2006-10: INTERNATIONAL COLLABORATION IN ENGINEERING DESIGN BETWEEN STUDENTS FROM JAPAN, SINGAPORE, AND UNITED STATES

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International Collaborative Project in Engineering Design Education
Between Japan, Singapore, and United States

Abstract
This paper reports positive learning outcomes from an international collaborative project in Engineering Design Education between Kanazawa Institute of Technology (KIT) in Japan, Singapore Polytechnic (SP) in Singapore, and Rose-Hulman Institute of Technology (RHIT) in the United States.

Two visiting academic staff from SP came to KIT from November 2002 to February 2003 to study the Engineering Design II course. As a result, SP implemented a new module called “Innovation, Design & Enterprise in Action (IDEA)” in July 2004. The first stage of an international collaborative project started between KIT and SP. A main theme of “Rooftop Gardens” was selected for this first collaborative project between the two institutions.

RHIT joined the collaborative project in 2004, and the second stage of the international collaborative project started between KIT, SP, and RHIT. Student teams at the three institutions worked on the same engineering design project, the main theme of which was “Bus Transportation/Urban Transportation System in the 21st Century”. Student teams chose their own project themes from specific design areas, which were related to the main theme. Their achievements were unique in their design solutions due to the differences in society and culture in Japan, Singapore and the United States, although all the design teams followed the same engineering design procedures. This collaborative project was a positive experience for both students and faculty members. Furthermore, students’ groups of the three institutions benefited from a study of the design solutions generated by their foreign counterparts.

In this paper the second stage of the international collaborative project between the three institutions is discussed in detail.

1. Introduction
Working on global collaborative projects will challenge students’ perceptions, enrich their minds and sharpen their communication skills. It helps to steer them towards divergent thinking in the knowledge-based economy as it equips them with multi-disciplinary skills and gives them the opportunity to work together with students from other countries.
This paper highlights the achievements gained from an international collaborative project in engineering design undertaken by students from the Kanazawa Institute of Technology (KIT) in Japan, Singapore Polytechnic (SP) in Singapore and Rose-Hulman Institute of Technology (RHIT) in the United States.

The first stage of the international collaborative project started between KIT and SP in 2003. A main theme of “Rooftop Gardens” was selected as the first collaborative project between the two institutions [1].

In 2004 RHIT joined the international collaborative project and the second stage of the project has started. “Bus Transportation/Urban Transportation Systems in the 21st Century” was selected as the main theme of the collaborative design project, because bus transportation system may be regarded as one of the primary urban transportation systems. Varieties of urban transportation system are deployed based upon the circumstances and needs of each local community.

Fifteen teams from KIT, one team from SP and four teams from RHIT worked on this project under the defined main theme. Student teams selected their project themes related to the main theme. The objectives were to design facilities, services and systems related to bus transportation/urban transportation which would provide safe, comfortable, convenient, and efficient transportation systems for passengers. Progress reports and final achievements were exchanged among the three institutions. Students benefited from seeing how other teams used different approaches to the design process.

While working on the international joint project, students also found that they need more training in soft skills such as cooperation, communication, and teamwork to achieve a more effective collaboration. In addition, they not only need to acquaint themselves with foreign languages, but also to explore overseas business opportunities and appreciate the cultural sensitivities in a foreign environment. This collaborative project provided a positive experience for students and also benefited the faculty members. Educational visits by faculty from the three institutions have led to valuable exchanges of engineering design viewpoints.

2. How the International Collaborative Project started
2.1 Engineering Design Education at KIT
EDE started in 1996 with the assistance of American professors from RHIT, a sister school of KIT, and other US institutions. These professors worked with Japanese
professors to develop two courses, Engineering Design I (ED I) and Engineering Design II (ED II). ED I is offered to approximately one thousand, seven hundred freshmen and ED II to approximately one thousand, seven hundred sophomores. Each course is taught once a week for two sixty minute periods. The terms last for ten weeks.

ED courses are characterized by project-based learning in groups. The goals of ED I and ED II are to have students gain actual engineering design experience through working on real-life projects, and to present their results in written and oral reports. Also, this is their first experience at working in groups. The students are given open-ended problems. In the process, they are expected to learn teamwork skills such as communication skills and leadership. Students choose engineering topics related to their daily life, identify projects, characterize design projects, generate design concepts, evaluate design concepts, select the most promising concept, and design in detail. Students are encouraged to develop distinct and creative design solutions.

