ROLLER HEMMING: ANALYSIS AND DEVELOPMENT OF AN AUTOMOTIVE ASSEMBLY

E. Ledesma*, a, P. Limon, V. a, E Aguilera a, H. Plascencia a, D. Diaz a, I. Ruiz b, O. Palomino b.

a University of Guanajuato/Mechanical Engineering Department, México.
b PEMSA/Engineering Department, Mexico.

*elias@ugto.mx

Abstract

Automotive Industry in Mexico is growing at a tremendous pace for the last 5 years, pushing local suppliers to develop new market opportunities. PEMSA, a local stamping company, is developing roller hemming process, in order to be more competitive, and to have a flexible metal forming method at low cost. Roller hemming engineering development is performed on a joint research project between PEMSA and University of Guanajuato. A parametric numerical simulation of an experimental hemming assembly made by a robot arm mounted roller is presented. The proposed geometry was generated on a CAD commercial software and then imported into a commercial code for an explicit finite element analysis. The analysis includes the simulation of the deep drawing, spring back, folded back, spring back, and hemming processes in order to include residual stresses, plastic stresses, and thinning generated in each previous manufacturing step. Several materials models were tested to match experimental data, before the roller hemming analysis was performed. Main hemming parameters were roller speed, roller diameter, entry angle, bending radius, and overhang. The analysis showed that residual stresses and sheet thinning due to deep drawing and folding do not affect the hemming process. Additionally, an analysis of experiments was performed, using a five factors factorial design with one replica, in order to get main effects on “roll in”, hemming thickness and maximum roll force. These response variables were measured on four different points around the rolled edge. It was observed that roll diameter, entry angle, and the initial bending radius are dominant parameters. The methodology developed was applied on a closure automotive part with closed path roller hemming, performing again a design of experiments on the roller hemming process.

Keywords: Hemming, deep drawing, FEA, DoE, Roller, Roll-in, Roll-Out, Roll force, metal forming.

Introduction

Roller hemming is a method used in the automotive industry to join two pre-formed metal panels. This process generally includes an inner panel inside a foldable exterior panel, which is bent with a robot guiding a parallel roller along a given path [1]. The sheets are joined by plastic deformation without using any additional fastening element. Among the advantages of this type of union is the low weight of the union, since it is not necessary to add additional material, the increased stiffness of the component and a significant reduction in risk of injury to eliminate any sharp edges. Usually this process is applied in vehicle doors, hoods, or trunk lid. These structural units are commonly referred as closure panels.

Roller hemming was introduced in the market in the 90s and has large areas of application in the automotive sector because is a flexible process and requires less investment on new product development, compared to conventional processes [2].

Roller hemming research had been made on theoretical, numerical and experimental studies aimed at improving the process, analyzing the plastic material recovery (springback), the optimum roller radius and fracture limit, sheet metal thinning in 2D surfaces and in fewer publications in 3D surfaces, by solid elements and shell elements.

N. Le Maout [3] proposed the S.Thuiller [4] specimen but adding the effect of the pre-stretching induced during the drawing process. The influence of Bauschinger effect, anisotropy and deformation history in the final geometry is studied. Materials characterization was performed through tension tests at different orientations of rolling, 0°, 45° and 90°. It was found that the material has a low variation of the flow stress in the flat sheet and only a slight Bauschinger effect. The identification of a mixed model of anisotropic hardening elastoplastic however, has given the best description of the mechanical behavior.

Fig 1. Roller hemming methodology proposed by N. Le Mao’ut [3]
The N. Le Maout specimen has the limitation of analyzing the roller hemming process on paths that do not have abrupt changes; this work presents the study of the process on a specimen that includes vertices as those commonly found in the corners of doors, gates and hoods.

Figure 2. Proposed roller hemming assembly [2].

Methodology

Finite element analysis were performed to model drawing, cutting, folding and roller hemming on our modified Le Maout [3] specimen, reporting results at each manufacturing stage.

Material model Hill 48 with isotropic hardening law is the criteria most commonly used [5]. The complete assembly of the tooling that was used to draw the prototype is showed in Figure 3.

Figure 3. Drawing fixture assembly

Finite element modeling of drawing stage

The finite element analysis models only the surfaces of interest; details of solid geometries such as holes, chamfers and fillets are omitted as long as they do not affect.

Figure 4. Finite element model of drawing stage.

The second general step to reach the final roller hemming is to take the mesh from the drawing model with results and cut the mesh to generate the model that will serve for the next step, which involves bending. Figure 5, back spring analysis was also performed.

Figure 5. Back spring, outer and inner trimming.

90° Roller hemming geometry

The geometries were generated based on a profile obtained of the location of the nodes on the previous stages analysis, through MATLAB and CATIA. The roller hemming simulation was conducted in two parts: first, the outer flange was folded on to the inner (Figure 10, red flange). Several hemming roller diameters were used because it was observed that if roller diameter is too small, the roller hits and drags the flange in the direction of movement without folding the flange. On the second part, the inner flange was folded also.
Roller hemming finite element model

The model was performed with inner, hem bed and roller like rigid parts. Inner and hem bed are fixed, and roller like a mobile part. A mapped mesh was used with Shell elements. Stresses and strains came from drawing and trimming stages. Roller path was calculated in MATLAB, and imported into LS-DYNA. Two roller hemming steps were analyzed, 45° and 90°.

A full factorial design of experiments was conducted on the roller hemming model. Input parameters were:

- Roller speed
- Roller input angle
- Roller diameter
- Overhang
- Flange fillet

Output variables were:
- Roll In
- Hemming thickness
- Roller maximum force

Results

The reduction in thickness for the first step at 45° is shown in Figure 8a. The maximum value is obtained as 0.1252% and is located at a point where the contact with the roller begins.

