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Educational Facilities for Blind Engineering Student in Thailand

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Abstract: The very first blind engineering student in Thailand started his college life at Chulalongkorn University in August 2016. The university had less than five months to prepare its facilities and classes suitable for the blind. In this study, we explain the procedure and outcome of such preparation. It includes the design of education facilities like classes, materials, labs, exams as well as other facilities that support his daily activities. The challenge lies in basic science labs and engineering, namely Physics, Chemistry and Engineering Drawing classes. In general, we provide teaching assistants for every laboratory classes. For most exams, we allow 1.5 extra times and provide a digital format of the exam to be used with a screen reader. For materials, we called student volunteers to help preparing the materials in a digital format, particularly the equations using an equation-editing software. For images, we employed a low-cost wire screen to produce tactile images. Finally, in the Engineering Drawing class, a combination of an innovative drawing board and the 3D-printed models are utilized. And for life on campus, a buddy system was set to help with his daily activities.

Key words: Blind, stem, engineering education, Physics, Chemistry, engineering drawing

INTRODUCTION

It is an unfortunate policy in Thailand that blind students have not been allowed to undertake science education during high school. As such, it eliminates any chance for them to pursue science or Engineering degree. Only until 6 years ago, a few blind students were selected to join Princess Sirindhorn's project that allows them to learn science in high school. Since then, there are five students in the program who went or are going to college. The first four are studying or have earned Computer Science degree at various universities in Thailand. In August 2016, the very first blind student passed the national university admissions exams to the Department of Computer Engineering, Chulalongkorn University whose courses typically demand sight.

The university learned about the news in March 2016, hence they had less than five months to prepare the facilities and adjust the policies before the first semester commencing in August the same year. The engineering dean formed a committee comprising representatives from academic affairs, student affairs, facilities management, Department of Computer Engineering and experts in assistive technology to identify obstacles or difficulties and to plan and handle the situation. They pinpointed four dimensions for the preparation: classroom activities, evaluation methods,learning materials and daily activities. As a leading university in Thailand, it is the policy from the management that one of the university's goals is to ensure education equality that promotes an equitable society. Though, the university has admitted many students with disabilities in the past, none was in the Engineering school. Therefore, the university's Disability Support Service (DSS) has no prior experience taking care of engineering students.

The committee's first action was to call a meeting with parties in- and outside the universities. The participants comprised representatives from universities who have admitted blind students and the agencies who awarded scholarship to our student along with those blind students who have completed their degrees in computer science. The result of the meeting suggested current best practices that the university should consider such as a buddy system, enlarged tactile images, navigation around campus and to inform all parties involved early on. Then, the team visited and discussed with more assistive technology experts and consulted with several universities in other countries to learn about accommodation for the blinds. We soon learn that the rules and regulations avail ranges of accommodation and modification and that each case shall be individually determined. This particularly refers to time accommodation as well as assistive technology, software and hardware. The committee also put much efforts contemplating suggestions from related research on how to prepare materials for blind students (Kouroupetroglou

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and Kacorri, 2009; Bernhard, 2014; Slavin, 2014; Cole and Slavin, 2013; Punyabukkana *et al*., 2016) available resources such as tools and equipment in math and science for blind students, Physics and Chemistry course for the blinds. The team decided to give priorities to low-cost options to serve the local needs in this part of the world.

This study aims at sharing how classes and facilities are prepared to welcome a blind engineering student to Chulalongkorn University. We focus on Engineering Drawing class that seems to be the most challenging step for any blind student.

Subject profile: Our first blind student is a 23 year old Thai male, born with white spot in his eyes indicating Glaucoma. He underwent >20 operations and started schooling at the age of 9, the same year that he owned his first computer. When he was 12 years old, it was the last of his sight after yet another major operation and became legally blind. Once he recovered from the trauma, he was admitted to a blind school in Bangkok. He spent 3 year at this blind school before he moved to a leading boy school in Bangkok for Grade 7-12 with full scholarship. He fell in love with computer and had strong passion to become a computer scientist one day. To enter the universities in Thailand, ones must take a national entrance admissions exam. There is no exception in this case since he wishes to study at one of the most prestigious universities in the country. He was able to pass the exam without any standard accommodation for the blinds. He was provided with the requested live readers and tactile images but no time extension. As he became totally blind later in life he is more comfortable with voice rather than braille.