The procedures covered in ED I and ED II are:

- To identify project/design opportunities
- To characterize design projects
- To generate design concepts
- To evaluate design concepts and to select the best concept
- To design in detail
- To present results

Design teams of ED I studied the bus transportation/urban transportation project and completed their design activities. Their achievements were summarized in the Project Summary Reports and delivered to Design teams of ED II, who then worked on the international collaborative design project.

2.2 International Collaborative Project among KIT, SP and RHIT
(1) Collaborative Project in the First Stage [2]
Two visiting academic staff from SP came to KIT under the staff exchange program from November 2002 to February 2003 to observe the Engineering Design II course. SP has implemented a new module called “Innovation, Design & Enterprise in Action (IDEA)” [3]. Since then, an international collaboration project in ED Education has started between KIT and SP. The collaboration project includes the following activities;

- KIT and SP continue the Faculty Exchange Program.
- KIT and SP continue to exchange information on ED education.
• Student teams of both institutions participated in common design themes of ED courses by using IT technologies, e.g. e-mails, websites and video conferences.
• Academic staff of both institutions jointly publish conference papers on ED education at prestigious international conferences.

In 2003, a main theme of “Rooftop Gardens” was selected as the first collaborative project between the two institutions. Japan and Singapore are countries whose populations are overflowing their geographical limits. People of both countries are very much concerned about improving their green environment and preventing the urban heat island effect. Therefore students of KIT and SP selected their own project design themes related to rooftop gardens to provide a relaxing and soothing environment to cater to Japanese and Singaporeans lifestyles. Eight teams at KIT and one team at SP worked on the same project. Nine teams independently worked on different gardens focusing on their themes of interest. Their progress reports and final achievements were exchanged.

Their achievements were unique in their design solutions due to the differences in climate and culture in Japan and Singapore, although all the design teams followed the same engineering design procedure. This collaborative project was a positive experience for both students and faculty members. Furthermore, both groups benefited from a study of the design solutions generated by their foreign counterpart.

(2) Collaborative Project in the Second Stage
In 2004, RHIT, joined the collaborative project, and an international joint project in Engineering Design Education was started between students in Japan, Singapore, and the United States. This international design project is called “The International Collaboration Design Project in Asia-Pacific Regions”. A main theme, “Bus Transportation/Urban Transportation Systems in the 21st Century” was selected for the first collaborative project among the three institutions.

3. Design Activities in the International Collaborative Project
3.1 Main Theme and Project Themes

The main theme, “Bus Transportation/Urban Transportation Systems in the 21st Century”, was selected for the first collaborative project among the three institutions, because bus transportation system may be regarded as one of the primary urban transportation system. Urban transportation system has been and will be utilized by
local residents. Varieties of urban transportation systems are studied based upon the circumstances and needs of each local community. Therefore, the main theme is best fitted for the international collaborative project.

The project themes of the design teams of the three institutions, who worked on the International Collaborative Project, are shown in Table 1.

3.2 Students of the three Institutions
(1) Students of Kanazawa Institute of Technology
Approximately 1,700 sophomore students of KIT enrolled in the ED II course. They were distributed across 50 classes of approximately 34 students per class, according to their course of study. The typical KIT sophomore student is 20 years of age. He/she has never held a technical or industrial position, and has little to no experience in design. Each class is divided into 5 to 7 teams and each team is composed of 5 to 6 students. The classes meet during two subsequent 60-minutes lectures on weekly basis for 10 weeks. Additional weekly office-hour meetings are assigned to the student groups for discussion of the team projects and class assignments, and to better monitor the teams’ progress and accomplishments.

Fifteen teams selected the international collaborative project, the main theme of which was “Bus Transportation Systems in the 21st Century”. The divisions of the students were Mechanical Engineering, Architecture, and Information & Computer Science. The teams independently worked on different bus transportation/urban transportation systems, focusing on their themes of interests.

A poster session was held at the end of the winter term. Award-winning posters were selected by judging the design solutions for distinctiveness and creativity. Posters produced by design teams of SP and RHIT were also exhibited together with those produced by KIT teams at the poster session.

(2) Students of Singapore Polytechnic
Students of Singapore Polytechnic are generally between 17 to 19 years old. They have completed the Ordinary Level of General Cambridge Examination in the secondary schools and met the entry requirements before enrolling into the polytechnic education. All the third year students in SP have to take up final year students’ projects in their respective three-year Diploma course. The aims of the final year students’ projects are to provide students an opportunity to apply theoretical and practical knowledge that
they have acquired in their courses to the projects.

