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Ahead of Its Time: 15 Years (1994 - 2009) of the Undergraduate Geothermal Engineering Degree Program of Negros Oriental State University, Philippines

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ABSTRACT

Negros Oriental State University (NORSU) started offering Bachelor of Science in Geothermal Engineering (BSGE) during the first semester of school year 1994-1995. The course was developed by NORSU in cooperation with the Philippine National Oil Company – Energy Development Corporation (PNOC-EDC) and the National Power Corporation (NPC), in response to a perceived need for a local training program that will serve the manpower needs of the companies involved in the geothermal industry of the province of Negros Oriental, Philippines. NORSU became the first higher-education institution in the Philippines to offer the course and became a pioneer in undergraduate geothermal engineering curriculum development.

In commemoration of its 15 years of existence, a review of the development and the results of the program was conducted, the results of which will be presented in this paper. Aside from providing an overview of the historical development of the geothermal engineering program, the paper will also present statistics gathered throughout the life of the program that are considered relevant to its evaluation. More importantly, it identifies the problems that were encountered by the program since its inception in 1994 up to today, and the solutions that were taken to address them. Lastly, it provides an overview of the plans of Negros Oriental State University to develop the program further.

1. INTRODUCTION

Negros Oriental State University (NORSU), the only state-run university in the province of Negros Oriental, Philippines, is the first higher-education institution in the country to offer the Bachelor of Science in Geothermal Engineering (BSGE) degree. It started offering the five-year course during the first semester of school year (SY) 1994-1995, by virtue of Resolution No. 7, Series of 1994, of the Board of Trustees of what was then Central Visayas Polytechnic College (CVPC).

The BSGE course was offered in order to address a need to supply qualified manpower to perform the continuous development, operation and maintenance of geothermal projects" and it is premised on the fact that "producing qualified people to work in geothermal projects would help the government save money for the training of manpower abroad. It was considered relevant since CVPC (now NORSU) is in Oriental Negros, one of the few provinces generating geothermal energy. The course is intended to prepare the students to work immediately in geothermal exploration sites and power plants, thus, contributing to the province's and the country's energy development programs.

The development of the pioneering curriculum and the personalities and organizations involved in its inception is described in the following section. The curriculum developed and its subsequent revisions are also provided.

2. THE CURRICULUM

2.1 Curriculum Development

The development of the Bachelor of Science in Geothermal Engineering curriculum was documented in the research paper "Geothermal Engineering: CVPC's Contribution to the Philippine Energy Development Program" Henry A. Sojor, Eva M. Moncada, Gonzalo C. Bulaclac, Jr., and Mary Evangeline F. Gajunera published in 1995.

The BSGE curriculum was developed using the DACUM (Develop a Curriculum) approach. DACUM is an approach to curriculum development based on occupational job analysis that has been proven to be effective, quick and low-cost. It is based on the following philosophies: (1) Expert workers are better able to describe/define their occupation than anyone else; (2) Any job can be effectively and sufficiently described in terms of the tasks successful workers in that occupation perform; (3) All tasks have a direct implication in the knowledge and attitude that workers must have in order to perform those tasks correctly.

The industrial partners of NORSU in developing the initial BSGE curriculum, PNOC-EDC (Philippine National Oil Company – Energy Development Corporation) and NPC (National Power Corporation), operate the geothermal field and power plant in Negros Oriental, respectively.

The process followed in the development of the BSGE curriculum is as follows: (1) A DACUM expert from Algonquin College, Ontario, Canada, gives an orientation session on DACUM to representatives of CVPC, PNOC-EDC and NPC; (2) A discussion of the needs of industry in the area of geothermal engineering are identified and prioritized; (3) Solutions to the needs of the industry in the area of geothermal engineering are reached and agreed upon; (4) DACUM output or draft curriculum is produced; (5) Meetings, with PNOC and NPC engineers and chemists serving as the experts, are held with CVPC faculty to clarify matters affecting the geothermal engineering course; (6) Geothermal Engineering Curriculum is finalized.

The curriculum development process started on February 1995 with a DACUM orientation session given by Prof. Steve Finnagan of Algonquin University, Canada, and the subsequent steps of the process followed immediately thereafter.