Thickness reduction on the 90° roller hemming steps is 0.5607% maximum, Figure 8b.

Plastic deformation for the first step at 45° on the periphery is shown in Figure 9a, where a maximum value of 0.1903 was obtained. While the second step to a maximum value of 0.4553 was obtained.

The graph of the force-time behavior between the roller and the flange to the first step was analyzed, getting a maximum value of 764.69 N. For the second step a maximum force was obtained equal to 17,776 N. Both
graphs show a similar behavior although the range of values of strength is very different.

![Graph](image_url)

Figure 10. Roller force vs. time, 45° step.

Conclusions

In our simulations it can be seen that in the first step remains a tendency for non-uniform deformation in the inner hemming, right where the shape is the most radical change of curvature although it is noteworthy that the shape of the specimen and the trimming done on the specimen, the curvature changes at all times. In the last roller hemming step the problem with ripples and uneven deformation tends to be corrected, but in the specific case of the inner hemming a slight defect persists. Our results were verified with preliminary experimental analysis.

Design of experiments analysis

Roll in

It was found that the most influential parameters in obtaining the output variable roll in are first is the radius of flange fillet, followed by the roller angle.

Hemming thickness

For measuring the output variable hemming thickness it was found that the most influential parameters are, first; roller diameter, roller angle followed by influencing nearly as significantly as the roller diameter, subsequently it is the flange fillet radius and at least influence the roller speed.

Roller maximum force

The most important main effect comes from roller diameter.

References


COLLABORATIVE TRAINING PROGRAMME BETWEEN NAGAOKA COLLEGE AND ADTEC MELAKA BASED ON THE SOLIDWORKS AND TETRIX ROBOTICS

Susumu Nakamura*, a, Tetsuro Iyama b, Yoshinori Tokoi a, Kensei Kaneko b, Naritoshi Aoyagi b, Makoto Yamazaki a, Rezawati binti Ismail c, Normazlinda binti Che Mahmood d and Mohd Zabidin bin Abd Samad e

a Department of Electrical and Electronic Systems Engineering, NIT, Nagaoka College, Nagaoka, Japan
b Department of Mechanical Engineering, NIT, Nagaoka College, Nagaoka, Japan
c Division of Mechatronic, ADTEC Melaka, Melaka, Malaysia
d Director, ADTEC Melaka, Melaka, Malaysia
*e Email: snaka@nagaoka-ct.ac.jp

Abstract

Nagaoka College has entered into a collaboration with Advanced Technology Training Centre (ADTEC) Melaka in training robot skills. ADTEC Melaka was built in 1998 and one of four ADTECs developed under the 7th Malaysian Plan, which was officially opened on January 11, 2003. ADTEC Melaka is fully governed by Manpower Department (JTM) of the Ministry of Human Resources, Malaysia. ADTEC Melaka is a technical skills training centre that provides 70% hands-on training and 30% theoretical education for its trainees. JTM Robot Challenge is one of annual robot competitions organized by JTM since 2008. The main objective of the JTM Robot Challenge is to enhance the skills and innovations related to robotics on JTM instructors or students. ADTEC Melaka’s team has participated in the JTM Robot Challenge every year. For 2015, the JTM Robot Challenge will be held in conjunction with JTM Technology Carnival at ADTEC Taiping on September 6 - 8, 2015. This year, they are aspiring to form a formidable robotics team to win this competition by taking the collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics. The collaborative training programme was conducted by the Nagaoka College’s lecturers using the college’s facilities. The main purpose of the programme is to assist ADTEC Melaka lecturers in developing the robot using current technology. In ensuring the effectiveness of the training, approach to be used is project based which includes planning and developing the robot within four working weeks at Nagaoka College. This training programme covers a fundamental and hands-on experience on design, fabrication, programming and operation of a robot. At the end of the training, the trainees should be able to: 1. Design, simulate and analyze structure, drive train and gripper/weapon of the robot. 2. Select the suitable material for the robot. 3. Calculate and make decision on sensor, motor and power transmissions for the robot. 4. Perform robot fabricating, machining, and joining for each part of the robot. 5. Program and operate the robot.

Keywords: Collaborative training, Design, Robot, SolidWorks, LEGO Mindstorms, TETRIX robotics

1. Introduction

The Manpower Department is one of 13 departments in the Ministry of Human Resources, Malaysia. The responsibilities of the Manpower Department are to provide skills and educational training for secondary school graduates and workforce, maintaining good relationship with the industry to ensure employability of its graduates, and to improve the quality of its instructors/lecturers.

ADTEC Melaka was built in 1998 under the 7th Malaysian Plan and was officially opened by Malaysian Deputy Prime Minister, YAB Datuk Seri Abdullah Hj Ahmad Badawi, and Malacca Chief Minister YAB Datuk Seri Mohd Ali Hj Rustam on January 11, 2003. ADTEC Melaka is a technical skills training centre that provides 70% hands-on training and 30% theoretical education for its trainees. It is one of four ADTECs in Malaysia developed under 7th Malaysian Plan.

ADTEC Melaka offers five main programmes which are Manufacturing Technology, Automotive Technology, Computer System Technology, Telecommunication Technology and Mechatronic Technology. The aims of these programmes are to enhance and strengthen their teaching and learning process by taking various initiatives to accomplish its educational excellence. One of the strategies implemented by ADTEC is to have collaboration with other parties to enhance the quality of their graduates. ADTEC Melaka paves the way for those
who aspire to become qualified skilled workers in any fields which involve the use of advanced technology in line with the rapid modernisation and global technological revolution. The ultimate vision of ADTEC Melaka is to churn out highly capable individuals in the quest to transform the country’s manpower development in becoming more efficient.