Each group usually consists of not more than three students who have to meet fortnightly and discuss their project with the Project Supervisor. Although the time for meetings with the Project Supervisor and the time allocated for practical work are written into the student timetable, students are free to work outside these allocated time slots. Students are expected to spend an average of three hours per week on their project. Project work is not "structured". Every project is unique and every problem may have more than one possible solution.

Students of the final year project are given 30 weeks to complete a project which will be credited as one module in their curriculum. The project theme was “Design of Small and Light Civil Engineering Structures, and the subtitle was “Bus Stops composed of Pedestrian Overhead Bridges and Bollards”.

(3) Students of Rose-Hulman Institute of Technology
The Rose-Hulman students ranged in age from 18 to 22 years. The students on this project ranged from first year to graduate level. Their disciplines included mechanical, electrical, civil, and computer engineering. There was also one humanity student. Therefore, there were many differences in their backgrounds. Some students had participated in an ABET approved design program in their major, while others were just getting started in the design sequence. Unlike students at KIT and SP, RHIT students were taking this project course as an elective.

3.3 Information Exchange and Instructors’ Visits to Other Institutions
Instructors of the three institutions discussed course structure through e-mails, and decided the following items before the term;

- Defining a goal for the project,
- Deciding the international project theme,
- Establishing a procedure of the project,
- Arranging the time schedule, etc

Progress reports and final achievements were exchanged among the three institutions and were exhibited in each class. Posters produced by RHIT students and by SP students were exhibited at the poster session at KIT.

In addition to exchanging students’ achievements, instructors visited the other
institutions, and talked with students and instructors there. Visiting instructors gave 
comments and advice about students’ activities and achievements. An instructor of 
RHIT visited KIT twice; at the beginning of the term in November 2004 and at the end 
of the term in February 2005, when the poster session was held. At the beginning of the 
term, he lectured to KIT students on the importance and significance of the International 
Collaborative Project, and on students’ life in US colleges in order to encourage and 
motivate KIT students. At the end of the term, KIT students presented their achievement 
to the US instructor in English at the poster session. Rose-Hulman Awards were granted 
to design teams whose design solutions were unique and excellent, and posters were 
aesthetic and persuasive.

Two instructors of KIT visited RHIT in May 2005, and met with an instructor and 
students on the International Collaborative Project. Major suggestions from RHIT 
students were as follows:

(a) Information on Japanese bus transportation system was insufficient to tackle 
    properly the project theme, Improving Japanese Bus Stop.
(b) It was not easy for US students to judge if the developed design solutions could 
    serve effectively as safe, comfortable and convenient bus stops.
(c) It would be better if Japanese students joined US design teams.

4. Students’ Achievements
(1) Achievements of KIT Students
As a typical example of design activities at KIT, the achievements of one design team 
are presented below.

Students of the design team selected a project theme, “Designing a system where 
passengers don’t have to wait for a bus”. The project was broken into the following five 
sub-problems.

(a) To determine when the bus, which a passenger wants to take, will arrive at the bus 
    stop.
(b) To determine how long it will take for the bus to arrive at the destination where a 
    passenger wants to travel.
(c) To clear up traffic congestion so that buses can be operated on schedule.
(d) To determine how long it takes for a passenger to walk to the bus stop.
(e) To determine a method to transmit information of bus operations.
Next they generated design concepts for each of the sub-problems followed by combining them to produce potential project solutions. After evaluating each project solution by taking into consideration the design specifications, which were determined by customer needs, the most promising design solution was selected.

The system configuration of the final design solution is composed of GPS satellites, a server of the bus operating system, buses with GPS and passengers carrying mobile phones with GPS as shown in Figure 1(a). The flow chart of the system is shown in Figure 1(b). The arrival time is determined by the distance of the bus approaching to the bus stop in accordance with its speed. The time taken for a passenger to reach the bus stop is determined by the walking distance and the walking speed. The proposed design solution enables a passenger to board a bus just in time without waiting more than five minutes at the bus stop. The procedures for a passenger to board a bus on time is as follows:

A passenger accesses to a server of the bus operating system and obtains necessary information, such as
(a) Where the nearest bus stop is located;
(b) How long it takes to get there;
(c) When the next bus arrives at the bus stop;
(d) Travel time to final destination.

Figure 2 shows a poster with their design solution.

