Ten Years Educational Activities Using Electric Vehicles at Kochi University of Technology: 1st Report of Extracurricular Activities in 1997-2000

Haruo Sakamoto

Department of Intelligent Mechanical System Engineering, Kochi University of Technology, sakamoto.haruo@kochi-tech.ac.jp

Abstract

This report describes the educational activities using electric vehicles in the past 10 years in the Kochi University of Technology, which was opened in 1997. Since the inauguration, extracurricular activities had been conducted in the intelligent mechanical engineering department in the university, and the author was a consultant for participated students. In this first report, the extracurricular activities using electric vehicles were the Eco-power race conducted in Kochi prefecture in 1997 and the Electric Vehicle Rallies in Shikoku Island in 1997-2000. Such activities were the first stage leaning for engineers to raise the motivation. Electric vehicles used in Shikoku Electric Vehicle Rally were converted ones from conventional automobiles. After such participation, the author switched the consultant role to an another faculty. In our laboratory the education has been conducted considering experiences in the real world as is described in the second report. One of the most promising experiences as mechanical engineers is a creation of thought to be design and production of products such as vehicles. Vehicles produced were small-sized hand-made electric vehicles, electric motorcycle, and tricycles. In this report, the former half regarding the extracurricular activities is described.

Keywords

electric vehicle, electric motorcycle, electric tricycle, electric vehicle rally

1. INTRODUCTION

The Kochi University of Technology has been trying to develop new engineering educational curricula such as first year seminars using real products [Sakamoto et al., 1997] experimental courses using vehicles [Sakamoto, 2001], computer assisted English education [Greene, 2001, Hunter, 2001], and so on. Among them, the author thinks that the design education is of great importance, as Fargason [Fargason, translated by Fujiwara and Sunada, 1995] mentioned that design is engineering synthesis. As design practices, electric vehicles can be good targets to start.

In 1997 when the university started, the author was informed that in Kochi the Eco-power race is held every year. The Eco-power race used to be the race for gasoline-powered small vehicles up to 1997. The race competes gasoline mileage, and vehicles are hand-made ones and the license for them to drive is not needed in the limited race place. When the author suggested students to participate the race, two teams raised their hands to join by electric vehicles as well as three gasoline-powered vehicles. This was the first for the race to hold by electric vehicles. The race is organized and held by Kochi Toyota Vista (changed now to Kochi Toyota Netz Nankoku).

In 1998, the Shikoku Electric Vehicle Rally was held. The rally is the first rally using public roads in Japan, while the Eco-power race and other rallies are conducted in the limited area outside of public roads. The rally had been planned and prepared prior to the date for a several years. The author joined the committee in 1997. The author again proposed students to join the rally. Three teams agreed to join. The rally was conducted in the east side of Shikoku Island following the route from Takamatau (North of Shikoku), Niihama (North West), Tokuhsima (East), and to Muroto (South East) and Kochi (South). Due to the transportation difficulty, the university teams joined from Tokushima. In 2000, the rally was again held in Kochi after the one in only Tokushima in 1999. For the 2000 Kochi rally, the author was a chair of the rally committee.

The above two activities were conducted mainly by 1st year and 2nd year grade students. As the early stage experiences in academic mechanical engineering life, they were able to learn engineering by thinking out and producing products focusing preliminary electric vehicles. The second step in 2nd report is the design and production by their own idea

2. KOCHI ECOPOWER RACE IN 1997

One day in May, 1997, the author noticed the Eco-power race in Kochi, which is organized and held by Kochi Toyota Vista (now Kochi Toyota Netz Nankoku), and a vehicle was exhibited in the Kochi castle. Since the