National Institute of Technology, Nagaoka College was established in 1961 under the Ministry of Education, Culture, Sports, Science and Technology, Japan. Based on the Japanese Government’s policy, all 55 National Colleges including Nagaoka College were incorporated as a new single legal entity in 2004 and are now under the umbrella of the National Institute of Technology (NIT), Japan. However, each college maintains its independent authority.

NIT, Nagaoka College is an established College of Engineering, focusing on Mechanical Engineering, Electrical and Electronic systems Engineering, Electronic Control Engineering, Material Engineering and Civil Engineering, which strives to produce young practical engineers of ability in a five-year higher education system along with two more years advanced courses to meet the strong demand from industry.

Nagaoka College and ADTEC Melaka signed an academic exchange programme on November 6, 2014. The first collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics was conducted from May 11 – June 5, 2015. The aim of this programme is to assist ADTEC Melaka lectures in developing the robot using current technology. In ensuring the effectiveness of the training, project based approach has been used which includes planning and developing the robot mechanism at Nagaoka College within four weeks. This training programme covers in designing using SolidWorks2014, prototyping with ink-jet and FDM type 3D printers, programming and controlling LEGO and TETRIX Robotics.

JTM Robot Challenge organized by the Manpower Department of the Ministry of Human Resources, Malaysia, is one of the annual robot competitions since 2008 [1]. JTM Robot Challenge serves as a platform to enhance the knowledge and skills level in robotics among the lecturers and students under the Manpower Department Institutions. ADTEC Melaka has participated in the JTM Robot Challenge every year without failure. For 2015, the JTM Robot Challenge will be held in conjunction with JTM Technology Carnival at ADTEC Taiping on September 6 - 8, 2015. This year, they are aspiring to form a formidable robotics team to win this competition by taking the collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics.

2. JTM Green Earth 2015

This year, ATEC Melaka’s team will take part in Green Earth 2015 competition which is one of the categories in JTM Robot Challenge. Figure 1 shows the playing field of JTM Green Earth 2015. The main rules of Green Earth competition are as follows:

1. Teams will compete on the playing field.
2. The playing field are divided into two teams, red and blue.
3. The size of playing field is 3000 mm x 3000 mm.
4. Each robot must remove the stump to the dump site of stump, take trees in nurseries and plant trees on the site.
5. Each team will be represented by four members, consist of three students, one instructor.
6. Robot weight should not exceed 15 kg.
7. At the starting point, the initial size of the cube robot cannot exceed 400 mm (W) x 400 mm (L) x 500 mm (H).
8. On the playing field, the size of the cube robot cannot exceed 500 mm (W) x 500 mm (L) x 500 mm (H).
9. The team must be able to put all the goods within 3 minutes and the fastest will be the winner.

![Diagram of JTM Green Earth 2015](image)

3. Collaborative training programme

The collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics was conducted from May 11 – June 5, 2015. The following describes the detail of the programme.

3.1 Modeling and prototyping a leg unit of KAWASAKI Robot

Basic operation of SolidWorks, making a part model and assembly model with SolidWorks, prototyping of robot parts with ink-jet and FDM type 3D printers and 3D modeling of a leg unit for KAWASAKI Robot Contest (KAWA-ROBO) were conducted for the first two weeks. Training schedule for the first two weeks from May 11 to May 22 is shown in Table 1.
Table 1 Training schedule for the first two weeks.

<table>
<thead>
<tr>
<th>DATE</th>
<th>Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 11</td>
<td>1. Introduction of NIT, Nagaoka College</td>
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<tr>
<td></td>
<td>2. Basic operation of SolidWorks</td>
</tr>
<tr>
<td></td>
<td>3. Making a part model with SolidWorks</td>
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<td></td>
<td>4. Using SolidWorks online tutorial</td>
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<tr>
<td>May 12</td>
<td>5. Making assembly model with SolidWorks</td>
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<td></td>
<td>6. Using SolidWorks online tutorial</td>
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<td></td>
<td>7. Laboratory tour in the Department of Mechanical Engineering</td>
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<td></td>
<td>8. Learning how to use 3D printer</td>
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<tr>
<td>May 13</td>
<td>9. Practice of SolidWorks Motion</td>
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<tr>
<td></td>
<td>10. Using SolidWorks online tutorial</td>
</tr>
<tr>
<td></td>
<td>11. Introduction of KAWASAKI Robot contest</td>
</tr>
<tr>
<td></td>
<td>12. Planning of a robot for KAWASAKI Robot contest</td>
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<tr>
<td>May 14</td>
<td>13. Participate in School Hiking with Malaysian students</td>
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<td></td>
<td>14. Design of leg unit</td>
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<tr>
<td></td>
<td>15. Participate a class (Subject: Creative Design and Manufacture)</td>
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<td></td>
<td>16. 3D printing (Model part)</td>
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<tr>
<td>May 18</td>
<td>17. Checking of printed parts and temporary assembling</td>
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<tr>
<td></td>
<td>18. Design of leg unit</td>
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<tr>
<td></td>
<td>19. 3D printing (Model part)</td>
</tr>
<tr>
<td>May 19</td>
<td>20. Checking of printed parts and temporary assembling</td>
</tr>
<tr>
<td></td>
<td>21. Design of leg unit</td>
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<tr>
<td></td>
<td>22. 3D printing (Model part)</td>
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<tr>
<td>May 20</td>
<td>23. Checking of printed parts and temporary assembling</td>
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<tr>
<td></td>
<td>24. Modification modelling</td>
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<tr>
<td></td>
<td>25. 3D printing (Model part)</td>
</tr>
<tr>
<td>May 21</td>
<td>26. Completion of assembling of leg unit</td>
</tr>
<tr>
<td></td>
<td>27. 3D modelling of robot parts excepting a leg unit</td>
</tr>
<tr>
<td></td>
<td>28. 3D modelling of robot parts excepting leg unit</td>
</tr>
<tr>
<td>May 22</td>
<td>29. Summary of the first two weeks</td>
</tr>
</tbody>
</table>

During the training programme, a leg unit of KAWA-ROBO was designed using Hecken link mechanism with 3D CAD, SolidWorks2014. SolidWorks is a software program used for solid modeling computer-aided design (CAD) and computer-aided engineering (CAE). SolidWorks users can create sophisticated parts and assembly designs quickly and efficiently. Since SolidWorks is currently used by over 2 million engineers and designers at more than 165,000 companies worldwide, users can have quick access to people and resources to gain the knowledge and support they need when questions arise.