Since English is a second language in Japan, KIT students found that it was not easy to communicate with foreign instructors and students of the international collaborative project. A response from one KIT student was “It was very instructive to be able to get a lecture from an instructor of RHIT, although it was not easy for me to catch his English. I tried to present our achievements during the poster session in English, but I could not do well. I will brush up my English so that I will be able to communicate with foreign counterparts and present my paper in English in future.”

(2) Achievements of SP Students
Activities and achievements of the design team of SP are presented below.
The purposes of the design team of SP were to examine the capability of the current transport infrastructure in Singapore to satisfy the increasing needs of the consumer and to propose new innovative designs to help satisfy these needs.
Close to 60% of the population in Singapore uses the public bus for transport. Bus stops, with bollards and Pedestrian Overhead Bridges (POB), thus become vital facilities for this group of people. The design of these facilities were however outdated. Not only are they old and rundown, they have also failed to catch up with the changing needs of commuters. The existing bus stops and POBs are not designed to cater to the aged with walking difficulties or the handicapped. Using the public transport, especially buses, were a great challenge to them.

The Urban Redevelopment Authority of Singapore (URA) has also announced that Singapore is capable of holding up to twice the number of current population. This means more housing, commercial, and industrial sites are to be created. With the creation of these, the need to provide more modern public transportation will arise.

Based on the information obtained from survey and research, the following Design Specification was derived:

1) The overall design of bus stop should be handicap-friendly with all necessary features.
2) The safety of commuters should not be compromised at bus stop.
3) Commuters should have a clear view of arriving buses at bus stop.
4) POB should be handicap-friendly with all the necessary features.
5) Bollards should be aesthetically pleasing and be able to act as a warning sign.

The design team generated many design concepts, evaluated them, and selected the most promising one by using the Decision Matrix method shown in Table 2. They determined the general configuration and major sub-systems, making sure that the needed functions are provided, and selected the most appealing appearance.

The features of the integrated bus stop with bollards and Pedestrian Overhead Bridges are described next.

(A) Bus Stop (Figure 3a)
The proposed bus stop design is different from the conventional bus stop in Singapore. Instead of relying entirely on columns for the main support, suspended cables are used. The roof of the bus shelter is partially supported by columns while suspended cables are used to hold the roof in place. An extension shelter will prevent commuters from getting wet when boarding or leaving the buses. The extension shelter has a maximum height that will allow double decked buses to pass under it. Although the design of the seats is
simple, they are positioned to ensure a clear view of incoming buses. The seats are located at the front of the bus shelter to prevent standing commuters from blocking the view of those seated. The back row seats are elevated higher than the front row seats. The seats are also tilted 45 degrees to the direction of incoming traffic to give a more relaxed posture when waiting for a bus. The roof is tilted to allow for natural drainage, eliminating the need for gutters.

The arc of the roof will also prevent standing commuters from blocking the line of sight of the sitting commuters. An opening in the roof will allow planting of trees in the bus shelter. This also helps reduce the temperature in the shelter. A groove fabricated around the opening will prevent rainwater from flowing into the shelter. Although rainwater can fall through the opening, most will be blocked by the leaves on the trees. The trees should not have deep roots to avoid damaging the foundation. Palm trees are preferred over rain trees. The bus stop is designed to meet the space required by wheelchair users. It is also equipped with tactile and ramps to assist the visually impaired. Tactile enables the visually impaired person to navigate their way from other public facilities to the bus stop. Special seats and spaces are allocated for the physically disabled as well as the elderly. Solar panels are placed on the roof to furnish electricity. Although the initial cost is high, it will be cost effective in the long term. The bus stop should be energy self-sufficient.

(B) Bollard (Figure 3b)
The bollard is designed to look like a pencil. The yellow and black colors will attract the attention of motorists. The top of each bollard is equipped with LED lights to warn motorists.

(C) Pedestrian Overhead Bridge (Figures 3c and 3d)
Passenger lifts were added to the bridges for the physically handicapped and the elderly. The stairs surround the lift core and hence save space. The stair design provides rest platforms and helps with safety concerns.

Shelters are added on top of the openings to provide protection from rain and sun. The additional shelters also increase the aesthetic appeal of the design.

(3) Achievements of RHIT Students
The RHIT design teams’ activities and achievements are shown in Figure 4. “Designing
safe bus stops for Japan” was the design theme. They designed four bus stops as shown below.