Table 1. NORSU Bachelor of Science in Geothermal Engineering Curriculum Subjects

PROFESSIONAL SUBJECTS	
Geothermal Systems and Resources	Geothermal Fluid Collection and Disposal System Operation and Maintenance
Geothermal Energy Technology	
Geothermal Geology	Geothermal Power Plant Engineering
Geothermal Geochemistry	Engineering Laws, Contracts, Specifications and Ethics
Geothermal Geophysics	Geothermal Energy Utilization
Geothermal Exploration Technology	Instrumentation & Process Control
Geothermal Drilling	Geothermal Power Plant Operation and Maintenance
Geothermal Reservoir Engineering 1 & 2	GE Project Study
Geothermal Production Technology	GE Computer Applications
Corrosion Engineering	Plant Inspection, Trips, and Seminars
Well Testing and Measurements	On-the-Job Training
BASIC & ALLIED ENGINEERING SUBJECTS	**LANGUAGES, HUMANITIES & SOCIAL SCIENCES**
Basic Electronics	Philosophy
Safety Engineering	Psychology
Heat Transfer	Humanities
Fluid Mechanics	Filipino 1, 2, 3
Plane Surveying	Economics, Agrarian Reform & Taxation
Engineering Management	Literature (Philippine Literature & World Literature)
DC/AC Machineries	Political Science (New Constitution & Philippine Government)
Engineering Drawing 1&2	**MATHEMATICS**
Strength of Materials	Basic and Advance Algebra
Computer Fundamentals & Programming	Plane Trigonometry
Thermodynamics 1&2	Mensuration & Spherical Trigonometry
Elem. Electrical Engineering	Analytic Geometry
Engineering Mechanics 1&2	Differential and Integral Calculus
Environmental Science	Differential Equations
Engineering Economics & Accounting	Advance Engineering Math
Engineering Materials & Testing	Engineering Probability & Statistics
NATURAL / PHYSICAL SCIENCES	**MISCELLANEOUS**
Chemistry 1&2	Physical Education 1, 2, 3, 4
Engineering Physics 1&2	National Service Training Program 1 & 2

2.2 Curriculum Revision

The NORSU geothermal engineering curriculum developed in 1995 was revised in SY 2001-2002. The revision streamlined the course and focused it more towards specialization. Subjects deemed non-vital to the course were removed. More subjects related to geothermal technology were added. "Geothermal Systems and Technology" was split into "Geothermal Systems and Resources" and "Geothermal Energy Technology" to provide more time for basic geothermal concepts. "Geothermal Computer Applications" was added to reflect the growing influence of the computer in the profession. The arrangement of some subjects was also shuffled to correct problems encountered by previous graduates.

Table 2. Summary of Unit Requirements for the NORSU BSGE Course

Classification	**Units**	**%**
Mathematics	32	19%
Natural / Physical Sciences	16	9%
Basic and Allied Engineering Subjects	54	32%
Professional Subjects	67	40%
Technical Subjects	**169**	**71%**
Languages, Humanities, Social Sciences	54	79%
Miscellany	14	21%
Non-Technical Subjects	**68**	**29%**
Grand Total	**237**	**100%**

2.3 Curriculum Content

The subjects involved in the current BSGE curriculum are provided in **Table 2**, while **Table 3** provides a summary of unit requirements for the said course. In the current curriculum, 71% of the 237 units required for the geothermal engineering degree are technical subjects. Of these technical subjects, 40% are professional subjects, those that focus solely on geothermal engineering.

3. THE PROGRAM

3.1 Student Requirements

Before being admitted into the BSGE program, applicants must first successfully pass a rated interview by the Dean, a University Entrance Test (UET); and Qualifying Exams in English.

Geothermal Engineering applicants must have at best a high school mathematics average of 85% and a high school general average of 85%.

In order to be retained in the program, Geothermal Engineering students must be able to do the following: (1) get 85% in all the Technical Subjects, or repeat taking it; (2) get 80% in all Non-Technical Subjects, or repeat taking it; and (3) repeat taking a subject only once.

