavily trafficked area in Seoul. Afterward, the Seoul Metropolitan Government planned a project to remove the elevated highway and restore the river. This river is called Cheonggyecheon (Figure 1). According to the theory of the configuration of the ground ("Pungsu" in Korean), Cheonggyecheon is the most important river in Seoul and everybody knows its name in Korea.

As a starting point of this project, an idea for a competition for twenty bridges that would connect roads on either side of the river was held. The aim was to attract the interest of citizens as well as

seek ideas. The application period was from December, 2002- January 2003.

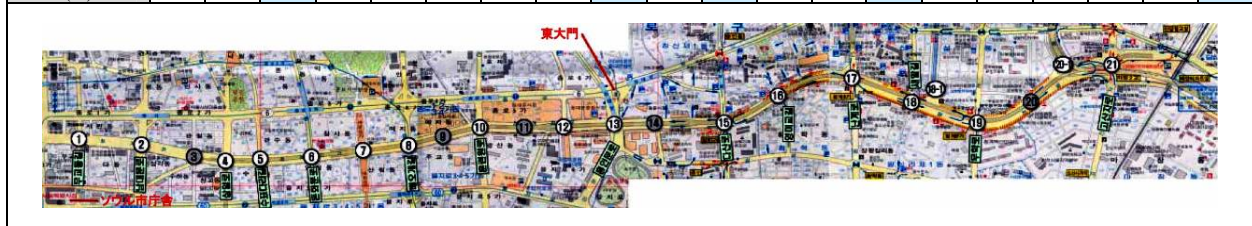


Figure 1: Plan for restoring Cheonggyecheon [3]

The twenty bridges were required to be designed as a symbol in the area with artistic and architectural beauty so that they could be well incorporated into the surrounding area. The locations of the 1st-6th upstream bridges were in a historical town. The 7th-13th bridges were in a commercial town and the 14th-20th bridges were in a new residential town. As for the bridge dimensions, the width was set to six meters for pedestrians for five bridges and the roadway width was set to 16-40 meters for 15 bridges for vehicles. The length was set to about 30 meters for 16 upstream bridges. These were smaller in scale than four downstream bridges. The lengths were either 60 meters or 70 meters (Table 1).

Table 1: Bridge dimensions

Area	1: Historical town						2: Commercial town						3: New residential town							
Bridge No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Type*	C	C	P	C	C	C	C	C	P	C	P	C	C	P	C	C	C	C	C	P
Roadway width (m)	22	38	6	38	16	18	32	26	6	29	6	20	38	6	36	16	29	20	29	6
Bridge length (m)	26	28	26	30	26	26	25	28	28	28	28	26	26	30	30	36	60	70	60	60



* C: Pedestrian/Car Bridge, P: Pedestrian Bridge

The entry's layout was set to an A2-size single panel (Figure 2) including a design viewpoint, a color perspective at a bird's eye view and a side view, and a free design (such as a drawing and a night scene). Entries for 1st-20th bridges were respectively judged. Awards were given as follows:

The First Prize: 20 Bridges, The Second Prize: 20 Bridges, The Third Prize: 2x20 Bridges



Figure2: Entry's layout

3. DISCUSSION OF THE STEPS FOR THE CREATION PROCESS OF OUR ENTRIE

This section discusses important points to improve the ability of aesthetic design along each step of the creating process of our entries. We followed the conventional process of creating aesthetic designs [4]. In other words, the first step is to think of creative ideas. Then, make form. Next, refine form. Finally, consider presentation.

STEP 1: THINKING OF CREATIVE IDEAS

This is a step for creating ideas about what kind of bridge would be ideal for the site. Each of our members created at least one design. Figure2 shows the designs contributed in the beginning.

Since almost all the members had no experience in creating an entry for competitions, they drew one ordinary-looking bridge. In addition, they had a tendency to use a drawing to express the idea. On the other hand, those who had experienced competitions had a number of novel ideas and used a perspective drawing technique or three-dimensional (3D) computer graphics to express the idea.

This competition sought out bridges which could be regional icons that have artistic and architectural beauty. Unfortunately, many of the designs created by our inexperienced members were not suitable for this competition. Thus, the designs were reviewed following our experienced members' advice.

Table2 Designs contributed in the beginning

1: Historical town				
2: Commercial town				
3: New residential town				

Important points to improve ability of aesthetic design at this step are summarized below:

(1) To master a perspective drawing technique

In order to create the ideas of novel structures and groundbreaking bridge space, it is necessary to draw many perspective drawings and see the image in three dimensions. Therefore, it is important to master a perspective drawing technique as a tool to consider.