(a) Small Bus Stop
This is the smallest stop in a group of four. This stop is designed to be installed directly into any sidewalk and not be in the way when not in use. The design consists of several columns that come up out of the sidewalk and then sprout small arms that create an enclosure where passengers can wait. It is accessible by wheelchairs and also keeps waiting passengers safe from being hit by people, and bicycles, using the sidewalk.

(b) Slightly Bigger Bus Stop
This is the second smallest stop in the group of four. This stop is designed to offer comfort as well as a small amount of protection to some of the smaller stops that already exist. This stop consists of a slightly raised platform that holds 2 benches for people to sit. The platform has a small ramp built into it to make it accessible to the handicapped and elderly.

(c) Medium Bus Stop
This is the second largest stop of the four. This stop is designed to divert those not waiting for a bus to a path other than directly through the stop. This stop consists of a ramp leading up behind the stop to a flat area and then back down the other side. The flat area of the top will form a canopy extending over the waiting area below. There are benches located on top of the canopy. This stop will be accessible by both handicapped and elderly. It is designed to divert the regular passersby to follow the ramp up and behind the stop. The slope of the ramp is greatly exaggerated in Figure 10.

(d) Large Bus Stop
This was the largest stop in the group of four. This stop is designed to completely separate itself from the sidewalk and allow only the people waiting for a bus to be inside. This stop is designed to span a four lane road and also have a couple of islands in the middle of each of the two directions of flow. The passengers will take stairs from the sidewalk up to the waiting area to wait for a bus. When the bus arrives they will take another set of stairs leading down to the island where the bus will be. The busses will pick up and drop off passengers in the middle lane. With the addition of elevators this stop would be completely accessible by both the elderly and handicapped.
5. Concluding Remarks

Important information obtained is listed as follows:

(1) Although student teams of the three institutions worked on the same project theme, they independently worked on different transportation systems focusing on their own interests. Their achievements were unique in their design solutions due to the differences in their traffic systems, societies, culture, tradition and economics.

(2) One of the KIT teams studied the possibility of a bus transportation system by which passengers need not wait for a bus more than five minutes. The final design solution is composed of GPS satellites, a server of the bus operating system, buses with GPS, and passengers carrying mobile phones with GPS. The proposed design solution enables a passenger to catch a target bus just in time without waiting more than five minutes at the nearest bus stop.

(3) Improvement of the bus transportation system in Singapore is very important, because close to 60% of the population in Singapore uses public buses. SP students cultivated the creative ideas and innovative solutions of a bus stop complex, which is composed of a bus stop, a pedestrian overhead bridge and bollards. The bus stop complex secures the safety of passengers and is barrier free.

(4) One of the RHIT teams designed safe bus stops for Japan. They designed four bus stops of increasing size and complexity. The bus stops create an enclosure where passengers can wait while waiting to be picked up by a bus. They are accessible by wheelchairs and also will keep waiting passengers safe from being hit by bicycles or vehicles.

(5) As English is a second language in Japan, KIT students found that it was not easy to communicate with foreign instructors and students of the international collaborative project. Most of them decided to brush up their English so they will be able to communicate with foreign counterparts and present their papers in English in the future.

(6) This collaborative project was a positive experience for both students and faculty members. Furthermore, both groups benefited from a study of the design solutions generated by their collaborative partners.

References


1. Identification of Design Opportunity
2. Project Characterization
3. Design Concept Generation
4. Design Concept Evaluation and Selection
5. Detailed Design

(a) System Configuration

(b) Block Diagram

Figure 1 Design Solutions by KIT Students
Figure 3a – Proposed Features of Bus Stop

- Allowance for tree
- Advertisement Board
- Extension Shelter
- Seat for the needy
- Seats
- Area of the wheelchair users and visually impaired persons
- Tactile for the visually impaired persons
Light Emitting Diode (LED) bulb

Ready-mixed concrete

Figure 3b – Proposed Design of Bollards

Suspended cable

Shelter

Deck

Figure 3c – Proposed Design of Pedestrian Overhead Bridge
Figure 3d – Proposed Design of Lift Core and Staircase at the Pedestrian Overhead Bridge
Goal

- Protect from bikers
  - Bikes popular in Japan
  - Few bike paths
  - No cultural regard for pedestrians
- Friendly to elderly and handicap citizens
  - Doesn’t require personnel assistance
  - Gives confidence for outdoor traveling
- Withstand Local Weather

