The SINAG Solarcar Project: Work-Based Learning in Campus

MARTIN ERNESTO L. KALAW
RENE D. FERNANDEZ
Mechanical Engineering Department
De La Salle University

ABSTRACT

The approaches and strategies used by faculty advisers of De La Salle University-Manila to manage the learning aspects of the first SINAG solar car project are presented. In retrospect, the project is a work-based learning program wherein the workplace is brought into the campus. From conceptualization down to design, fabrication, testing and deployment of the car to the World Solar Challenge in Australia, building this unique, exotic vehicle of the future, has become the center of a focused work environment. The purpose of this paper is to share our insights on this unique opportunity and experience.

Keywords: work-based learning, experiential learning, open curriculum

I. INTRODUCTION

In October 27, 2007, SINAG, the first Philippine solar car arrived in Adelaide, Australia, thus completing the 3000 km plus cross-continent race, dubbed as the 2007 Panasonic World Solar Challenge. Building SINAG and pitting it against some of the best designed solar cars in the world instantly became a source of national pride: both events were unprecedented in the Philippines.

SINAG crossing the finish line in Adelaide
(source: http://SINAG.dlsu.edu.ph)

II. BEGINNINGS OF THE SINAG SOLARCAR PROJECT

The idea for a Philippine solar car joining the World Solar Challenge in Australia was first envisioned by Henry Co, then President of Ford, Phils. in one of his visits to Australia. Having seen a staging of the cross-continent race, he noted that many teams participating in the race were composed of students, some of them still in high-school. He wondered *why not Filipino students*? But he understood that fielding a Philippine team to the World Solar Challenge would entail formidable challenges in organization, resources, manpower, and skills. Realizing that the challenges at hand were difficult but do-able, he immediately embarked on a quest to bring together major industry sponsors and one academic institution to transform a dream into reality. And the rest is history.

III. THE POTENTIAL FOR LEARNING

One of the unique characteristics of this project was the involvement of students, specifically engineering students from the De La Salle University-Manila. As team membership was entirely voluntary - with no enticements of remuneration, whatsoever, - recruitment had to be carefully planned. Right at the onset, the university needed to know what aspects of the project would most appeal to the students. These aspects should be attractive enough to convince them to take on challenges over and above their current academic pressures.

The major reasons cited for joining the project were threefold:

- the excitement of building the first Philippine solar car
- the historic first participation in the World Solar Challenge and the prospects of going to Australia
- learning through the process

In all of these, however, the university has great influence on the learning aspect. The rest are extra-curricular and the successful meeting of those expectations would depend largely on personal factors. It is the enduring value of learning that must be emphasized and be made clear to the students. Anything beyond the value of learning is a risky promise to make.

The faculty-advisers of SINAG were well aware that not everyone who volunteered would end up going to Australia to race the car. And so, this reality, despite the sensitivity of its nature, had to be revealed early to avoid false expectations. Such unguided expectations could lead to catastrophic complications later. The project administrators were continually treading a fine line between winning over students all the way on the one hand and creating waning interests and early disappointments on the other. Reasons for waning interests can come also from other sources. For example, the original excitement that students would normally have would considerably deflate once they start experiencing the realities of actual work. For those who could stay on to the very end, the constant struggle between wanting to stay and wanting to leave, which are borne out of painful shop experiences, becomes an indelible part of the learning process.

Thus, the project itself is seen as a great potential for experiential learning through actual work.

IV. WORK-BASED LEARNING

In work-based learning, students learn by actually engaging in work. The work may be through the rendering of service to an employer (from whom the student gets paid a salary), apprenticeship work, or volunteer work.

Among the many forms that work-based learning may take, the following are most applicable for engineering:

Apprenticeship
Career mentorship
Cooperative work experience
Internship
Job shadowing
Practicum
Service learning

The following are their descriptions as excerpted from the Minnesota Department of Education:

Apprenticeship
An apprenticeship is a relationship between the student and a company in which the student agrees to work in exchange for instruction to gain skills necessary to work successfully in that occupation.