(2) To store ideas on a regular basis

It was difficult for us to create ideas about novel structures and groundbreaking bridge space and maintaining structural rationality. It is important to get interested in various things on a regular basis and store ideas.

STEP 2: MAKING FORM

This is a step to describe ideas in drawings. We understood that this competition aimed to seek ideas. Nevertheless, we decided the bridge proportion and dimensions of elements, thus, trying to make our design feasible from the engineer's point of view (Figure 3).

This step took considerable time since the ideas of the structural form were different from those in our usual work.

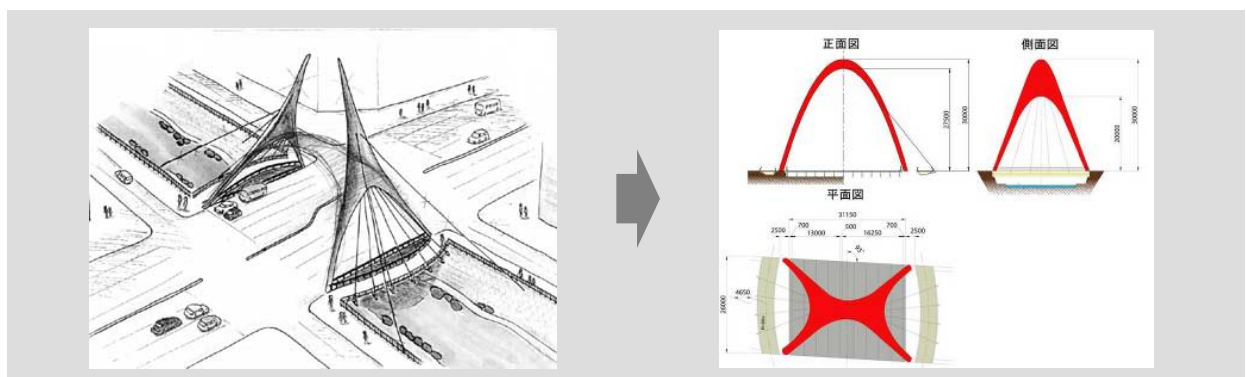


Figure3 Examination of bridge proportion

In order to make our design feasible, important points at this had to be considered, such as, getting interested in information regarding new technology and storing knowledge on a regular basis.

STEP 3: REFINING FORM

Refining form is a step to imagine the form in three dimensions and elaborate the details of the bridge proportion. Ideally, all the members should refine form from their own design. This time, however, only experienced members participated in this process because of time limitation. As they were used to this process, many good ideas were obtained.

In this step, members could quickly understand differences in the forms by comparing the idea of before and after. Therefore, it can be said that ability of aesthetic design will be improved as we gain experience. Table 3 shows completed perspective drawings.

Important points at this step are shown below:

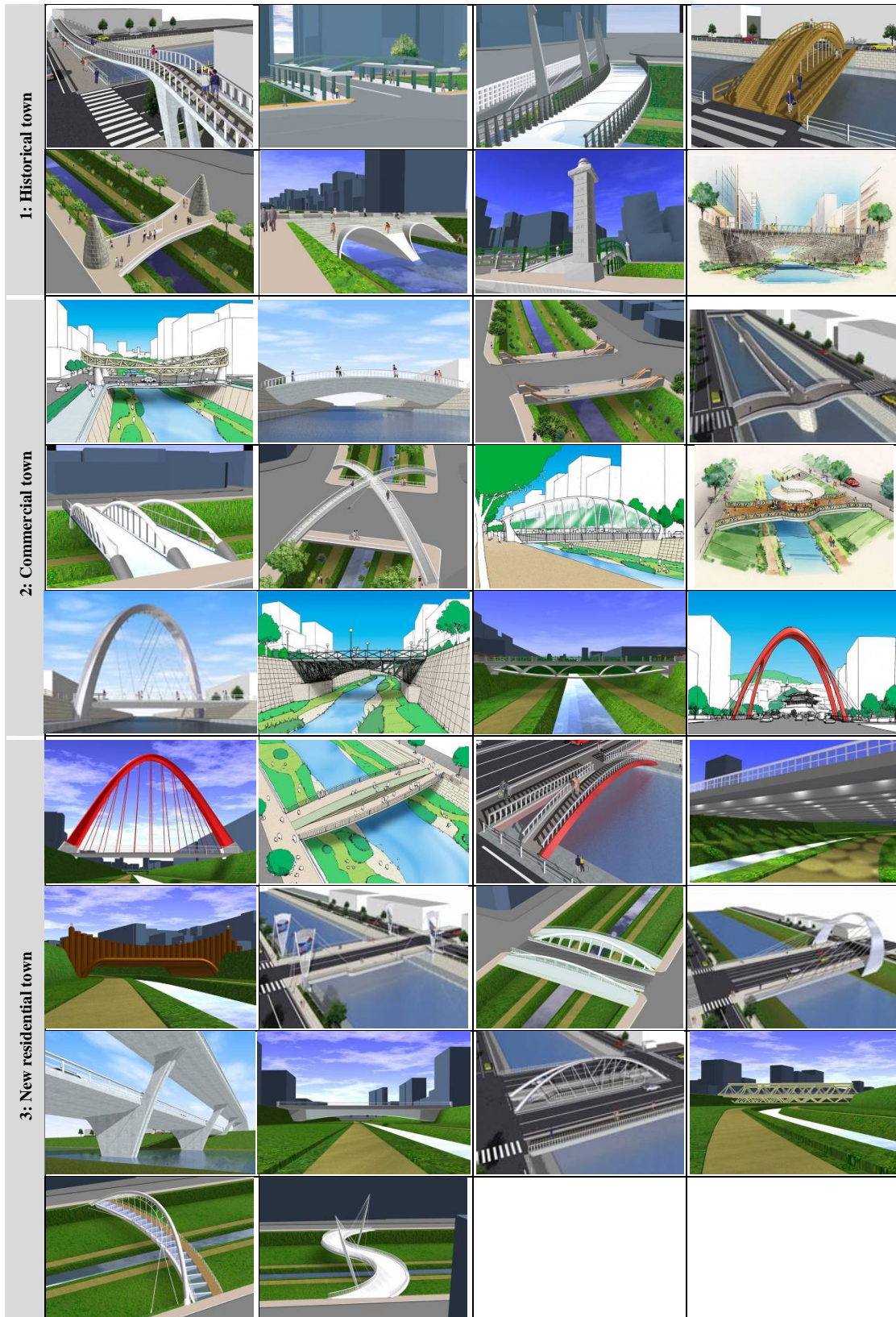
(1) To master techniques for perspective drawings or 3D computer graphics

In order to imagine the form in three dimensions, each engineer must master the technique of perspective drawings or 3D computer graphics.

(2) To gain experience

It is important to gain experience in refining form. However, it is difficult for engineers who usually engage in structure design to do this kind of work continuously. Therefore, they are required to participate in competitions or work on practice exercises in order to get such an opportunity.

Table3 Completed perspective drawings [5]



STEP 4: CONSIDERING PRESENTATION

Considering presentation is a step to create images and panels for submission. As for the application method, the layout guideline was provided. In order to attract the judges' attention towards characteristics of our bridges, we thought consideration for the angle of the perspective drawing and the content of a free design which would indicate its characteristics are important (Figure 5). Unfortunately, we couldn't get enough interest for our designs because of the time limitations and lack of experience.

Important points at this step will be shown in section 5 titled "Discussion of our prize-winning works".

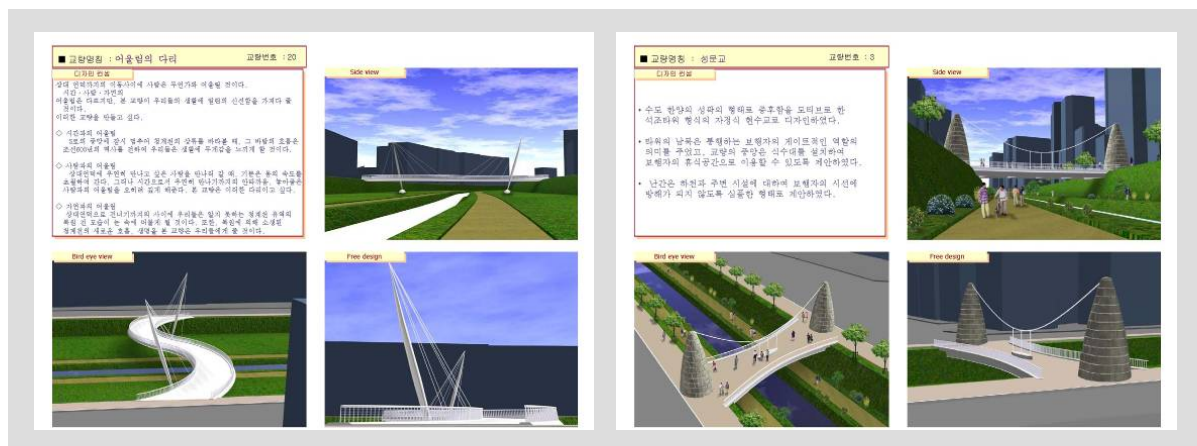


Figure5 Panels for submission [5]