Facilities: A team of staffs from facilities management division surveyed the premise of the Faculty of Engineering in details. Moreover, they took our blind student on tour of the university especially on the routes that he will frequent most. We found that most of our elevators are equipped with braille plates or voice announcement. The team makes sure that the voice feature is operational. There are covered walkways throughout the university that has braille blocks embedded. Although, they may not be properly installed in some areas, it is acceptable. Unfortunately aside from the elevators and braille walkways there is no tactile accommodation around the Engineering school. Our blind student and the staffs identified four risks. The first concern on the risk is with wide areas. Whenever he cannot find walls nearby, it would be rather difficult to navigate further. The second obstacle is road crossing. This is particularly challenging because none of the crosswalk has voice accommodation. The third major concern is the location of classrooms and labs that he will attend. Finally, the last issue is the canteen. We found that it is impossible for a blind student to line in a queue, buy his meal and safely carry the tray to the table. To resolve these issues and thereby minimize the risks we created a tactile map using a braille embosser. However, only the map cannot answer the other three items. We choose to solve the rest with the buddy system and asked for volunteers. There are 15 freshmen from the Computer Engineering Department who are his buddies. The buddy takes turn accompanying him between the dormitory and classrooms, taking him to canteen, riding the shuttle bus and anything in between. Whenever none of the buddies is available he will go directly to the student affairs office to ask for help.

Classes: The classes that our student are taking during the first semester are Engineering Drawing, General Chemistry, General Chemistry laboratory, General Physics I, General Physics I Laboratory, Calculus I and Experiential English I.

Engineering course-Engineering drawing: Engineering Drawing is the only course offered by the Faculty of Engineering during this first semester. It is perhaps one of the most challenging subjects for any blind student. Its main objective of this subject is to prepare the student with an ability to transfer the information from 3-2D picture or orthographic writing and from 2-3D picture which is isometric picture or orthographic reading. These abilities can be classified as "spatial visualization ability" which is one of the most important abilities for science and engineering learning. To develop this ability, the teacher gives lectures and issue assignments for students to practice.

In class, our blind student attends the lectures with one Teaching Assistant (TA) specifically assigned for him. This TA explains the content whenever our student asks. A quick tool that the TA uses is a wire screen shown in Fig. 1 to draw the embossed pictures. Moreover, the teacher uses 3D printer to print the models shown in Fig. 2 for blind student to touch and understand the various types of surface before drawing the orthographic pictures.

After our blind student understands the concept of orthographic projection, the teacher changes the input method from touching 3D models to tracing tactile pictures from paper. To create embossed pictures we use Juliet Pro 60 Braille printer and PictureBraille Software. The example of embossed picture from Juliet Pro 60 printer is shown in Fig. 1-3.

Fig. 1: Low-cost wire screen

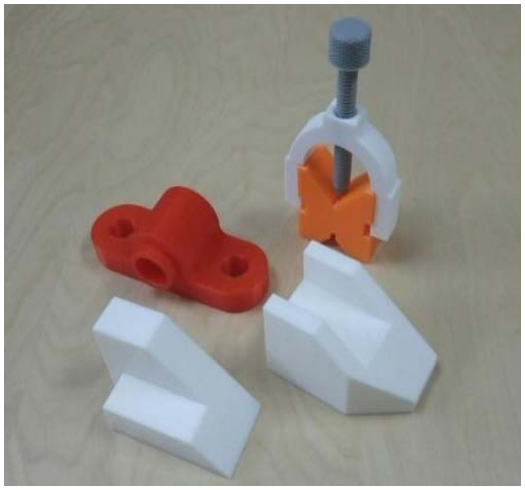

Fig. 2: Sample models printed from 3D printer

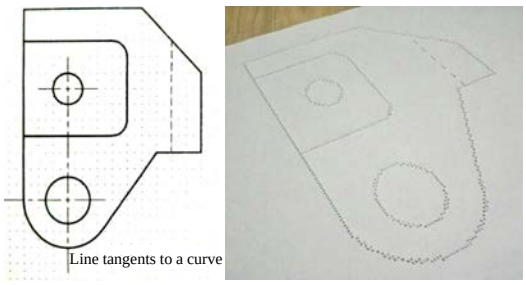

Fig. 3: Example picture and its embossed picture printed from a Braille printer

However, such picture can be used to communicate with our blind student only about its shape but not size. To let the blind student knows its size we need to use another model of printer. The VP SpotDot printer from Ratchasuda College, Mahidol University is selected for printing the embossed pictures with grid line. Due to the capability of this printer we can print the picture of the object along with the grid line with various height of Braille dot. That way, our blind student can feel the printed tactile picture and use grid line as marker to measure the size of the object. Figure 4 shows the example of the printed picture with different level of embossed line.