Fig. 1 Attendees in the Kochi Eco-Power race

Fig. 2 Teams from the Kochi University of Technology

Fig. 3 Participated electric and gasoline-engine vehicles

author was from a steel and iron maker before working with the university, he had no knowledge on both of vehicle and engineering education for such an extracurricular activity. Although it was thought that another faculties might have such an extracurricular experience, no faculties had been engaged in such activities. Only the author appealed the 1st grade students and asked whether they might be interested in. 5 teams expected to participate. The race was announced to perform in the early November. Because the students except one team had no experience as well as the author, they needed to consider, plan, and fabricated by themselves. The one team had such an experience in their senior high school days. Figure 1 shows the people participated in the race. The role of the faculty was to obtain the funds and cooperation with some private companies which can help us. Figure 2 shows the members of the Kochi University teams. From the left, the gasoline-powered vehicle which was produced before 1997 by students in their senior high school days. What they did was to modify the vehicle in order to obtain more efficient mileage record. The second and the third are electric vehicles which were produced by themselves for the race. When the faculty proposed to 1st grade students in June, 1997 to participate in the race, two teams wanted to participate by electric vehicles. The forth is a gasoline-powered vehicle produced for the race. The fifth is a gasoline-powered one which the team borrow from the Kochi Toyota Vista. In other word, the fifth team participated just for driving experience.

The race was conducted in a circular–like place, whose total race length is 10km. The circular length is about 400 m for one round, and totally they need to run 24 rounds. Regarding the produced gasoline-powered vehicle in Figure 3 right, the production was just finished at 6 am early morning on the race day after spending overnight as well as several day overnights prior to the race day. Although the vehicle was completed, the gasoline engine did not work. Since it was thought that in the race location there must be attendees who know the engine much more us, we decided to transport the vehicle to the place. 9 am was the time to start the race. After some of the attendees took a look at the engine, they notice that a valve in the engine placed in a state of upside down. Fixing the valve, they were able to start the engine, and the race started for them right after fixing. The time was 11 am. In the remained time in the morning race hour, they were able to join the race as the last team. However, because of the elongated belt produced the slippage during the engine rotation, the gasoline mileage was terribly bad. They were not able to accomplish the race. In the afternoon session, the race organizer permitted to pour gasoline during the race. Their record obtained in the race was 28 km/l. Meanwhile the best record among participated teams was about 600 km/h. 28 km/l was the worst in the races conducted in the past. However, they succeeded to produce the gasoline-engine vehicle, and fulfilled the race. The author thinks that a success experience like in this time will enhance the student learning especially design and production.

As far as electric vehicles, two teams expressed their intention to participated and prepared the vehicles. However, the race is basically for gasoline-powered vehicles, and two teams were not able to join the race. Instead, they were requested to drive as a demonstration in the race place after the race. The two teams were fabri-

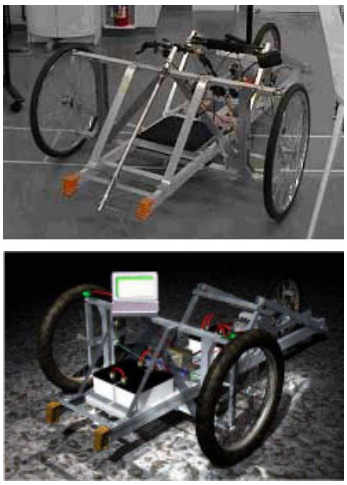

Fig. 4 Fabricated electric vehicle (top) and its CG (bottom)

cated having enough body strength and powerful motor and batteries. There were no problem for running. After the race, one team in Figure 3 left draw their vehicle by CG (Computer Graphics), which is shown in Figure 4. After the race was conducted, one student was curious about CG and tried to draw. From such activities, 1st year grade students experienced their first entrance into mechanical engineering.

3. SHIKOKU ELECTRIC VEHICLES RALLY

3.1 The rally in 1998

In 1998, the Shikoku electric vehicle rally was held in the east part of Shikoku Island. The rally is the very first in Japan in a sense to use public roads. Normally, rallies are held in some circuits, which the rally route is limited as is the Kochi Eco-power race in 1997. Since the rally is conducted in public roads, the automobile vehicle license safety test and registration is required. The rally was planned in 1997 by university and technical college faculties in Shikoku. The author joined the rally organization committee in 1997 when the university opened. Totally about 50 teams joined in the 1998 rally. Among such 50 teams, three teams participated from the Kochi University of Technology. The teams were based on the ones for the Kochi Eco-power race in 1997. Since it is hard to fabricate vehicles from an original idea, most participated vehicles are converted ones from conventional automobiles. This means that they put gasoline engines out, and added an electric motor and batteries instead.