4. DISCUSSION OF THE QUESTIONNAIRE SURVEY CONDUCTED WITH OUR MEMBERS

A questionnaire survey was conducted, by asking each member to choose the best five bridge designs among our submitted works and write down reasons for the selection (22 respondents).

The highly-vaunted works were 14th bridge (9 votes), 13th bridge (8 votes), 4th, 12th, 20th bridges (7 votes), and 1st, 7th, 9th bridges (5 votes) (Table 4).

Keywords used to state their reasons for the selection were extracted from the results. The best five keywords used for the highly-vaunted works are shown below in order.

1st place Novel form to become an icon





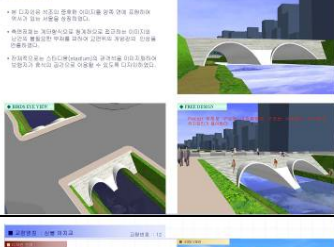



2nd place Structural rationality

3rd place Innovative use of space

4th place Harmony with the surrounding areas

5th place Decorative effect

Table4: Results of the questionnaire survey

	Work	Number of Reason*					Work	Number of Reason*					
		A	B	C	D	E		A	B	C	D	E	
14th bridge (9 votes)		0	7	1	1	1	20th bridge (7 votes)		6	1	0	0	0
13th bridge (8 votes)		5	0	0	3	0	1st bridge (5 votes)		1	1	2	1	0
4th bridge (7 votes)		0	2	4	1	0	7th bridge (1 votes)		4	0	0	0	1
12th bridge (7 votes)		5	2	0	0	0	9th bridge (5 votes)		4	0	2	0	0
Total of Number of Reason								25	13	9	6	2	

* Number of Reason; A: Novel form to become an icon, B: Structural rationality, C: Innovative use of space, D: Harmony with the surrounding areas, E: Decorative effect

Novel form to become an icon and structural rationality were highly placed.

As suggested in Step 1 "Thinking of creative ideas", it is necessary to store ideas on a regular

basis in order to come up with a design equipped with novel structures and groundbreaking bridge space as well as structural rationality. These criteria were confirmed as a common perception among the members. This questionnaire survey also enabled us to understand both strong and weak points of each member's work through evaluation of others' works.

An important point in this section is to see future issues by evaluating others' works.

5. DISCUSSION OF OUR PRIZE-WINNING WORKS

The judges for this competition consisted of 11 academic experts, including a professor at Seoul National University, fluent in: design and aesthetics, history and culture, structure and construction. The number of entries reported was 455. The first prize was given to four bridges, all of which were pedestrian bridges. The second prize was given to 13 bridges. The third prize was given to two entries per each bridge. Thus, the total number of entries which won the prizes was 57. Among these, we won six prizes (table5, 6).

Focusing on the features of the prize-winning works, it could be noticed that modern and light forms such as suspended structure and truss structure tended to win the prizes, even though some of these works would be questioned about the structural rationality.

The reason that 22 of 30 first and second prizes expected to be given to road bridges were not actually given to any work would be that many designs failed to grasp structural aesthetics because of the road bridges' broad width compared to the bridge length. The works which won the prize of road bridge designs included ones innovatively designed with side forms of girder, handrails, or floor plates. As for our design of the 13th bridge that won the second prize, its huge arch structure and gate-like monumental design which bears close resemblance to "Dongdaemun" were considered to be highly evaluated. Likewise, our works of the 12th bridge, with a highly monumental design and the 1st bridge, with an innovative use of bridge space, won the third prizes. These works were also highly evaluated in our questionnaire survey and it can be said that our evaluation criteria were similar to those of the judges.

