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Bachelor of Science in Astronomy Technology: A Model

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Astronomy is one of the most fascinating fields of study and has captured the interest of a growing number of young people in the Philippines. In this piece, I describe a new program designed to introduce astronomy to younger people, with the goal of encouraging them to make science and technology their lifetime careers. Perhaps the experiment that we are conducting in the Philippines can serve as a model for astronomy educators in other developing economies that wish to encourage the formal pursuit of the science even with limited resources.

The study of astronomy in the Philippines lags far behind what is offered in many other countries. Recent discoveries in astronomy have been the direct consequence of technological advances in instruments that yield unprecedented power, such as telescopes with 10-meter mirrors, orbiting satellite observatories, deep space missions capable of sampling planetary atmospheres and surfaces, and huge laboratories for detection of elusive cosmic neutrinos and gravity waves. The Philippines has to content itself with a 450-mm telescope installed in the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Observatory at the University of the Philippines Diliman (UP Diliman), and several small telescopes owned by amateur astronomers. Astronomy education in the Philippines is limited to a few chapters in elementary, high school, and collegiate science textbooks that are sometimes woefully out of date or inaccurate.

To provide greater opportunities for astronomy education, the Rizal Technological University (RTU) began offering a master of science in astronomy program starting in the 2005–2006 school year. This is the very first astronomy program offering in the Philippines. It is a collaborative project between the RTU and PAGASA under the Department of Science and Technology. The students of the program are expected to graduate in 2008. However, there is a growing demand for the offering of a bachelor's program in astronomy, and such demand is probably being created by the growing interest in the science due to the popularization efforts by amateur astronomers.

DESIGNING THE CURRICULUM

The first step toward establishing the program was to design the curriculum. A committee was established by the president of the RTU, Dr. Jose Macaballug; members included representatives from PAGASA, the National Committee from the IAU, and several RTU faculty members. The committee started its work by gathering samples of bachelor of science in astronomy programs from various universities abroad.

We realized that crafting a curriculum appropriate for the Philippines required a clear statement of the overall philosophy and goals. What do we want the program to be? Will the program be attractive to the prospective students and, most important, to their parents? What are the strengths of the RTU that can be transfused to the program? And for Filipinos, this is possibly the most important question: Will the graduates of the program find a good job in the Philippines, and perhaps abroad?

In analyzing these questions, we arrived at the philosophy that the program should integrate into astronomy the engineering subjects that we perceive to be important in astronomy. We also realized that because we do not yet have the capability to engage in purely theoretical cutting-edge research in astronomy, we will have to start with what the world already knows about the science. Accordingly, we designed a "smorgasbord" curriculum that will allow the student to "taste" astronomy in various configurations. The student should be able to choose his or her favorite "dish" when he or she has advanced in the program.

Inclusion of the technological component in the program not only will ensure the ability of graduates to contribute to the growth of the science here in the Philippines but also will enable them to work as experts in astronomy-related fields anywhere in the world. We hope that there will be less need for retraining in the case that the graduates work as technicians in leading observatories. We also estimated their employability outside astronomy and determined that the opportunities would be good. Employability is what the parents of the students inquire about first when the kids tell them what program they intend to pursue at the tertiary level. It is always that way here in the Philippines, and perhaps in all developing economies around the world. This is why nursing is one of the most attractive programs in the Philippines; employment is almost assured.

The decision to combine astronomy with technology will use the particular strength of the RTU as one of the leading universities in the Philippines in the field of engineering and technology. We were initially tempted to call the program Astronomy Engineering but decided that the program falls somewhat short of being a full-bodied engineering program; therefore, we opted for the more general Astronomy Technology title. After consultations with entrepreneurs, scientists, engineers, and business experts, we are satisfied that the future graduates of the program will have plenty of opportunities to apply their knowledge directly in scientific careers in government agencies or universities. The degree will give the graduates scientific knowledge, an extensive understanding of communications and computers, management skills, and teaching skills. Students can then apply such knowledge in many different fields or develop new innovations and exploit them to create new businesses.

THE BACHELOR OF SCIENCE IN ASTRONOMY TECHNOLOGY PROGRAM

Astronomy draws from, and contributes to, many fields of knowledge. It is inextricably related to engineering, geology, remote sensing, physics, atmospheric and environmental science, biology and biochemistry, and even philosophy and entrepreneurship. We incorporated these interrelated fields into the BS in Astronomy Technology program, which is designed to be wide in scope (see Table 1 for a listing of courses). Research and observation will be given priority. The inclusion of every subject has been discussed in minute detail with experts in the fields. The curriculum overcame numerous draftings and redraftings, 11 in all before it passed the judgment of the Board of Regents. I would say that we found unknown reserves of patience and perseverance in this job.

The program is rigid and requires five years of concentrated study. The future students of the program must have the discipline to complete the courses required of all RTU students taking up engineering and technology. We have also faithfully complied with the general education subjects mandated by the Commission on Higher Education to ensure the fullest development of the students as human beings and citizens of the Republic. We still have to shepherd this program for many years before we can see whether it will be successful. We were told that this is a bold experiment, and we agree. Astronomy, however, is a very versatile field. In the future, perhaps it can be combined with philosophy or with education to arrive at a bachelor of science in astronomy philosophy program, or maybe a BS in astronomy education, or even a BS in astronomy entrepreneurship. Whatever form it might take, the sublime beauty of astronomy as a science will assure that students will not only find a living but will also find a life.