Solution

<table>
<thead>
<tr>
<th>Stop Type</th>
<th>Number of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1,345</td>
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<tr>
<td>Bench</td>
<td>815</td>
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<tr>
<td>Roof</td>
<td>636</td>
</tr>
<tr>
<td>Access Sign</td>
<td>116</td>
</tr>
<tr>
<td>Guide Sign</td>
<td>73</td>
</tr>
<tr>
<td>Guide System</td>
<td>6</td>
</tr>
</tbody>
</table>

- Four different designs
  - Small stops need and have less space
  - Large stops can be quite elaborate

Raised Seat

- Benches
  - Protect from bikes
  - Provide resting place
  - Wheelchair spot
- Elevated platform
  - Allows wheelchair loading onto bus
  - Protects from bikes
  - Ramp allows wheelchair access

Rising Columns

- When not in use:
  - Columns hidden in sidewalk
  - Tips flushing with surface
  - Columns activated a few minutes before bus arrives
  - Pressure or light sensors keep post from rising under people
- While in use:
  - Horizontal Bars completely enclose for further protection
  - People stand within protected zone

Figure 4 Achievements of RHIT design team
Overpass

- Rooftop above stop
- Weather protection
- Pleasant park
- Loading to double-decker buses
- Underpass accessibility
  - Decorative flower planters prevent biker accessibility
  - Ramp allows bikers and joggers to pass

Superstop

- Traditional Architecture
- Waiting area
  - Climate controlled
  - Weather-proof
  - Accessible to handicapped
  - Escalators to sidewalk
  - Elevators to median
- Median
  - People board buses from median
  - Flower bed protect passengers from automobiles
  - Elevator and bus arrival time coordinated

Conclusion

- Bus stops meet the criteria:
  - Protect handicap and elderly
  - Handicap accessible
- Wide range of sizes matches waiting capacity required
- All withstand severe weather

Figure 4 Achievements of RHIT design team
<table>
<thead>
<tr>
<th>Purpose of Design</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designing a more visible bus timetable</td>
<td>KIT</td>
</tr>
<tr>
<td>Improving the inner environment of a bus</td>
<td>KIT</td>
</tr>
<tr>
<td>Designing a new and easy bus fare payment system using fingerprints</td>
<td>KIT</td>
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<tr>
<td>Designing system which passengers don’t need to wait at a bus stop</td>
<td>KIT</td>
</tr>
<tr>
<td>Designing a easy and adaptable bus fare payment system</td>
<td>KIT</td>
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<tr>
<td>Designing a easily payable bus</td>
<td>KIT</td>
</tr>
<tr>
<td>Improving an interior design of a community bus to attract passengers</td>
<td>KIT</td>
</tr>
<tr>
<td>Designing an attractive bus stop in order to increase passengers of a community bus</td>
<td>KIT</td>
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<tr>
<td>Designing a safe and convenient bus stop at night</td>
<td>KIT</td>
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<tr>
<td>Designing a distinguishable and aesthetic bus stop</td>
<td>KIT</td>
</tr>
<tr>
<td>Introducing “Point Card” to increase passengers of a community bus</td>
<td>KIT</td>
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<tr>
<td>Designing a website which convey information on the current location and topics of the community bus, etc in order to increase passengers</td>
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<tr>
<td>Designing a website of the community bus for mobile phones</td>
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<tr>
<td>Designing a bus stop which attracts townspeople toward a community bus</td>
<td>KIT</td>
</tr>
<tr>
<td>Designing an attractive bus stop which is equipped with an air conditioner, ticket-vending machines and the community flower of Nonoichi Town</td>
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<tr>
<td>Designing various small and light civil engineering structures from creative, innovative and functional aspects</td>
<td>SP</td>
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<td>Designing a modular bus stop suitable for use in Japan</td>
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<tr>
<td>Designing a safe and useful bus stop suitable for use in Japan</td>
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<tr>
<td>Designing four types of bus stops of increasing size and complexity</td>
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<tr>
<td>Design Solution</td>
<td>Criteria</td>
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<tr>
<td>-----------------</td>
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<tr>
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<td>Design 3</td>
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<td>Design 4</td>
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Remarks:
1. Selection Criteria
   A: Aesthetic
   B: Safety
   C: Visual Deterrent
   D: Not an Obstruction to Human Traffic
   E: Economical

2. Score of each design solution against each criterion is graded as follows:
   1: Does not meet criterion well
   2: Meets criterion fairly well
   3: Meets criterion well
   4: Meets criterion very well
   5: Meets criterion extremely well