Figure 2 shows the leg unit using the Hecken link mechanism. Figure 3 shows training class of 3D model with SolidWorks. KAWASAKI Robot Contest is one of popular robot contests which has been held in Kawasaki city since 1994. Content of the contest is “robots battle”. The participating robots have to be driven by a walking mechanism. That means driving wheels and tires are not accepted in the regulation. To achieve this, several four-link mechanisms are commonly used for the robots.

Four-link mechanism is the most basic mechanism and it consists of three-link. Schematic illustration of four-link mechanism is shown in Figure 4. Figure 4 (a) shows the normal four-link mechanism. A trace pass of edge point $\mathbf{1}$ will not become an arc. The Hecken link mechanism is in a type of four-link mechanism and its schematic illustration is shown in Figure 4 (b). The mechanism has a particular length ratio. The Hecken link mechanism can get a smooth arc pass at over 180 degree. In this training programme, we designed the leg unit having the Hecken link mechanism.

![Figure 2](image1.png)  ![Figure 3](image2.png)

Figure 2 Leg unit using Hecken link.

Figure 3 Making 3D model with SolidWorks.

![Figure 4](image3.png)

Figure 4 Schematic illustration of four-link mechanism.

In this training programme, two types of 3D printers were used for prototyping the leg unit of KAWA-ROBO which was designed by SolidWorks. The 3D printers normally require “*.STL style files” to read the 3D model.
Most 3D CAD systems support the STL file as an output model. Figure 5 shows the parts of robot’s leg formed by FDM type 3D printer.

![Figure 5 Prototyping of robot’s leg parts with FDM type 3D printer.](image)

### 3.2 Building LEGO robot and TETRIX robotics

In order to upgrade ADTEC Melaka lecturers’ robot skills, LEGO robot (LEGO Mindstorms NXT 2.0) and TETRIX robotics (TETRIX® MAX Starter set) were used for the next two weeks from May 25 to June 5. Training schedule for the latter two weeks is shown in Table 2.

Table 2 Training schedule for the latter two weeks.

<table>
<thead>
<tr>
<th>DATE</th>
<th>Programme</th>
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</thead>
<tbody>
<tr>
<td>May 25</td>
<td>1. Introduction of LEGO robot</td>
</tr>
<tr>
<td>(Mon.)</td>
<td>2. Assembling of LEGO robot</td>
</tr>
<tr>
<td></td>
<td>3. Participate in a class of Experiments of Electrical Engineering I in the Department of Electrical and Electronic Systems Engineering</td>
</tr>
<tr>
<td>May 26</td>
<td>4. Programming of instruction to motor using LEGO robot</td>
</tr>
<tr>
<td>(Tues.)</td>
<td>5. Programming of instruction to sensor using LEGO robot</td>
</tr>
<tr>
<td>May 27</td>
<td>6. LEGO robot programming</td>
</tr>
<tr>
<td>(Weds.)</td>
<td>7. Participate in Experiments of Electrical Engineering II in the Department of Electrical and Electronic Systems Engineering</td>
</tr>
<tr>
<td></td>
<td>8. Participate in Experiments of Electrical Engineering III in the Department of Electrical and Electronic Systems Engineering</td>
</tr>
<tr>
<td>May 28</td>
<td>9. Practice of LEGO robot</td>
</tr>
<tr>
<td>(Thurs.)</td>
<td>10. Practice of LEGO robot</td>
</tr>
<tr>
<td>May 29</td>
<td>11. Introduction of TETRIX robotics</td>
</tr>
<tr>
<td>(Fri.)</td>
<td>12. Assembling of TETRIX robotics</td>
</tr>
<tr>
<td>June 1</td>
<td>13. TETRIX programming</td>
</tr>
<tr>
<td>(Mon.)</td>
<td>14. TETRIX programming</td>
</tr>
<tr>
<td>June 2</td>
<td>15. Practice of TETRIX</td>
</tr>
<tr>
<td>(Tues.)</td>
<td>16. Final presentation</td>
</tr>
<tr>
<td></td>
<td>17. Courtesy visit to Tokyo College</td>
</tr>
<tr>
<td></td>
<td>18. Study tour of Tokyo College (Embedded system)</td>
</tr>
</tbody>
</table>

LEGO Mindstorms is a robotics kit which allows anyone, including children, to build robots that do what they want. The LEGO Mindstorms NXT 2.0 was launched in early August 2009. It is a very popular product line in the area of robotics education. It contains 619 pieces (includes sensors and motors), two touch sensors, an ultrasonic sensor, and introduced a new colour sensor. The main component in the LEGO Mindstorms NXT 2.0 kit is an intelligent brick computer which enables it to execute user-written programs based on feedback from a variety of sensors. It can take input from up to four sensors and control up to three motors, via a modified version of RJ12 cables. The brick computer has a 100×60 pixel monochrome LCD display and four buttons that can be used to navigate a user interface using hierarchical menus. It has a 32-bit ARM7TDMI-core Atmel AT91SAM7S256 microcontroller with 256KB of flash memory and 64KB of RAM, plus an 8-bit Atmel AVR ATmega48 microcontroller, and Bluetooth support. Power is supplied by 6 AA (1.5 V each) batteries in the consumer version of the kit and by a Li-Ion rechargeable battery and charger in the educational version.