Career mentorship
Career mentorships allow a student to set up a formal, long-term relationship with someone more experienced working in a specific career of interest.

Cooperative work experience
A cooperative work experience offers services and activities to help students develop skills in a paid work environment. These experiences are not the same as paid internships. An internship connects a student to a field of study. A cooperative work experience provides students with occupational and workplace skill development.

Internships
An internship is a short-term experience where the student works under supervision in an occupation to gain practical skills and experience in that occupation. Internships can be both paid and unpaid experiences. They are usually paid when the student performs work-related duties during the internship.
Job shadow
In a job shadow, the student follows an employee at their workplace anywhere from a few hours to a couple of days. The student experiences real day-to-day work in a specific occupation or industry. The student can ask detailed questions and see tasks being performed and the knowledge and skills required to perform those tasks.
Practicum
A practicum is an opportunity for students to complete an individualized project related to their chosen career at a worksite. This short-term experience allows students to demonstrate their knowledge and ability through performance-based measures. It also gives them the opportunity to take advantage of state-of-the-art technology and resources, which businesses and industries use to remain competitive but are too expensive for schools to purchase.
Service learning
Service learning helps students understand the needs of their local community while gaining valuable skills which will benefit them as citizens and employees. Local businesses, non-profit, social service organizations and schools form partnerships to address community needs and involve the youth in learning experiences. This type of learning can be a short-term program or a long-term project.

V. CHARACTERISTICS OF THE SINAG PROJECT AS A WORK-BASED LEARNING PROGRAM

Considering the characteristics of work-based learning as elucidated in *Work-Based Learning: A New Higher Education?* (Boud and Solomon, 2001), the following are in common with the SINAG project:

1. *A partnership between an external organization and an educational institution has been established.*

   Through the initiative of Henry Co, industry sponsors, namely, Pilipinas Shell, Ford Phils, San Miguel Corp., Motolite, SunPower, Philippine Airlines, Ventus, among others, formed the Philippine Solar Car Challenge Society, a non-profit organization, chaired by former Secretary of Energy Vince Perez. The Society, as it is called, went into partnership with the De La Salle University-Manila (DLSU), which was later brought in as a member and a co-sponsor.

   The main point of the partnership was that the Society would provide all the resources while the partner academic institution would provide the technical support and the manpower through its faculty and students. The Society agreed that the design, building, testing and racing of the solar car would be done by the engineering students and faculty of DLSU subject to the rules of the 2007 Panasonic World Solar Challenge.
2. *The learning follows from the needs of the work, in this case the building of the solarcar; thus, essentially the work is the curriculum.*

   Many of the work knowledge and skills required in the design and production of SINAG are not in the formal curriculum. For example, advanced light-weight materials, cutting-edge solar technologies and special fabrication techniques are involved. But, since these are needed to realize SINAG, volunteers have to find time to explore beyond the bounds of the current academic program and pursue an active role in research. Students are able to explore many obscure channels of information, mostly through the internet, and learn to discriminate between what is useful and what is worthless. With minimal guidance by their advisers they have been able to piece together these bits and pieces of information from diverse sources and apply them to SINAG. It is the role of the faculty advisers and the nominated consultant, David Fewchuk of the Aurora Solarcar Team of Australia to ensure that many of the potential pitfalls are identified early and addressed immediately so that costly mistakes could be avoided.

3. *The students are grouped in recognition of their current competencies and which areas of the solarcar development they are interested to learn.*

   At the start of the project there were about sixty volunteers, most of which were junior and senior Mechanical Engineering (ME) and Electronics and Communications Engineering (ECE) students. In their application forms, they were asked about their skills and work interests and were grouped accordingly. There were four main work groups, the Shell Design Group, the Mechanical Group, the Electrical Group, and the CAD Support Group. The Mechanical Group was further divided into the Steering, Suspension, Brakes and Wheels, and Cockpit System; and the Electrical Group, into the Solar Array, Battery Protection, Telemetry, Motor Control, and Dashboard Instrumentation.