Even electric vehicles, they need to pass the vehicle inspection for getting a license. Figure 5 top shows the two converted electric vehicle produced by students and a vehicle during electric charging time. Although the rally started from Takamatsu (North East of Shikoku), the teams from the university joined from Tokushima (East of Shikoku). The reason is the transportation is-

Fig. 5 Start of the rally and a vehicle in the charging time

sue, which is batteries life per one charging. Regarding the vehicle inspection needed prior the rally, three teams submitted the required materials one week before the rally to related Kochi organization. However, three teams failed to pass the inspection. They needed 2-3 days to pass, since their experience at this time was the first in such work.

Besides the inspection troubles, one team had a trouble by an electric issue right after the start. Since the author was a member of the committee, it was impossible to understand whether student teams were doing good and to take care of. However, they were able to recover by buying a part. During the rally, there was a long driving distance of about 50 km which is hard to drive within one charging chance. Three teams thought out by omitting their navigator. They needed to take care of batteries during the race. At some place of Muroto, Kochi (South East of Shikoku), they needed to obtain electricity by full charging, since there is a long distance to climb to a mountain. The teams were divided into two categories. One is a driver and navigator, and the other is students who take care of batteries all night long. Although one group was able to sleep on beds, the other needed to take a rest on concrete. After some troubles and difficulties for driving, three teams succeeded to reach to the final goal at Kochi (South of Shikoku). Figure 6 shows the moment when the teams were welcomed by supporting people. In the middle, a reporter is inter-

Fig. 6 Three teams succeeded to reach the goal

viewing.

In the race, one team from MIT (Massachusetts Institute of Technology) joined. The car is fully equipped with solar panels, and is, therefore, expensive one. The author assumes that the cost is more than $100,000, which is 100 times of our converted electric vehicles. The car can speed at 100 km/h, and our converted cars speed less than 50 km/h. The rally from Tokushima where our teams joined last three days. The rally ended at Jibasan Center in Kochi, where the closing party was held. Figure 8 shows the party. The left figure is the one in which students were interviewed, and the right is the Kochi governor, Mr Daijiro Hashimoto, joining in a photograph with students after the party. The rally succeeded, and each participated student had a successful experience.

Fig. 7 MIT team using a solar car (Manta)

Fig. 8 Closing party celebrating the success of the rally

3.2 In-class experiment using electric vehicles

Since the author needed to take charge of an experimental lecture in 1998 after the rally. He thought that electric vehicles could be used for the experimentat study.

Fig. 9 Experiment using electric vehicles (Preparation and running experiment)

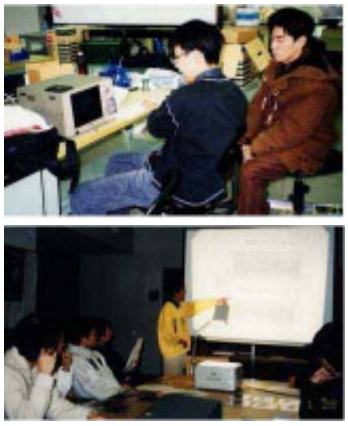

Fig. 10 Experiment using electric vehicles (Analysis and presentation)

The lecture included plan, preparation of strain and acceleration measurement, measurement during running tests, analysis of strain and acceleration, and final presentation. Figure 9 and Figure 10 show how students did in the experiment. The first stage is the preparation of the measurement. They needed to use stain gages and accelerators in the body of the vehicle according to their plan. The second was the measurement. The driving was conducted around the building where the preparation was made. In the car, a student needed to hold the instrument since we did not have a compact instrument at that time. After the measurement, they analyzed the measured results which are the time history and frequency response. Finally, they presented what they did and obtained. Grades were made mainly by attendance and presentation.

3.3 The rally in 2000

The rally in 1998 was conducted using the route from Takamatsu to Kochi, which is too long. The committee found the issues of batteries life and transportation for participated members except a full-dressed vehicle like

Fig. 11 Electric vehicles in 2000

Mitsubishi motor' electric vehicle. That is not like converted electric vehicles. Our electric vehicles used a conventional compact car and were converted to electric ones by using a motor and batteries. From such a reason, the committee decided to hold at each prefecture. The first was in Tokushima in 1999, and the second was in Kochi. Because that the author was a chair of 2000 Shikoku electric vehicle rally, he was not able to consult with students. The teams were only two. Figure 11 shows the two vehicles ar the rally. The left of Figure 11 is the same which participated in the 1998 rally. The right of Figure 11 is the normal vehicle size. The team of the right vehicle did their best to accomplish assembling for driving, and finally they failed. Although the rally was successful one, this team was not able to be celebrated.