In addition we designed and created a drawing board which can be used to draw both 2D and 3D picture. The first version of drawing board[5] consists of multiple layers as shown in Fig. 5 and can only be used for 2D picture drawing.

Our blind student uses rope or knitting wool to draw the picture by using slim stick also shown in Fig. 5, to push them into holes. There are various types of line in Engineering Drawing but only two types of line, visible and hidden line are enough for blind student to understand the fundamental of Engineering Drawing subject. We use different type of rope as shown in Fig. 6, so the blind student can select one type of the rope to represent the visible line and another for hidden line.

However, the student cannot draw an arc or circle with this board. So, we came up with the final version of the board made of Velcro liked material as shown in Fig. 7. We also cut small pieces of such material and glue them on the board as markers. The blind student can use these markers to measure the distance during drawing process. By using Velcro liked material, the blind student can now use knitting wool to draw an arc, circle or lines on the drawing board as shown in Fig. 8.

Math and science courses-calculus, Chemistry and Physics: These courses are offered by the Faculty of Science. There are 274 students in Chemistry I lecture class, 155 in Physics I lecture class and 57 students per section in Calculus I. Therefore, the teachers chose to maintain class speed as usual while replacing gestures with voice instructions to aid our blind students. The teachers allowed video record the sessions using smart phone so that the student could later review the lectures with his friends or his helps. Screen wire board is still the tool used to communicate between teachers and student whenever student requests for picture.

Physics lab maintains 162 students and Chemistry lab has 57 students per section. Considering the limited space in the labs and the contents, the most important aspects to be aware of is safety. We were pondering whether or not to exempt Chemistry lab for our blind student. After much consideration we decided to arrange a dedicated teaching assistant for him to help whenever sight is

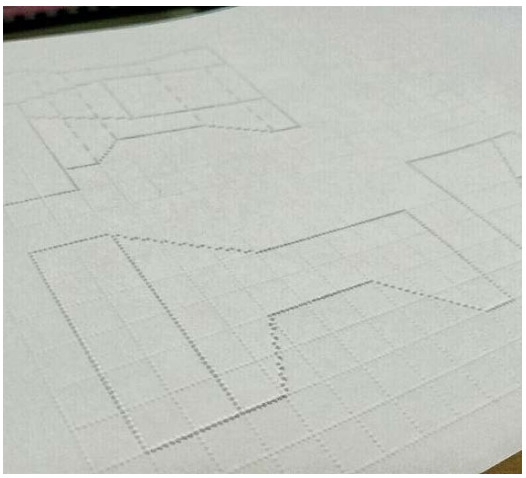

Fig. 4: Embossed picture with various dot height

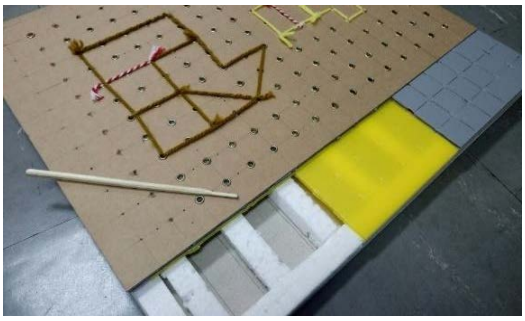

Fig. 5: The first version of drawing board

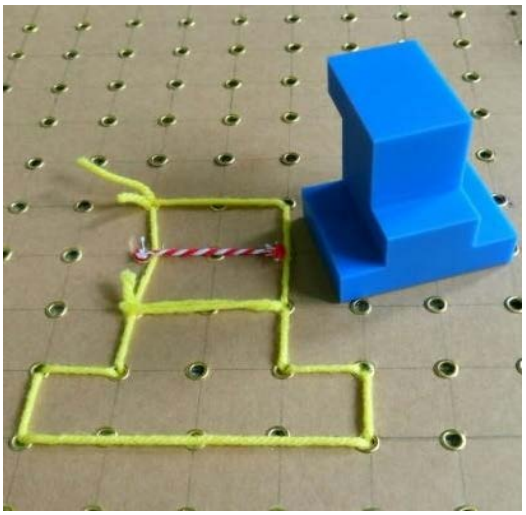

Fig. 6: Front view of the object drawn by blind student

essential to the task such as titration laboratory. Lab teachers meet with this student one week prior to the labs

