

Consideration Concerning Proof Verification of Energy Education Teaching Material in Technical High School

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Abstract- In The new Education Ministry guidelines to be completely carried out in high schools which will start from the 25th year of the Heisei era), the following goals are described in the aims of the industrial high school's industrial education purposes : "To make the students master the fundamental/basic knowledge and technology as well as understand the industry's significance and role in the present society; so that they can pay attention to the environment and energy so as to solve the industrial technologies' various issues proactively, rationally and with moral values; in this way, the students grow up their creative abilities and practical attitude to develop the industry and society." In this respect, to deal with the new Educational Ministry guideline and satisfy the above mentioned purposes, we have introduced the solar car manufacturer. We, to deal with the above mentioned contents, herewith propose a cross curriculum teaching system, by adding a solar car manufacturer in the classes of the industrial department.

I. INTRODUCTION

In The new Elementary School Education Ministry guidelines [1] to be completely carried out starting from the 23rd year of Heisei era, and in the new Junior High School Education Ministry guidelines to be completely carried out starting from the 24th era of Heisei; there are many key words shown with regard to "Environment" and "Energy." In this way, the environmental education and the energy education will be further strengthened. Particularly, in the new Educational Ministry guidelines, which will be completely carried out in high schools, the respective subjects and schools are defied in accordance with a report to the CENTRAL Educational Council as follows: Cultivate the future-specialists Cultivate the human resources who bear the region and industry Cultivate the professionals being rich in humanity. Based on these three viewpoints, the respective subjects' constitution and contents have been improved; with regard to the normative consciousness or ethics, technical development and environment, attention to energies, safety of food, information moral, importance of security management knowledge, etc. In these viewpoints for the students to obtain the knowledge, technology and qualification required for

each industry, each subject's constitution and contents have been planned that to be improved. Among them, in the technical department, an "Environmental Engineering Basic" subject will be newly established.

Until now the authors have discussed with each other how the manufacture of solar car should be involved in the practical lessens during the duration before the students join the international race; in which the students actually manufacture a solar car so that they may learn the environment and energy education in the technical department since the 20th of Heisei era.

Therefore, in this study, we report our experiences in our solar car manufacture. We think of the energy / environment education [2] which aims at "The sustainable society formulation" proposed by the Resource / Energy Agency for the technical high schools, and we bring up the people who can all their lives intentionally and appropriately act for solution of the energy / environment problems. In this way, we have examined an educational effect of the solar car manufacture, in which we placed the energy/environment education as our pillar, and also we report how the solar car manufacture should be involved which we examined in our past practices.

II. OUTLINE IN SOLARS

Fig. 1 shows the simple structures of gasoline-driven, electric, and solar cars. In the case of general solar cars, they use two types of solar energies; i.e. the heat energy and the light energy. Generally, a solar car is driven by the electric energy which is converted from the sun light to the electric energy. The sun light energy is converted to the electric energy. That is the photovoltaic power generation equals the solar battery. In a solar car, this type of solar battery and another battery which stocks up the generated electricity. In other words, a solar car is

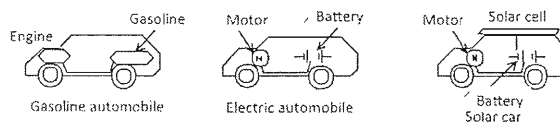


Fig.1. Basic structure in car

an electric car driven by a motor while electric power generated by a solar battery put on the car. In Miyazaki prefectural industrial high school, where solar car class practices were carried out, solar car development activities have been conducted as a part of after-school club activities, thus they have participated in the world event 10 times on end.

The highest peak of solar car race started in 1992 (4th of Heisei era) is conducted under the rule that the cars driven only by the solar battery compete in the endurance race for 4 or 8 hours. There are 4 participation classes in all; which are divided depending on the car capability etc.[3]

Fig. 2 shows the course of Suzuka Circuit where the race was conducted. In 2010, Miyazaki Industrial high school made an entry in the 8-hour endurance race (CHALLENGE CLASS). The solar car race Suzuka, which they participated in, is the highest peak of solar car race; which Federation Internationale de l'Automobile (FIA) officially endorses. While the earth's warm event was calling out, FIA started in 1992 so that they would target manufacture of the cars run by the clean sun light energy. Another world famous solar car race "World Solar Challenge = WSC" (Australia) was held in 1987 for the first time. Thus the solar car race Suzuka is proud of its long history next to WSC. Until the first half of 1990s, a large number of corporation teams participated in the race, and in the last half of 1990s, the number of teams of universities, specialized vocational high schools, high schools, etc. was going to increase. The main reason why the number of those students increased is that the high school, specialized vocational high school and university authorities highly evaluate those students who for themselves get involved in manufacturing of the car body etc., that is they go to the place where they can learn the basic of "Monozukuri (Manufacturing)".

The race is an international competition approved by Federation Internationale de l'Automobile (FIA). Therefore, the general outline of the race is applied to FIA's international motor sports rules and JAF's domestic competition rules [3].