4. DISCCUSION

In this report, the extracurricular activities using electric vehicles are described. The vehicles consist of handmade small three wheel vehicles and converted ones to electric from conventional light weight four wheel vehicles. Besides, the experimental lecture using light weight electric vehicles is reported. These activities were conducted by mainly 1st and 2nd year grade students except the 2000 electric vehicle rally.

4.1 Team member and club formation of extracurricular activity

In the activities of the Kochi Eco-Power race in 1997 and the Shikoku Electric Vehicle rallies in 1998 and 2000, there were no formal extracurricular activities admitted by the university management office. Instead, the author was the only faculty who took care of the activities. That situation was not disputed at that time when the university was just inaugurated. The team members were just students who were interested in such activities. The teams consisted of half from the electrical engineering department and half from the mechanical engineering department. There was no chief because that the activity was not admitted as a formal club. Therefore, these were groups of participated members and an adviser (the author). Since it is thought that such activities may not last long, the official club activity as an electric vehicle activity started in 2001. They were able to receive the budget from the university. Regarding the budget, the author had a budget for the Kochi Eco-power race because the budge was not so large. In the Shikoku Electric Vehicle rally, the budge became large. The author asked the budget to the committee as well as asking private companies nearby to cooperate. After being a consultant for the club from 2001, the author switched to the another faculty in 2003.

4.2 Theme for extracurricular activity

The department which the author belongs to is the mechanical engineering (Intelligent Mechanical Engineering Department). As learning about mechanical engineering, the author thinks that such electric vehicles are appropriate. It is also appropriate for electric engineering. It has been good targets for 1st and 2nd grade students as was explained. Regarding the club activities, 1st, 2nd, and 3rd year grade students join in such activities. Therefore, such extracurricular and club activities are considered to be good practices as the beginning of mechanical engineering. Today, we have the club activities for electric vehicle, robot, and formula vehicle in our department. In our laboratory, the chiefs of electric vehicle club and robot club used to play their role, and now they are graduate students.

5. CONCLUSION

As an engineering education, the extracurricular activities are reported. The following results are obtained.

(1) As an extracurricular education, the author was engaged in the Kochi Eco-power race and the Shikoku Electric Vehicle rally. Students participated were 30-40 in the two activities. Although the club activities like such extracurricular ones did not exist in the beginning 2 years in the university, club activities of electric vehicle, robot, formula began since then.

(2) Although the author was not able to guide their activities because of the student large number, the participated students were able to obtain their success experience. One exception was the conventional vehicle size electric vehicle in 2000. The author was not able to take care of the team. The author hopes that such a success experience may promote their engineering learning and life in the society..

(3) The extracurricular activity theme was focused on electric vehicles. They need to plan, fabricate, and make the vehicles to drive. There exists a lot of engineering issues they need to solve. Such an experience is thought to be the base for them to learn engineering. The author hopes that based on their experience, they study the higher level engineering.

Acknowledgement

The author greatly acknowledges Dr. Koichi Miyashita of Naruto University of Education the chair of Shikoku Electric Vehicle rally committee, and Dr. Hiroshi Nomura of Kochi NationalCollege of Technology Members participated in the race and the rally and cooperated industries are also specially thanked.

References

Fargason E. S, translated by Fujiwara and Sunada, *Gijutsusha no Shingan*, Heibon Co., 1995.

Greene D., "LATCH: a syllabus design for EFL instruction in CALL" in Computer Assisted Language Learning, *Lisse, The Netherlands*, 11, 4, 381-96. 2001.

Hunter L., "Text nouveau: visible structure in text presentation" In Computer Assisted Language Learning, *Lisse, The Netherlands*, 11, 4, 363-79, 2001.

Sakamoto H., Design and Manufacture of Small-sized Electric Vehicles for Mechanical Engineering Education, *Journal of Robotics and Mechatronics JSME*, Vol. 13, No. 4, 426-431, 2001.

Sakamoto H., Kusukawa K., and Jorgensen J., Mechanical Engineering Education for 1st Year Seminar Using Real PProducts, *ASME,* DE-Vol. 102, 13-17, 1997.

(Received November 8, 2007; accepted December 21, 2007)