In programming for the brick computer, a variety of unofficial languages exist, such as NXC, NBC, leJOS NXJ, RobotC and BrixCC. BrixCC is the integrated development environment (IDE) used to write, compile, and edit NBC and NXC programs for the NXT. In this training programme, we used BrixCC because it has many utilities such as NeXTEXplorer (upload/download files, defragment the NXT, use file hex viewer) and NeXTScreen (view what’s on the NXT’s LCD display, and capture images and video). Figure 6 shows that ADTEC Melaka lectures are building the LEGO robot.

![Figure 6 Building LEGO robot.](image)
TETRIX is a robotics building system that was created by Pitsco, Inc. The main structural TETRIX pieces are aluminum channel with a trademarked hole pattern that enables connections at multiples of 45°. The pieces are attached using bolts. Other building elements such as gears, wheels, motors and servos are included in the package. The TETRIX system is intended for use in educational settings for hands-on explorations of mechanisms and robotics. It is also designed for use in robotic competitions, such as the FIRST Tech Challenge, a team-oriented contest for high school students [2].

The TETRIX robotics system is designed to allow users to create stronger, heavier-duty robots while leveraging the programming of NXT software and the autonomy of the intelligent brick computer. Robots built from TETRIX components may also be controlled via radio control equipment - hand-held radio transmitters like those manufactured by Futaba, and receivers mounted on the robot chassis. This enables a human operator to control the robot’s movements from a remote location.

Features of the TETRIX robotics are as follows [3]:
• Uses elements made from heavy-duty, aircraft-grade aluminum to maximize stability and reliability.
• Uses powerful drive motors that drastically increase the capabilities of Mindstorms with TETRIX robots.
• Can be combined with LEGO Mindstorms and either National Instruments LabVIEW for LEGO Mindstorms or RobotC to build sophisticated, versatile robots that are able to handle complicated tasks autonomously.
• Offers flexibility in build design and can be expanded using additional materials.
• Gives users the opportunity to master the concepts of wiring, motor control, and much more.
• Fosters creativity and ingenuity amongst students.
• Develops engineering and problem-solving skills.

Figure 7 shows a prototype machine for JTM Green Earth 2015 competition. This machine is a four-wheel drive using TETRIX robotics and the intelligent NXT brick computers. Two NXT brick computers are used to use three photo sensors to detect a line and one ultrasonic sensor to detect obstruction.

4. Conclusions

In order to upgrade ADTEC Melaka lecturers’ robot skills, the collaborative training programme between Nagaoka College and ADTEC Melaka based on the SolidWorks and TETRIX robotics was conducted by the Nagaoka College’s lecturers using the college’s facilities. This training programme covered a fundamental and hands-on experience on design, fabrication, programming and operation of the robot.

This programme is the first step to develop strong relationship between Nagaoka College and ADTEC Melaka. We are planning to send 15 students of Nagaoka College to ADTEC Melaka this August for one week and have cooperative programme using LEGO robot.

Acknowledgements

We sincerely appreciate Ms. Chin Phaik Yoong, Director General of the Manpower Department of the Ministry of Human Resources, Malaysia, giving us the opportunity to do the collaborative training programme.

References

ENVIRONMENTAL CRITICAL THINKING DEBATE AND
PRESENTATION WORKSHOPS ON SUSTAINABILITY ISSUES TO NURTURE
FUTURE GLOBAL TECHNICAL LEADERSHIP

K. Pak a, S. Seki b, J. Shin c, J. Wanner Kawahara d, J. September e, P.J. Wanner d, f, Y.N. Azzizah g, h, A. Rahman g, h, H.N. Cui f, J.Y. Zhang f, F. Emetia g, h, M. Kato i, M. Takeuchi i, A. Yazawa a, Y. Kubota a, K. Fukuchi a and D. Pushpalal g, h

a Department of General Science, National Institute of Technology, Sendai College, Sendai, Japan
b Department of Intelligent and Electronic Systems, National Institute of Technology, Sendai College, Sendai, Japan
c Department of Medicine and Science in Sports and Exercise, Graduate School of Medicine, Tohoku University, Sendai, Japan
d International Graduate Program in Language Sciences, Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan
e Global Program in Economics and Management, Graduate School of Economics and Management, Tohoku University, Sendai, Japan
f Department of Language Education, Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan
g International Post-Graduate Program in Human Security, Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan
h Department of International Resources Policy, Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan

*pak@sendai-nct.ac.jp

Abstract

This paper highlights effective speaking skills development in students. This development includes critical thinking through debates and presentations in classes specializing on current environmental crisis and sustainability issues for nurturing future global technical leadership. Hundreds of engineering students of the National Institute of Technology (NIT), Sendai College and international students from the International Post-Graduate Program in Human Security at Tohoku University, have participated in the two-year multicultural classes since the academic collaboration was initiated and designed in 2010. This innovative curriculum and the intercultural communicative teaching methods were designed for enhancing critical thinking and global leadership skills through focus on thematic topics such as climate change, natural disaster, refugee camp conditions, desertification, large-scale water pollution, and lack of natural resources. Targeted leadership skills were: (1) identifying a problem, (2) debating, (3) problem solving, (4) decision making or (5) doing dynamic presentations over global controversial issues such as various noticeable challenges in science, technology and engineering toward environmental protection.