Table5: Prize-winning works (First Prize and Second Prize) [5]



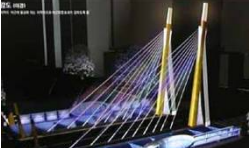





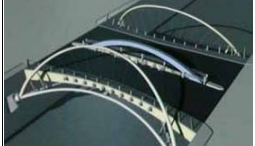

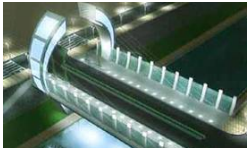













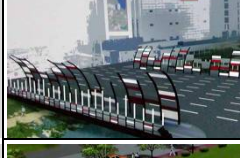

















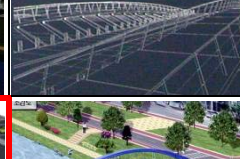







	First Prize	Second Prize		First Prize	Second Prize
1st bridge	Nothing		11th	Nothing	
2nd	Nothing	Nothing	12th	Nothing	
3rd			13th	Nothing	
4th	Nothing	Nothing	14th		
5th	Nothing		15th	Nothing	Nothing
6th	Nothing		16th	Nothing	
7th	Nothing	Nothing	17th	Nothing	
8th	Nothing		18th	Nothing	Nothing
9th			19th	Nothing	Nothing
10th	Nothing	Nothing	20th		

Table6: Prize-winning works (Third Prize) [6]

	Third Prize		Third Prize	
1st bridge			11th	 
2nd			12th	 
3rd			13th	 
4th			14th	 
5th			15th	 
6th			16th	 
7th			17th	 
8th			18th	 
9th			19th	 
10th			20th	 

On the other hand, our designs of the 17th, 16th, and 19th bridges also won the third prizes despite the low evaluation in our questionnaire survey. It is assumed that, although these designs did not fully satisfy the requirement of the structural rationality, their monumental designs, innovative use of bridge space as well as sophisticated designs would deserve such high appraisals. The high quality of the overall perfection is more important than anything else.

Panels of the prize-winning works had a technique to attract a lot of attention of their features. Presentations with modern, light, and monumental forms, attractively decorated facilities on bridges, and an effectively use of illumination tended to win prizes (Figure 6).