The following qualifications are necessary for participation :

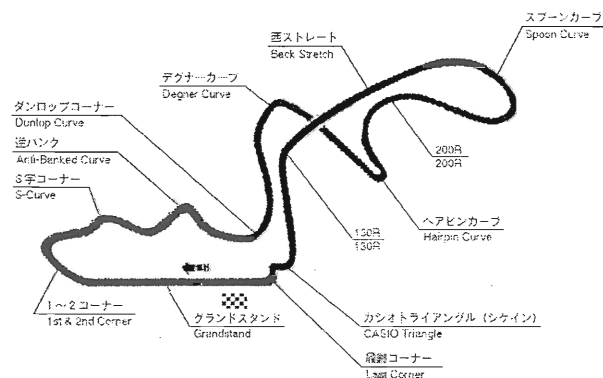


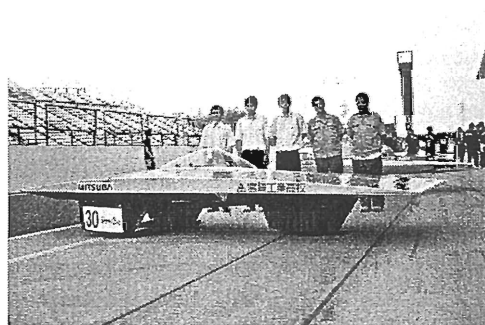
Fig.2. View of SUZUKA circuit course [3]

1. "International entrant license" Qualifications of Manager/responsible person.
2. "International solar car license" Driver's license.
3. "Medical certificate" Driver's health certificate.

The team's basic lineup consists of the entrant, driver and pit members; and up to 8 persons can be registered.

- Entrant : 1 person (20 years old or over)
- Driver : It is mandatory to have two(2) drivers, and up to 3 drivers can be registered.
- Pit member : 15 years old or older as of the race day (Junior high school students are not available)

Photo 1 shows an appearance of the time soon after the race started. In the race of 2010, the weather was blessed; so the solar car race was conducted under a fine weather which is proper to the solar cars. All the cars wasted electric energy on the first day, but all of them were able to stock electric energy by means of charging from their solar battery panels. In this race of 2010, the weather was fine and the car racing proceeded in high speed; therefore, a lot of unexpected machine troubles occurred such as the punctures of wheels, shearing of axles, minor collision of cars, etc.



Photograph.1. Appearance of the time soon by solar car

III. MANUFACTURE OF SOLAR CAR MACHINES

Fig. 3 shows an appearance diagram of a car manufactured. The basic design of the car body is according to a competition vehicle, which is pursuant to the vehicle code and standard of

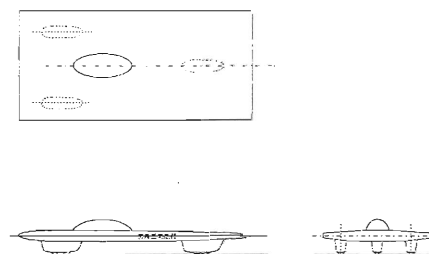


Fig.3. View of SUZUKA circuit course

“Dream Cup Solar Car Race Suzuka”. The material of the car body is of carbon composite in order to realize weight saving. In addition, the car body is designed to be thin type so that it realizes a stable running in high speed (100km/h) preventing air resistance.

Fig. 4 shows the data measurement system configuration which obtained by using a current integrator the generated output and electric power consumption of the solar battery when the manufactured solar car was running. With regard to the data collection, an electric shunt is used for the 2 units of current integrators and the current detection part. When the car is running, the driver checks the data of digital display and reports it by cell-phone. In this way, a variety of data is checked at the pit; thus grasping the machine condition by the whole team. A variety of digital data is accumulated by the data logger (GRAPHTEC Co.Ltd.,; midi LOGGER GL200) which has 10 channels independent input terminals. This system can also grasp the energy conversion as well as the energy balance of electric energy amount used, on the basis of the solar light of each race.

Fig. 5 shows the consumption current, the voltage, the running speed of the solar car, and the relationships between them; which were measured by the system of Fig. 4 in the lap of car running. The numbers written in Fig. 5 are the same as those written in the course of Fig.2. When running, the changes of the charging current and battery voltage are repeated due to

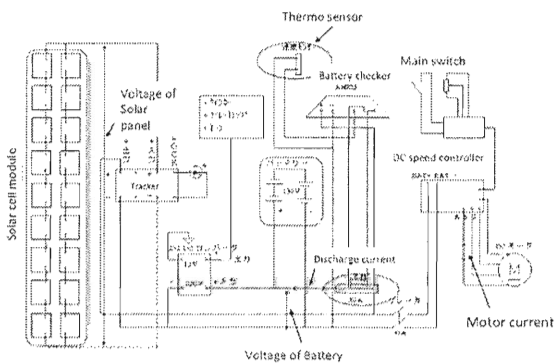


Fig.4. Outline of data measurement system

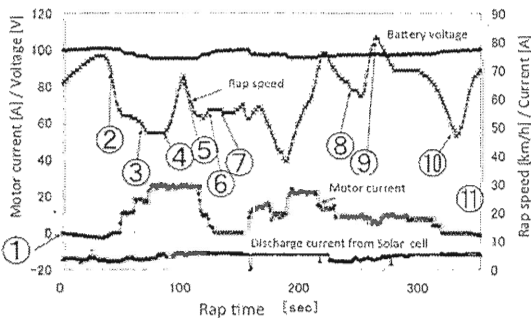


Fig.5. Basic structure in car

the direction and angle of the sun seen from the solar battery module. As for the differences of the measurement results, these results were brought by some main reasons such as shadow areas due to hindrance, no sun light to a part or all of the solar battery module, and a variety of competition time between day time and evening.