THE CURRICULUM

Table 1. BS Astronomy Technology Curriculum 10th Draft: The Complete Five-Year Curriculum

First Year–First Semester			
Course	Subject Description	Lecture Units	Lab Units
Astro 1	Introduction to Astronomy	3	
Chem 1E lec/lab	General Chemistry lecture/lab	3	1
Psycho 1	General Psychology	3	
Math 1	College Algebra	3	
English 1	Communication Arts 1	3	

Math 5	Plane and Spherical Trigonometry	3	
Fil1	Sining ng Kasanayan sa Pakikipagtalastasan (Communication Arts in Filipino)	3	
NSTP	CWTS/LTS/ROTC	3	
PE1	Physical Fitness & Self-Testing Activities	2	
First Year–Second Semester			
Physics 1	Mechanics, Wave, and Heat	3	
Physics 1 lab	Laboratory		1
Math 7	Analytic Geometry	4	
Astro 2	Observational Astronomy I lecture	1	
Astro 2L	Observational Astronomy laboratory		2
Eng2	Communication Arts 2	3	
Filipino 2	Retorika	3	
Math 3	Elementary Statistics	3	
Engineering Science 21	Computer Fundamentals and Desktop Applications	2	
Engineering Science 21L	Computer Fundamentals and Desktop Applications laboratory		1
PE2	Fundamentals of Rythmic Activities	2	
NSTP	CWTS/LTS/ROTC	3	
Second Year–First Semester			
Physics 2	Electricity, Magnetism, and Optics	3	

Physics 2 lab	Physics laboratory		1
Astro 3	The Solar System	3	
Math 8	Differential Calculus	3	
Engineering Science 22	Computer Programming Language	2	
Engineering Science 22L	Computer Programming Language Laboratory		1
Astro 4	Introduction to Stars and Galaxies	3	
Humanities 2	Survey and Appreciation of Fine Arts	3	
English 3	Speech and Oral Communication	3	
Astro 5	Astronomy and Geology	2	
PE 3	Individual & Dual Sports	2	
<i>Note:</i> NSTP = National Service Training Program; CWTS = Civic Welfare Training Service; LTS = Literacy Training Service; ROTC = Reserve Officers' Training Corps			
Second Year–Second Semester			
Astro 6	Introduction to Astrophysics	3	
Astro 7	Basic Astronomy and Meteorology	3	
Engineering Science 12	Drafting with Auto CAD		1
Chemistry 2	Organic Chemistry	3	
Astro 8	Astronomy and Biochemistry	3	
Math 9	Integral Calculus	4	
Astro 9	Basic Astronomy and Remote Sensing	3	
Economics 1	Principles of Economics with Taxation and Land Reform	3	

PE 4	Team Sport	2	
Third Year–First Semester			
Computer Engineering 31	Advanced Programming and Laboratory	2	1
Physics 3	Modern Physics	3	
Civil Engineering 31	Introduction to Geodetic Engineering	3	1
Mechanical Engineering 31	Thermodynamics 1	3	
Electronics and Communications Engineering 31	Electronics Engineering 1	3	
Math 10	Differential Equations	3	
Electrical Engineering 31	Electrical Engineering 1	3	1
Third Year–Second Semester			
Instrumentation and Control Engineering 33	Automatic Control Theory	3	1
Astro 10	Astronomy Instrumentation	3	
Astro 11	Astronomy Education 1	3	
Astro12	Observational Astronomy 2 lecture	1	
Astro 12a	Observational Astronomy 2 laboratory		2
Physics 4	Quantum Physics	3	
Literature 2	World Literature	3	
Civil Engineering 32	Higher Surveying	2	2
Fourth Year–First Semester			
Astro 13	Astronomy Education 2	3	

Astro 14	Issues in Astronomy	3	
Astro 15	Astronomy Research 1	3	
Physics 5	Elementary Particles and Waves	3	
Philosophy 1	Introduction to Logic	3	
Instrumentation and Control Engineering 40A	Data Communication	3	
Communications 44	Wireless Communication	3	
History 1	Philippine History, Roots, and Development	3	
Fourth Year–Second Semester			
Instrumentation and Control Engineering 42A/L	Programmable Logic Controllers and Robotics with Astronomy Applications	2	1
Astro 16	Introduction to Cosmology 1	3	
Astro 17	Celestial Mechanics	3	
Astro 18	Astronomy Research 2, Thesis	3	
Communications 46	Advanced Communication	3	
Political Science 2	Philippine Government and Constitution	3	
Sociology 1	General Sociology	3	
Fifth Year–First Semester			
Civil Engineering 48A	Observatory Design	3	
Astro 19	Astronomy and Entrepreneurship	3	
Astro 20	Life in the Universe	3	
COE 1	Cooperative Education in Industry	3	

Fifth Year–Second Semester			
Astro 21	Astronomy Education 3: Community, School, and University Outreach	3	
Astro 22	Astronomy and Philosophy	3	
Hist 3	Rizal’s Life & Works	3	
COE 2	Cooperative Education in Industry 2	3	

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