The methods of English education at NIT vary, but have mostly focused on performance on English achievement tests as in other Japanese secondary schools; mid-term exams and finals based on grammar, reading comprehension and translation questions. Furthermore, some tertiary school level classes have set their goals for scores or accomplishment on listening and reading to prepare for tests such as TOEIC or EIKEN respectively. Naturally, most non-native speakers have difficulty achieving sufficient communicative skills with only these types of test preparation. However, these results do not necessarily improve effective verbal communication or debate skills in student’s respective areas.

This study aims to create one of the most effective teaching methods providing strong incentives in the students. This can lead towards remarkable improvement in English communicative skills by giving tasks of multinational debates and presentations based on global sustainability issues. This curriculum and the joint support of NIT and the Graduate School of International Cultural Studies, Tohoku University develop: 1) the blueprint of a successful global technical leader training program to create better intercultural understanding, and 2) richer human resources contributing to academic achievement and international cooperation of the next generation.

Keywords: intercultural understanding, critical thinking debate, sustainability issues, English communicative skill, competitive advantage
Introduction

The majority of Japanese English instructors in public secondary and tertiary schools are focusing on vocabulary building, grammar, translation, reading or preparation for TOEIC or EIKEN tests which are designed to better evaluate listening and understanding of readings. As English instructors emphasize grammar and translation teaching methods in their classes in their mother language, it doesn’t effectively improve speaking skills development, however, too many grammar exercises on error corrections are virtually possible to be one of the main factors of disturbing students’ motivation in speaking English. Furthermore, to nurture active verbal abilities in specific purposes require more practical and professional training with fluent English speakers.

On the other hand, Japanese National Institute of Technology (NIT) has very clear educational purposes to nurture practical and well-trained engineers in from 5 years to a maximum of 7 years. It is therefore possible to work effectively in an industrial company right after graduation. Since the educational goals of NIT are mainly set on practical technical knowledge, the students should learn special core curriculums which are very different from other high schools or universities.

We were focused on specific knowledge and English communication abilities required for the 21st century in fostering intrinsic student motivation and tried to create the most competitive English learning activities through academic collaborative intercultural workshops.

Materials and Methods or pedagogy

For the most effective communicative skill development, we have invited totally over fifty international graduate students as tutors to join the intercultural workshops since 2010 and have set up common interesting discussion topics on environmental and sustainable issues such as climate change, natural disaster, refugee camp conditions, desertification, large-scale water pollution, and lack of natural resources.

The majority of foreign tutors from the International Post-Graduate Program in Human Security at Tohoku University have handled their group discussions successfully, and maximized student concentration amazingly in cross-cultural communication studies as well as global technical leadership training as shown in Fig.2. The main purpose of intercultural discussion was to nurture practical communicative skills on identifying a problem, debating, problem solving, decision-making or giving a presentation over sustainability issues toward environmental protection.

The intercultural critical thinking debate and presentation workshops followed the steps listed below.
① Pre-task Session; The instructor introduces the debate or presentation topic and gives the students clear instructions on what they will have to discuss at the task stage and might help the students to recall some vocabularies and expressions that may be useful for the task. The pre-task stage can also often include watching tutors model presentations and their debates on specific purposes. This gives the students a clear model of what will be expected of them. ② Task (Group Discussion) Session; The students complete a task in groups using the language resources that they have as the teacher monitors and offers encouragement. ③ Planning Session; The students prepare a technical presentation or debate with several Power Point slides on the topic of their group discussions. Meanwhile the tutors are available for the students to ask for advice to clear up English questions they may have. ④ Presentation or Debate Session; Students give a presentation or participate in a panel debate in the class. The teacher and tutors evaluate student presentation or debate individually. ⑤ Question & Answer Session; Finally, the student presenters answer various critical thinking questions from instructor, tutors and other students. The teacher and tutors evaluate student feedback about the questions individually.

This intercultural workshop is truly strong communicative approach where students must spend the most of their class time for communicating.

Results and Discussion

Evaluation methodology of delivery and Q&A

These intercultural workshops as the most effective communicative English teaching methods have provided strong incentives in the student participants. These educational methods could lead towards remarkable improvement in English communicative skills by giving tasks of presentations and critical thinking debates focused on global sustainability issues. We aimed at evaluating the main elements of presentation delivery and the feedback in the question and answer session. The evaluation parameters for presentation delivery consisted of following fifteen contents; “Avoided fillers”, “Spoke loudly enough to be heard in the room”, “Pronounced words clearly”, “Spoke without noticeable pauses in mid-sentence”, “Used falling intonation at the end of sentences”, “Varied rate of delivery”, “Changed pitch for emphasis”, “Looked at entire audience”, “Spoke key points, intro, and concluding remarks without reading”, “Did not read to audience much from screen”, “Used concept-related gestures to show relationships”, “Avoided nervous hand movements”, “Stood straight”, “Planted feet” and “Appeared confident and enthusiastic”. All students made the thematic technical presentations and the
evaluation results on deliveries of the 1st and the 4th presentation are shown in Fig. 3 and Fig. 4.

At the final presentations, the student evaluation results on delivery were improved dramatically compared with the first evaluation scores. The majority of student presenters raised their scores on delivery a lot, especially for the content of “Spoke loudly enough to be heard in the room” of which average score was raised from 5.5 to 9.0. It means their voice clear to listen to and it can be a strong evidence of self-confidence improvement. The average score rising on the other contents such as “Avoided nervous hand movements”, “Stood straight”, “Planted feet” and “Appeared confident and enthusiastic” has also supported these positive results. For the expression ability using body language, “Used concept-related gestures to show relationships”, even it is naturally weak point for Japanese due to their cultural background, the average score shows a great improvement from 3.4 to 7.2.