4. *The learning projects are undertaken in the workplace.*

   In SINAG the work environment was created intra-campus. The University administrators approved a facility renovation that converted part of the old ME laboratory area into a functional SINAG Workshop. A nearby office was furnished with an extra desk and a high-speed desktop PC loaded with Solid Works, a high-end CAD package. In this workplace, the CAD team translated into digital drafting files all drawings of SINAG and its components, and all aerodynamic and finite element analyses carried out.

   A dedicated service line for procurement and financial services was also requested from the University to fast-track all SINAG related requests.

5. *The learning outcomes are assessed by the educational institution.*

   As this was the initial implementation of the project, there were no established methods and bases for academic assessment. However, it was recognized early on that since students were engaged in actual engineering work, their participation should be credited to their respective programs. Students were given the option to credit their participation as equivalent to their Practicum Course (OJT) and/ or their Thesis Project Course. Assessment was based on the quality and the depth of their reports as well as the extent of their involvement in the project.

VI. STRATEGIES USED TO ENHANCE THE LEARNING EXPERIENCE

Most members of the SINAG team entered the project with practically 'zero knowledge' about solar cars. Learning about what need to be learned for the different stages of building the car had to be accelerated, though more often jump-started. The following were some of the strategies used:

Action Learning

This was particularly helpful in building the half-scale model and the plug. The plug is a full-scale replica of the final car except that it is made out of wood and foam and painted over to replicate the glossy surface finish of the real car. Most student activities involved pattern-making and woodworking.

Mentoring

CAD design is a specialization that few, even among the faculty, have mastered. In this area some students established learner-mentor relationships with the CAD experts.

Seminars

Faculty advisers and consultants, like David Fewchuk, conducted seminars with the students in the areas of shell design, aerodynamic analysis, and structural integrity.

Problem-Based Learning

This strategy is particularly useful in the design of mechanical and electrical systems as each group explores different possibilities to perform a particular task.

Plant Visits

The visit made by student-volunteers to the SunPower Corp production facility, located south of Manila, and their subsequent interaction with the R and D group helped students understand the proper use, protection, cooling, and maintenance of silicon-based solar cells.

Idea Sharing/Evaluation thru Internet Forums The team created a SINAG Yahoo Group, an internet-based forum for sharing, discussing, and testing ideas. Students also successfully linked up with several international solar car teams through forums such as the WSC Yahoo Group. Through chat rooms and emails they were able to find out what new technologies were being considered for their next-generation cars. The students, through these connections, also learned how different teams felt about certain technologies, which though generally accepted, have either remained in the fringes or were still regarded by others as controversial.

VII. CONSTRAINTS AND CHALLENGES

The technical team was faced with many challenges both administrative (e.g. University services to handle SINAG finances and procurement requests) and academic. Those that had a direct impact on the academic aspects of the program wee the following:

1. This was the first solar car ever built in the Philippines, therefore, there were no established bodies of work or experience available locally for reference.
2. The car had to be road-tested by end of September in time for the race in October, 2007. This meant that the car barely had nine (9) months to get itself designed, built, and tested. Most experienced teams had a lead time of about two years between races in this biennial solar car challenge.

The first constraint was addressed by getting the assistance of David Fewchuck as consultant. Fewchuck is at the helm of the Aurora Vehicle Association, a non-profit Australian organization that investigates and promotes alternative sources of energy for cars of the future. The organization is a veteran of the WSC, having joined in all twenty (20) races to date. Consultations with Fewchuck, however, were few and mostly centered on major issues that could paralyze the project. The rest of the decisions - those day-to-day nuances - were made by the team. Judging on the quality of results, many of these decisions were reflective of the apparent lack of experience and expertise in the team.