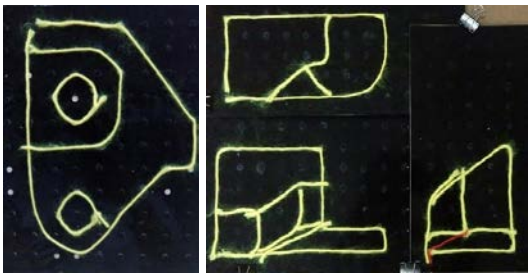

Fig. 7: Pictures drawn on the Velcro board

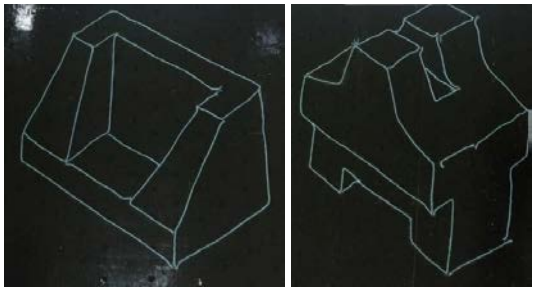

Fig. 8: Isometric pictures drawn by our blind student

to ensure that the experiments can be carried out by our student and the TA during normal class schedule. Most of the tools and equipment was those standard ones used by sighted students with the exception of a light probe that is used in many labs.

Language courses-english: The university's Language Institute is responsible for providing experiential English I course for engineering students. In the past, the institute has enrolled numbers of students with visual disabilities and has hence arranged standard accommodation such as time extension and readers. We found no obstacle during the lectures, homework or activities.

MATERIALS AND METHODS

To prepare the materials we found that popular resources like bookshare. org or learningalley.org are not helpful as most books are not available in our region due to copyrights limitation. We therefore, sent requests to every publisher of the required textbooks, most in the United States with representatives in Thailand asking for a digital copy such that our student could read aloud the materials using screen reader software. We found that the digital copies that we received still miss equations and images. To resolve we called for a hundred students to type the text and equations from Calculus textbook and were able to complete the book in 1 week. They types

text using Microsoft Word and generated equations using MathType while ignoring all figures. For Chemistry textbook we asked for volunteers from a project called "The Guide Light" that pulls together volunteers from the public. However, we found that not many volunteers were able to write equations which results in low response rate from the pool of their volunteers. We turned to our engineering students for help with the typing of text, generating equations and also producing figures. To produce figures we first tried using braille embosser but found that the resolution is the crispness of the lines is insufficient for a blind to distinguish. We finally turned to the wire screen as shown in Fig. 1. For Physics textbooks and the rest we repeated the methodology that we used with Calculus and draw the pictures using screen wires. We must note that preparing materials is a highly labor-intensive task that is the most time-consuming.

RESULTS AND DISCUSSION

Evaluation: For quizzes and exams we have asked various universities in the United States to learn how they accommodate the blinds. We took the suggestion into consideration and found that there are two items to handle for every course: time and format of the exam.

For Chemistry, we printed tactile pictures to complement with the exam questions which are typed out and read back using screen reader. To answer, our student types the solutions using the computer that we prepared for him, equipped with Microsoft Office MathType-for equation editing, MathPlayer-a plug-in for MathType Notepad-for general editing) NVDA-an open-source screen reader, Vocalizer-Text-To-Speech (TTS) for NVDA, Braille display and its driver and Miktex-a Latex editor. We also provide wire screen for our student to draw on an A4 or A3 paper. He is able to write the letters of 1-2 cm.

We have asked every course to consider time extension. For Physics I, Chemistry and Calculus I, the teachers allowed 1.5 times extra. For Chemistry Lab and English, additional 30 minutes were allotted. For most of the courses, our blind student uses screen reader to read aloud questions with the exception of Chemistry where live reader is used.

CONCLUSION

The preparation for a blind to study Science and Engineering is a responsibility that requires attention to great details. We found that the function that demands the most time is the preparation of the materials. It is an on-going activity that demands efforts from volunteers. The extra benefit is that sighted friends learn to be more mindful of others and try to help each other whenever possible. It truly creates a wonderful and caring environment. We learn that we should request for original digital version of textbook from the publishers early on. If the permission and the files are available early enough, it could have reduced much of the efforts in materials preparation. We hope that our experience could help others especially for the universities with limited budget.

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