

Chemical Engineering at . . .

Yangon Technological University

“This is Burma, and it will be quite unlike any land you know about.”

—Rudyard Kipling, describing his 1889 visit to Burma^[1]

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Yangon Technological University (YTU) is the premier engineering school in Myanmar, formerly known as Burma. It is Myanmar’s oldest engineering program, and its students currently have the highest entrance exam scores of any university in the country. The YTU Department of Chemical Engineering has existed since 1958. Myanmar itself is a country with a long history of engineering excellence, which can be seen in its many beautiful temples that date back over a thousand years. It is the 25th most populous country in the world, with more than 50 million people, and it is situated between some of the fastest-growing economies in the world (China, India, and Thailand). The university is located in Yangon, Myanmar’s largest city and its former capital.

But, paraphrasing Kipling: This is Myanmar, and the Department of Chemical Engineering here is quite unlike any department you know about. Based on the context described in the paragraph above, the reader would probably be surprised to find out that:

- (i) *There are only 534 undergraduates currently at YTU, including only 26 chemical engineering undergraduates, and all of these students are in their first two years of study.*
- (ii) *Seven of the nine full-time engineer-*



Faculty and students in traditional dress pose in front of the Yangon Technological University main building in 2013. Back row fifth from left is Daniel Lacks of Case Western Reserve University, visiting on a Fulbright program. On his left is co-author Nwaynay Hlaing.

ing faculty members are under the age of 35, and all seven received their degrees from the same university.

- (iii) *Women constitute 70% of the Department of Chemical Engineering (at all levels—faculty, graduate, and undergraduate).*

- (iv) *The campus environment is unique, both inside and outside the classroom: computer methods (e.g., spreadsheets, process simulators) are not used in the curriculum; students will kneel and bow to faculty with their face touching the ground, in a show respect; lines of monks in crimson robes are welcomed daily on campus for food donations.*
- (v) *YTU has had four different names in its 53-year history.*

To understand these unusual circumstances, one needs to consider the recent political history of Myanmar and its impact on the university system.

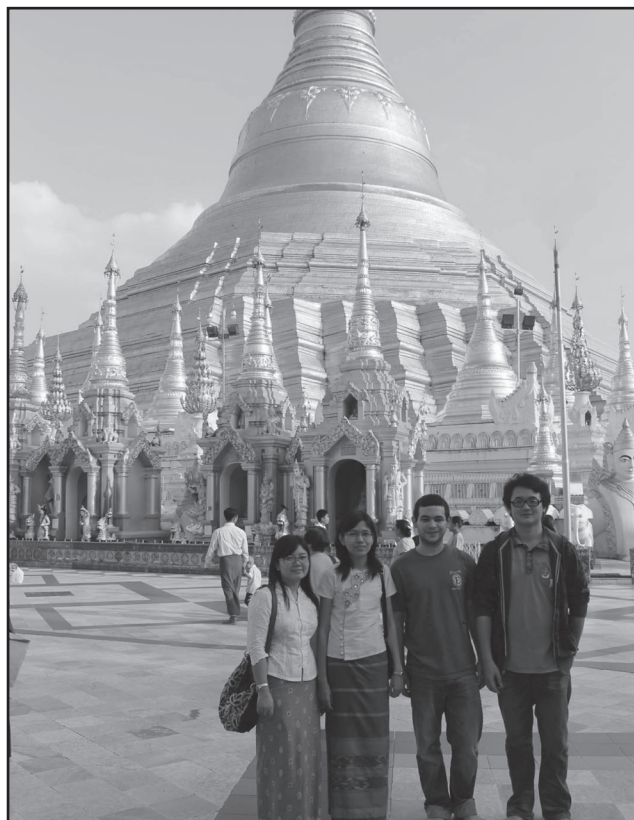
AN INTERWOVEN HISTORY OF MYANMAR AND YTU

The British colonized Burma in the 19th century and Burma was ruled as a British colony from 1885 until 1948. The capital of Burma was Rangoon, the largest city in the country. There have been colleges in Burma since the early times of British rule, and several of these colleges merged to form Rangoon University in 1920. An engineering department was formed at Rangoon University in 1924. An engineering society, the Association of Engineers of Burma, began in the 1920s.