The second constraint presented a real major hurdle. The issue was on how to balance work output with learning experience. Everyone knew that the *raison d'être* of the project was to build the Philippines first solar car in time for the 2007 Panasonic World Solar Challenge. The highly compressed schedule was beginning to be viewed by many as unachievable and had driven the team to the edge. Consequently, many of the pre-planned academic activities (seminars, updates, briefings, reports, etc), which were supposed to be delivered in step with every major milestone achieved, were now given back-seat priority. They were cast aside to give way to those activities that would bring the car nearer to its objective. The students instead were just given basic instructions to go about their work activities, and the demand for more work and tight deadlines steadily climbed up.

The increasing pressure due to the unrealistic timetable, however, was not enough to break the morale of the students. It needed something else. And when that something else finally came, it did not only pull down morale, it brought down direct participation as well. The following were the possible reasons:

1. The specialized work on the car (machining of parts, composites lay-up, etc.) were sub-contracted to professional workers.
2. The students were assuming the work of laborers (assemblers) rather than learning the relevant design and production skills.
3. The students were not adjusting to the industry-type management style.
4. The students felt their ideas were being ignored and that their contributions were not recognized.
5. There was growing friction between team members that resulted into polarity and factionalism.

Once the official line-up of the team that was going to race the car in Australia (composed of 10 students and 5 faculty members) was finally announced, team participation dropped even more significantly. And that was expected.

VIII. RESULTS AND ASSESSMENT OF THE PROJECT

The Project's outright measure of success is SINAG's performance in the 2007 World Solar Challenge. In that maiden participation, SINAG ranked 12th in a field of 21 entries in the Challenge Class category, defeating entries from first world countries such as France, Canada, Wales and Switzerland.

This achievement was a reflection of the sheer hard work that the team had put into SINAG, a car that was handicapped in innumerable ways and yet had performed beyond what many expected. SINAG was, indeed, a product of countless sleepless nights and an unshakeable conviction of a select group of students and their advisers that making the impossible happen is different from dreaming the impossible. Their persistence and willingness to learn had paid off. At this stage the team has achieved some level of mastery of the technical aspects of the car.

SINAG Solarcar (source: http://SINAG.dlsu.edu.ph)

A different way, though less rigid, of gauging success is through the quality and depth of both oral and written reports that capture for posterity the many anecdotal accounts of how students resolved problems in the workplace and in the race. These reports will be corroborated, of course, through a more methodical assessment approach by their advisers that evaluate student participation and the quality of work done.

SINAG Team (source: http://SINAG.dlsu.edu.ph)

In recognition of the above, the University agreed to credit students' work in the project

1. as a practicum (OJT) program for their OJT Course
2. as their thesis project for their THESIS Course

subject to the relevant requirements pertaining to each course (such as in-depth technical reports and oral defense for Thesis, and work program and technical report for OJT, among others). In all, six (6) thesis groups (3 from ME and 3 from ECE) and about a dozen OJT students benefited from the program. The last thesis group completed their requirements just last trimester (2nd Term, SY 2008 – 2009) in the DLSU school calendar.

Further, as a result of the project, the College of Engineering of De La Salle University-Manila, particularly the Mechanical Engineering Department and the Electronics and Communication Department, have gained intellectual capital and recognition of their technical capability in the process.

It is the vision of the Philippine Solar Car Society that the solar energy technology be propagated nationwide through the Society-academe partnership with SINAG as its symbol.

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Martin Ernesto L. Kalaw is assistant professor of the Mechanical Engineering Department of De La Salle University-Manila. He holds the degree of Bachelor of Science in Mechanical Engineering and Master of Science in Mechanical Engineering from De La Salle University-Manila. He is currently pursuing PhD in Mechanical Engineering from the same University.

Rene D. Fernandez was assistant professor of the Mechanical Engineering Department of De La Salle University-Manila. He holds a Bachelor of Science in Mechanical Engineering from University of San Jose Recoletos and is currently pursuing Master of Sciece in Mechanical Engineering from the University of Illinois in Chicago.