Fig. 6 shows the situation of charging from the solar battery to the battery before the race. In respect of fully charging the battery, it is important to keep the solar battery module stationary, and keep the battery upward to the sky and adjust the position and angle of the body cowl; so that the battery may be well charged. We learned from the past racing that it is very important to insert Maximum Power Point Tracker (MPPT) [4] in-between the solar battery module and the battery depending on the amount of solar radiation. MPPT is used not only to keep the terminal voltage in a fixed value but also used to supply a fixed voltage to the secondary battery capacity. It is also necessary to increase the power generation efficiency at full by means of cooling down the surface of solar battery module using cold water. It is because the surface temperature of solar battery module has an effect on the charging current. By processing these data collection, it is possible to confirm the power generation voltage of solar battery, the battery charging current, the current passing from the battery to the motor while the car is running, the charging current to the battery by the regenerative braking while the car is running downhill slope, the electricity charging capacity itself, etc.

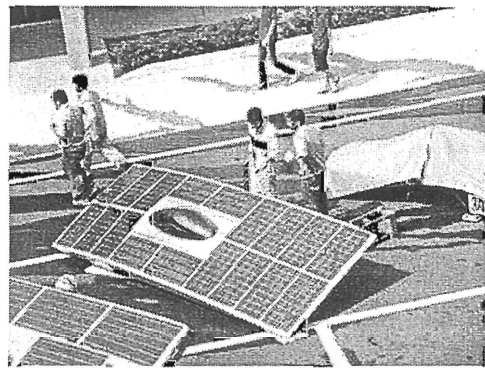


Fig.6. Situation of charging from the solar battery in solar car

IV. OTHER

For example, in the basic guideline of Energy / Environment Education, “In order for Japan to steadily promote the countermeasures against the energy security and the global environment problems to constitute a sustainable society, it is required for everyone of the Japanese should consider the closely related energy problem and

the global environment problem as their own challenges, and make judgment and conduct themselves [5]. In order for that, they say it is important to enrich the energy environment education in the fields of schools, societies and homes". This study's solar car participation corresponds to the school education or the social education. However, at the site of school education, it is not easy to manufacture a solar car in the school class, because Education Ministry guidelines set down the contents of classes. In order to have a solar car manufactured in the class while meeting the Ministry's assignment, it is necessary to consider the cross-curriculum in respective subjects. In addition, it takes long time to manufacture a solar car. Therefore, it is necessary to consider a cross-cutting cross-curriculum and take it in the classes throughout three years.

Fig. 7 shows one suggested cross-curriculum punch diagram, which was actually considered in a mechanical department. As indicated by the same diagram, the manufacturing contents of solar car can be handled only in industrial high schools where classroom lectures and practical trainings can be done in parallel. We think our new teaching style is that we should involve new processes cleverly and successively in our classes; and we think our career teaching in such

methods will be closely relative to the industry being progressing day by day.

V. CONCLUSION

The manufacture of solar car consists of an effective utilization of light energy in the photovoltaic generation. Thinking of the economization or recycling of the resources, we think they pay much attention to the environment and energy in the processes of the selection of resources, processing, assembly work and disposal; thus performing the classes being matched to the technical department. These contents are meaningful when being dealt with the technical department, but there are some big problems in respect of the fund and long-time manufacturing period. These contents esteem the independence of the students who willingly deal with the car body design/manufacture, trial running, and the other works to participate in the competition; thus we think a very beneficial education effects shall be obtained.

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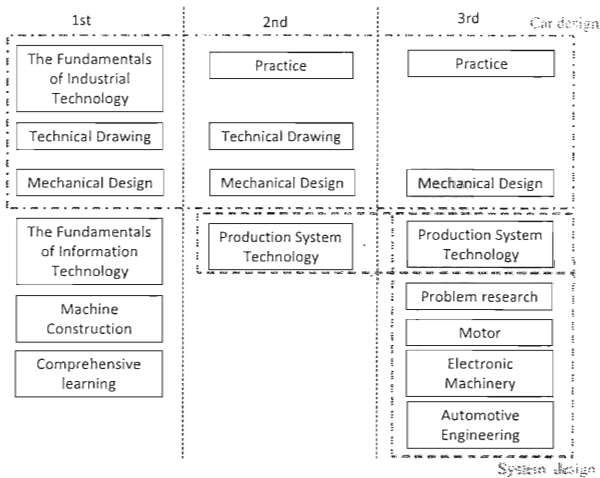


Fig. 7. One suggested cross-curriculum punch diagrams