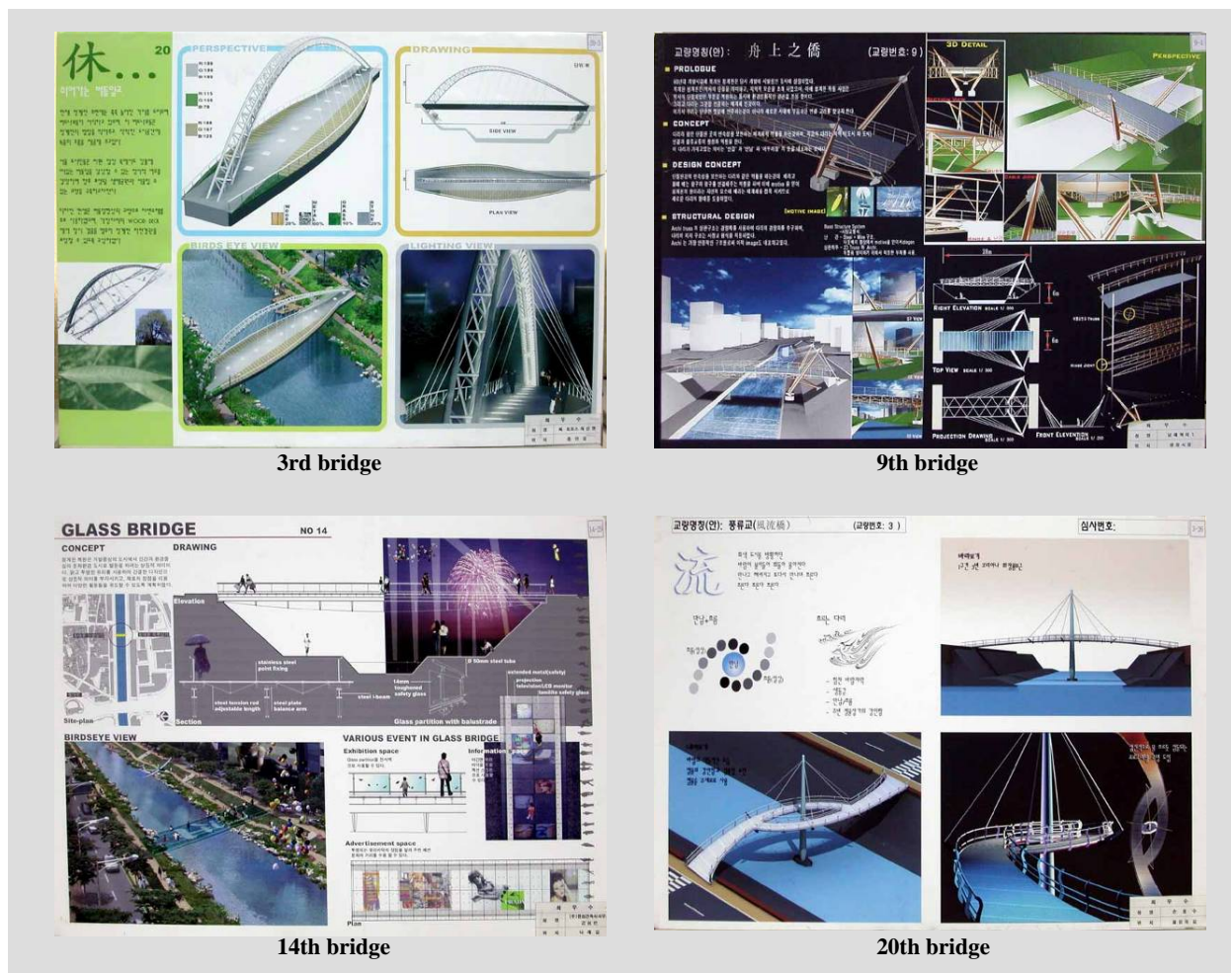


Figure 6: Panels of the prize-winning works [5]

Important points in this section are to come up with a presentation method which enables viewers to imagine an attractive use of the bridge and to design details of the bridge such as a handrail or a pavement.

6. RESULTS OF TWO SUBSEQUENTLY COMPETITIONS

We participated in two competitions after the Cheonggyecheon bridge design competition as part of our continuing group activities.

We submitted two entries to the Ebisu Bridge design competition by Osaka city⁶⁾. Among 217 total entries, three works were selected after the initial screening where our entries were rejected. In comparing these three selected works with our works, our ideas were quite similar to them. We confirmed that we had moved toward the right direction of thinking creative ideas (Figure 7).



Figure 7: Ebisu Bridge design competition Submitted works and Prize-winning works

We also submitted four entries to the Clifton Crossing Competition 2006 by Bristol University and NCE, New Civil Engineer, the English journal⁷⁾. Among 118 entries in total, our work won the third prize (Figure 8).

Consequently, this experience has proved invaluable in gaining experience and links directly to improvement of ability of aesthetic design.



Figure 8: Clifton Crossing Competition 2006 Submitted works

7. CONCLUSIONS

Through our participation in these competitions, we have gained an entirely new viewpoint and learnt future issues that we missed in daily design work. There are a variety of options to choose in a process of putting together ambiguous images into one form. Our job is to seek the most appropriate option by using a perspective drawing technique or 3D computer graphics. This very process is design. Through this process, our design ability has improved. To sum up, important points at each step required to improve ability of aesthetic design are shown below.

Step 1: Thinking of creative ideas

To master a perspective drawing technique as a tool to consider

To get interested in various things on a regular basis and store ideas

Step 2: Making form

To get interested in new technology information and store knowledge on a regular basis to make feasible designs

Step 3: Refining form

To master technique of perspective drawings or 3D computer graphics in order to imagine the form in three dimensions

To gain experience in refining form by participating in competitions and working on practice exercises

Step 4: Presentation

To improve presentation techniques to help viewers imagine an attractive use of the bridge

In order to improve ability of aesthetic design, it is important to gain experience. However, it is difficult to find such an opportunity in Japan. The future issues are summarized below.

To increase opportunities to participate in competitions in Japan.

To offer more practical classes in university level.

REFERENCES:

[1] Among ten universities with civil engineering departments in the Tokyo metropolitan area, only three universities offer practical classes of aesthetic design.

[2] Among 22 members, eleven members are engineers who work for the civil engineering consultants and the other eleven are engineers who work for the steel bridge manufacturers.

[3] <http://japanese.metro.seoul.kr/chungaehome/seoul/main.htm>

[4] Y. NAGAMI, "A study for the bridge aesthetic design by idea competition participation", Japan Society of Civil Engineers 2003 Annual Meeting abstract collection, IV-313, 2003

[5] The Subcommittee of 3E in bridge design of JSBEA, Japan Steel Bridge Engineering Association, Design competition for bridges over Cheonggyecheon Work collection, 2003.2

[6] <http://www.city.osaka.jp/kensetsu/newarv/press/2001/20030801.htm>

[7] <http://research.cen.bris.ac.uk/cc06>