Fig.3 The 1st evaluation scores on deliveries

The evaluation parameters for handling a question and answer session consisted of following 6 evaluation contents; “Listened to question without interrupting”, “Repeated or rephrased question”, “Addressed response to everyone”, “Began with general answer and then followed up with details”, “Stood ground or stepped toward questioner” and “Avoided cover-up gestures (fig leaf, behind back, arms crossed)”. As the evaluation results on deliveries, the most of students got much better scores for their 4th Q&A session handling as shown in Fig.5 and Fig.6.

Fig.4 The 4th evaluation scores on deliveries

At the final presentations, the student evaluation results on Q&A session handling were also improved compared with the previous evaluation scores. The average score of Q&A session handling were raised from 7.5 at the 2nd presentations to 8.9 at the final presentations and it shows that the students had improved their listening levels to understand the questions as well as answering abilities towards powerful critical thinking communicative skills.

The evaluation results shows that these types of classes can lead towards remarkable improvement in English communicative skills by giving tasks of intercultural debates and presentations focused on global sustainability issues.

Conclusions

All Japanese NIT students deserve a chance to be successful in their practical English studies to create better intercultural understanding and responsible NIT must respond to their student needs towards well-educated students of the highest global standard, now in the future.

To conclude, through these innovative cross-cultural critical thinking debate and presentation workshops on sustainability issues, the students can dramatically improve their verbal communication skills for specific purposes, as well as future global technical leadership. Furthermore, the abilities will lead them not only to make a high-value technical presentation effectively, but also to debate more actively in the case for topic discussions that require negotiation over global controversial issues.
Acknowledgements

This dissertation would not have been possible without the guidance and the help of many individuals who in one way or another contributed and extended their valuable assistance in the preparation and completion of this study. My utmost gratitude to Dr. Motomu Takeshige, Vice President of NIT, Sendai College whose steadfast encouragement and endless support I will never forget.

The international graduate students from Tohoku University also have been my inspiration about intercultural leadership training curriculum based on academic collaborations for this research work.

References


Cultural and technological exchange through industrial program
“ICT Project in TOBA”

Keita Tsuzuki*, Tomohiro Kameya*, Junji Miyamoto*, Nobuo Ezaki*, Norihiko Hashizume*, Kunimitsu Ishida*

*National Institute of Technology, Toba College / Department Information and controlling engineering, Toba, Japan

E-Mail tsuzuki@toba-cmt.ac.jp

Abstract

In March 2014, the engineering-based cross-cultural exchange program called “ICT project in Toba” was launched in National institute of technology, Toba College (NIT, Toba). The purpose of this program for overseas students is cultural exchange through the practice of technical projects using ICT technology. The project has been held once every year for a period of six weeks, and undertaken in the Ise-Shima region listed as an international tourist destination in Japan.

This program is not only for receiving overseas students industrial department in NIT Toba, but also for local students from Japan to encourage international minds. In every year, support students joined this program were more than 20 which is equivalent to 10 % of the industrial related department in NIT, Toba. Those local students helps and work together with overseas students to conduct the technical project. They planned and visited at regional tourist facilities and accommodations, and ate local food with the cooperation of the local community.

As a result of the technical project, exchange students created tourist support system, such as a sightseeing map which automatically collects information from websites and displays places of significant activity. In the case of other group, a prototype of a real-time communication system using a hands-on device was developed. Thanks to this program, the most of support students gained opportunities to learn the cultural and technological differences between Japan and overseas. In addition they were able to think about their identity and the global perspective.

In this paper, we will report on technical outcomes, ways to encourage the local support students and the schedules of the project including preparation before foreign participants’ arrival.

Keywords: Student Dispatch, Cultural Exchange, Support Students, Information, Electrical, SNS group, technical projects, English Convesation.

1. Introduction

In Recent years, Japanese government encouraged to further globalisation of Japanese higher education. Japanese Prime Minister has announced to launch an ambitious scheme to attract 300,000 international students over the next six years, to enrol in its universities in 2014. The plan also includes that strengthening English-language proficiency among Japanese students.

On the other hand, according to the 2012 statistics compiled by Organisation for Economic Co-operation and Development, there were 60,138 Japanese nationals studying overseas which is an increase of 2,637 (5%) compared with the previous year.

While the above tread was taking place, National Institute of Technology, Toba College established short term student research and cultural exchange program “ICT project in Toba” with overseas engineering universities to promote student global engineering competencies based upon 6 weeks with academic research in laboratory and field work experiences in the local community.

The program was started in March 2014, supported by JASSO. In this program, we have set different goals and objectives to short-term international students and acceptance side of the Japanese students (Support students), respectively.

1.1 Overview of Students and Calendar

NIT, Toba has approximately 600 students and 25 advanced course students. Approximately 1 % of the students are international students. National Institute of Technology, Toba College has been 134 years since Toba Mercantile School, as it was originally known, was founded in 1881. NIT, Toba has set the following three educational goals, (1) students should keep in mind while training to be high-level, (2) practical engineers with a rich senses of humanity, (3) creativity and internationality.

The institute’s mission is to educate person with a liberal spirit, to be an engineer with a creative mind and to be a person with good international sense. The final year of the undergraduate student is devoted to laboratory research and graduation thesis.

The academic calendar of NIT, Toba follows the Japanese fiscal year, class starts in April and ends in March. It is consisted 15-week semesters which the one is from April to August, and the other one is from September to February. This unique calendar makes difficult to exchange students for semesters since it does not match most overseas academic institutions’ calendar.
However, we have 1 month of long holiday from the end of February to beginning of April, it allows for overseas exchange students to interact with NIT, Toba students.

Several exchange model of receiving exchange students at department of maritime engineering was conceived to accommodate partner college and polytechnics with NIT, Toba. However, there were no experience for the engineering department to receive short-term exchange students. Therefore, the project was set up and managed by engineering department.

2 Technical project

2.1 Model of the Project

Figure 1 shows a model of the technical exchange program ICT project in Toba which composed of field activity and technical tasks conducted by students.