3.2 Faculty

Most of those who have taught the professional BSGE subjects are coming from PNOC-EDC, supported by the graduates of the course, and those from NPC, DENR, and NORSU. PNOC-EDC engineers working in the Southern

Negros Geothermal Production Field (SNGPF) have supported the program consistently, taking the time to teach BSGE students on a part-time basis after their regular office hours. This ensures that the program is constantly updated as to the actual requirements of the geothermal industry, as seen through the eyes of practicing professionals.

3.3 Enhancement Activities

All NORSU Geothermal Engineering graduates, since the beginning of the program, have had their On-the-Job Training, consisting of at least 340 hours, in PNOC-EDC's SNGPF. The old BS Geothermal Engineering curriculum required the student to undergo two phases of on-the-job training, first with PNOC-EDC and then with NPC. However, after NPC showed reluctance and delayed the taking in of trainees from the program, the second phase was scrapped. This matter was subsequently reflected in the revised curriculum.

PNOC-EDC has fully and consistently supported the apprenticeship program of the course. It has also provided preferential treatment to the students of the course when they go on frequent field trips to its geothermal fields.

3.4 Student Organizations

A student organization, called the Philippine Association of Geothermal Engineering Students (PAGES), was also organized to enhance the program. The organization was registered with school authorities for two school years, from 2000 to 2002. The group was eventually discontinued due to its small number of members, which made applying for school recognition uneconomical and impractical.

As an alternative, the course student government, which does not require registration, was utilized to organize the students and the activities of the program geared towards enhancement. The students have also been recently made aware of possible membership in the National Geothermal Association of the Philippines (NGAP) in a road show held last September 2004.

Table 3. Geothermal Engineering Program Enrolment Figures from 1994 to 2009

Semester	Students	Semester	Students
1994-1995 1st	64	2001-2002 2nd	26
1994-1995 2nd	61	2002-2003 1st	23
1995-1996 1st	90	2002-2003 2nd	19
1995-1996 2nd	81	2003-2004 1st	29
1996-1997 1st	98	2003-2004 2nd	12
1996-1997 2nd	84	2004-2005 1st	13
1997-1998 1st	95	2004-2005 2nd	9
1997-1998 2nd	56	2005-2006 1st	5
1998-1999 1st	50	2005-2006 2nd	5
1998-1999 2nd	46	2006-2007 1st	3
1999-2000 1st	35	2006-2007 2nd	3
1999-2000 2nd	34	2007-2008 1st	2
2000-2001 1st	28	2007-2008 2nd	2
2000-2001 2nd	21	2008-2009 1st	1
2001-2002 1st	29	2009-2009 2nd	0

4. STATISTICS

4.1 Enrolment

Maximum enrolment figure enjoyed by the program was 98 students during the first semester of SY 1996-1997. Dogged by employability issues, enrolment has since consistently dropped to as low as 0, where the program currently stands. It is important to note that the number of female students in the program equals that of the male students.

4.2 Graduates

The program, since 1999, has produced a total of 32 graduates. Eighteen (18) of the graduates are male. Fourteen (14) are female. The highest number of graduates in a year was in 1999 with 17, the first batch. The numbers have been consistently decreasing since 1999.

Table 4. Geothermal Engineering Program Graduates (1994 to 2009)

Year	Graduates		
	Male	**Female**	**Total**
1999	12	5	17
2000	3	4	7
2001	1	1	2
2002	2	0	2
2003	0	0	0
2004	0	0	0
2005	0	2	2
2006	0	1	1
2007	0	0	0
2008	0	1	1
2009	0	0	0
Total	**18**	**14**	**32**

4.3 Employability

According to a tracer survey done among the graduates of the course, of the 32 geothermal engineering graduates, only 15 are employed in jobs related to the engineering field. Of these 15, only 6 are in jobs utilizing their knowledge of geothermal engineering. One graduate is currently holding the position of Casing Drilling Coordinator, Tesco Drilling Systems in Jakarta, Indonesia. Another is the Controlled Pressure Drilling and Testing Engineering Coordinator for Indonesia of Weatherford. Another two (2) are Controlled Pressure Drilling Engineers with Weatherford in Jakarta, Indonesia. Weatherford has also employed two more as Fishing and Retrieval Engineers in Singapore. All six (6) geothermal engineering graduates have been involved in one way or another in geothermal operations in the Asia Pacific region.