ICT project in Toba was developed to practice technical training using ICT technology and mechatronics at industry-based department as well as cultural training at Ise-Shima region listed the international tourist city. Students from abroad to stay over a period of six weeks among local support students.

For the field activity, both side of the participants went for field activity which is to visit regional tourist facilities, accommodation, restraint, and engineering factory to learn cultural background and manufacturing technology of Japan.

Technical project is a task for the students from oversea. The project to establish the system or device support many foreign tourists visit at Toba city where NIT, Toba is. The students should be able to summarize their opinions from the field activities from the point of view of foreigners.

On the other hand, local support students, belong to NIT Toba, is possible to experience communication using foreign language and cross-cultural understanding to enrich their practical skill as an international person.

As a summary of the program to perform a joint presentation of the participating students and support students. Those projects and activities create an opportunity to faces the differences between own culture built by historical and technological background to all the participants.

2.2 Admission of oversea and local students

A summary of the students from abroad involved in ICT project in Toba is shown in Table 1. We approached several universities, colleges and polytechnics. For the exchange students, development of a tourist support system, such as information display system and electrical device for foreign travellers, was set as a goal. While the short-term foreign students to stay, they visit around the tourist destination with support students to discover what the attractive points of the Ise-Shima area are. Thanks to the experience they had from the tourist spot, exchange students work on the ICT project with understandings the information what should be and how to distribute to foreign travellers.

During the project, problem-solving ability of ICT skills, and cross-cultural understanding was trained.

Table 2 shows number and attribute of the local support students. Task of the support students imposed a planning and guidance of the field activity taken a place at Ise-Shima region. In each year, more than 20 support students were able to interact with students. In addition, for the support students in to introduce their local place, where they grow up and well known, in English. Goals was set to achieve the development of cross-cultural understanding and communication skills.

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2.2 Laboratory, Research and Cross-Cultural Experience

Before the project starts, election for both of the dispatch student from foreign institution and local support students belongs NIT, Toba was performed.

Participant students from overseas fill the format and send their information about their topic in application admission form prior to arrival propose a research plan. This helps to authorize the topic of the project.

Support students were also selected as motivated students by announcement to the whole college. Because Toba is located the country side of Japan there were few case to talk in foreign language.

Usually Japanese students need to participate dispatch program to the outside of their country by spending much cost if the students desired to talk in other language. However, this program produces good opportunity for the elemental English speakers to communicate deeply without paying a lot of money.

As shown in Figure 2, communication by using web-based group page was created to start communication through network following the selection of the exchange student and support students. It makes possible for local students and staff to catch the prior information before the overseas students arrive. Exchange students and support the students were able to take the contact to teachers including dispatched institution which gives closer relation between members of the project. Also, during their stay in Toba, the students from the overseas uploaded the photo at the nightly 22 o’clock at accommodation for organizing staff to be sure for their return.

As shown in Figure 3, Japanese students created activity report in English, and then overseas student checked their report. Students from overseas and local support students from NIT Toba were well communicated by working together on field trip to research problems at tourist spot and creating their activity reports.

To encourage smooth communication between students, there were no sufficient rules to strict the activity of the students for this group page. Therefore, students started to share their activity by uploading daily photo during the project as shown in Figure 4.

Figure 2 Communication on group page: Closed group page on the internet worked to communicate for exchange information about activity, share the electrical files

Figure 3 Example of activity report: Summary of the activity is written by Japanese students and reviewed by overseas students

Figure 4 Photos taken during cultural exchange and field work program:
(Left) Field trip at Aquarium to find attractive facts
(Right) Welcome Party planned by local students

Figure 6 FY2014: Presentation of the work at hall of Chamber of Commerce and Industry in Toba

Figure 7 FY2015: Presentation of the work at hall of NIT, Toba
3. Technical research program

During the technical program, common working room which 5th grade and advanced course stay for graduation thesis is able for exchange students to use freely among with the Japanese students. Therefore, foreign students were able to touch to support students and a lot of Japanese students at laboratory. On the other hand, private room accommodation was prepared to ensure privacy.

As shown in Figure 6 and Figure 7, summary of the program including a presentation and a demonstration of the products was given not only to the students at Toba College but also to the community members.

In the case of the project titled “Tourist information display system for foreign travellers”, basis of the webpage was developed in cooperation with the Chamber of Commerce and Industry of Toba. Before students from overseas arrive in Japan, they were asked to investigate the location where you want to sightseeing in Ise-Shima region and reported on the survey methods. As a result, Web sites that the information for foreign tourists was found not to be browsed. Creating mechanisms to work with the Web site of Chamber of Commerce and Industry to launch basic information of Toba.

Those results gives that exchange students and support students to be not only loaded with valuable experience but also given a good stimulus for the local area. For international students was able to learn specific ICT technology through system development (PHP, MySQL, various API) as well as the charm of Ise-Shima region through among with a lot of Japanese students.

4. Conclusions

Since FY2014, NIT Toba launched technological exchange based on engineering training program ITC project in Toba.

Students from overseas and local support students from NIT Toba were well communicated by working together on field trip to research problems at tourist spot and creating their activity reports.

Launch of a Web-based group page for the project was carried out to enhance the communication between exchange student, support student and teachers and staff. It helped a lot to understand each other and share the information even before and after the project taking place in Japan.

Overseas students successfully gave a presentation and demonstration about their outcome to share with local students and community. After the project, Japanese students recognized the need of English communication in English through the activity which spend the time together with exchange students, motivation to English learning was grown up. Also, it is successfully offered chances to be aware of the differences between the cultures of other countries.

Acknowledgements

This work was partly supported by Japan student services organization (JASSO). This work was partly supported by Toba chamber of Commerce and Industry.

References