A total of ten (10) graduates of the program are working outside of the country. As previously mentioned, six (6) are in jobs related to geothermal engineering. PNOC-EDC previously employed one (1) NORSU geothermal engineering graduate, but he has since resigned to work abroad.

5. CHALLENGES

5.1 Lack of Instructional Materials

It being the pioneering program for geothermal engineering in the Philippines, one of the main problems faced was the lack of instructional materials, particularly references for the professional subjects being taught. To solve this, a Geothermal Engineering Library was created, with

reference material coming from the following: (1) materials provided by PNOC-EDC personnel; (2) information downloaded over the Internet; (3) books / magazines provided by the International Geothermal Association, Geo-Heat Center and the US Geothermal Education Office; and (4) books purchased by the NORSU Library. A specific section of the NORSU Library has been devoted to this compilation.

5.2 Employability

Before 2003, no graduate of the program was employed in the companies operating in the geothermal industry in the country. Most of the graduates have applied in PNOC-EDC and PGI / Unocal / Chevron, and have taken the company examinations, but none were employed until 2003. Most have taken up jobs which are not related to the course. This has resulted in the constant dip in the number of enrollees / graduates of the program. A graduate of the GE program, who subsequently took up mechanical engineering and topped the Mechanical Engineering Board Exam, was employed by PNOC in 2003. As of 2009, six (6) of the graduates have been employed by international drilling service companies to work on geothermal projects. It is also important to note that most, if not all, of the graduates of the program are currently employed, if not self-employed.

6. PLANS

6.1 Program Improvement

Negros Oriental State University intends to develop the program further by undertaking the following activities: (1) development of Geothermal Engineering modules that will allow for the delivery of the curriculum using open learning techniques, targeting those who are already working in the industry but need additional training and education; (2) soliciting scholarships for Geothermal Engineering students; (3) offering partnerships with other universities in other provinces with geothermal resources for the development of their own geothermal engineering program; and (4) assessing the feasibility of offering a “Diploma of Geothermal Technology” course that will provide technicians for the geothermal industry.

6.2 Enhanced Industry Linkage

Since aside from instruction, universities have to conduct research and extension activities, NORSU intends to forge closer ties with industry to undertake projects focusing on these. NORSU intends to strengthen the linkage it has with PNOC-EDC, now EDC, by pursuing a memorandum of agreement on the further development of geothermal engineering, including research projects on geothermal tourism, downhole heat exchangers, cascading heat geothermal community, and mapping and testing of geothermal manifestations. The feasibility of establishing a joint geothermal laboratory will also be explored. Extension possibilities through a geothermal watershed awareness program will be pursued as well.

6.3 Geothermal Engineering Law

To fully develop the BSGE program, NORSU will be advocating the passage of a geothermal engineering law, which will mandate the following: (1) provide official government recognition of the profession; (2) put the course under the Professional Regulation Commission, so that the quality of the graduates can be maintained and licenses can be issued to geothermal engineers; (3) standardize the curriculum and the profession; (4) allow for engineers who have worked in the geothermal industry for at least 5 years to be granted the degree of Geothermal Engineering once they apply and are found qualified for it; (5) require the presence of geothermal engineers in projects related to geothermics; and (6) provide incentives for companies who will be supporting the geothermal engineering programs of universities.

This law is intended to produce the following benefits: (1) increase employment opportunities for geothermal engineering graduates locally and internationally; (2) standardize the profession and regulate the universities that are offering it; (3) emphasize the fact that geothermal technology is being systematically taught and improved, in coordination with industry, through the universities in the country; (4) concretize the concept that the Philippines is a world leader in geothermal engineering curriculum development; and (5) allow the country to capitalize on the growth of the geothermal industry in the neighboring countries, particularly Indonesia.

CONCLUSION

After 15 years of existence and after conducting a review of the development and results of the program, it can be said that despite of the adversities encountered, the program is starting to come into its own, as evidenced by the growing number of graduates who are getting employed in companies involved in geothermal operations. The decreasing number of enrollees and graduates of the program have mostly been due to concerns regarding the employability of graduates. This number is expected to recover soon, now that the question of employability has been addressed and answered.

The recent uptake in the employment of NORSU geothermal engineering graduates at the international level, combined with the plans that the university intends to implement immediately, will help ensure the continuity and relevance of the program in the years to come.

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