In late 1946, General Aung San, the father of Burmese independence, became Deputy Chairman of the Executive Council of Burma, a transitional government. But on July 19, 1947, political rivals assassinated General Aung San and several cabinet members. On Jan. 4, 1948, Burma achieved independence from Britain, and became a democracy based on the parliamentary system. This period saw the formation of the Department of Chemical Engineering within the engineering program at Rangoon University in 1958. Then, in 1961, the engineering program from Rangoon University moved to a new campus and was named the Burma Institute of Technology.

In 1962, General Ne Win launched a military coup and established a nominally socialist military government that sought to follow the “Burmese Way to Socialism.” The government enacted a law banning all associations in 1963, and so the Association of Engineers in Burma was abolished. In 1964, the Burma Institute of Technology became an independent university, and was renamed the Rangoon Institute of Technology.

There were sporadic protests against military rule during the General Ne Win years and these were almost always violently suppressed. In 1974, the military violently suppressed anti-government protests at the funeral of U Thant, the former United Nations Secretary General. In 1987, currency devaluation wiped out many people’s savings and triggered nationwide anti-government riots. In 1988, large demonstrations against the government occurred all over the country; these had originated with students from the Rangoon Institute of Technology. Thousands of people were killed when the



Standing outside the Shwedagon Pagoda—the glittering Buddhist monument in the heart of Yangon—are YTU faculty members Dr. Su Su Hlaing and Dr. April Htet (both on the left) along with two CWRU students.

government suppressed the protests and all universities in Myanmar were closed for two years.

The State Law and Order Restoration Council (SLORC) was formed in 1989 by the military to govern the country. It immediately declared martial law, arresting thousands of people including many advocates of democracy and human rights. The National League for Democracy (NLD) leader Aung San Suu Kyi, the daughter of General Aung San, was put under house arrest. Furthermore, the government renamed Burma as Myanmar and Rangoon as Yangon; thus when it re-opened in 1990 the Rangoon Institute of Technology became the Yangon Institute of Technology. In protest of the regime, the United States did not recognize the names Myanmar and Yangon, and did not have an Ambassador to Burma from 1990-2012.

As of mid-1996 the situation for chemical engineering education in Myanmar was as follows. Two universities, Yangon Institute of Technology and Mandalay Institute of Technology (founded 1991), offered undergraduate and master degrees in chemical engineering. There were no Ph.D. programs in chemical engineering in the country. In addition, there were several government technical institutes that offered two-year diploma programs for training technicians in chemical

engineering-related areas (*e.g.*, plastic, rubber, and food technology); these diploma programs are similar to associates degree programs at community colleges in the United States.

But the situation changed drastically in 1996. Aung San Suu Kyi, who had won the Nobel Peace Prize in 1991 while under house arrest, was released in 1995. As she attended her first NLD congress since her release in 1996, the government arrested more than 200 delegates on their way to the party congress. These arrests prompted student demonstrations in Yangon, again originating with students from Yangon Institute of Technology and Yangon University; many of these students were arrested. At this time the United States and the European Union imposed economic sanctions, banning imports to Myanmar and investment within Myanmar. The government responded to the student protests by closing all the universities and colleges in the country. All universities and colleges remained closed for the 1996-97 academic year.

Around this time a new government ministry, the Ministry of Science and Technology, was formed. The Yangon Institute of Technology was transferred from the Ministry of Education to the newly formed Ministry of Science and Technology, and renamed as the Yangon Technological University (YTU). Two initiatives began at YTU. First, a Ph.D. program was started at YTU in 1997. Second, a “special program,” which was tightly controlled and had a military-like character, started at YTU in 1998. This special program was limited to small numbers of students (50-150 incoming students per year, in all engineering fields), who were designated as government officers and received a salary. The special program required students to live on campus, included daily physical exercise classes led by retired military officers, and required the students to sign contracts to serve in the Ministry of Science and Technology after graduation—four years for a bachelor’s degree, six years for a master’s degree, and 15 years for a doctoral degree.

The “special program” at YTU was limited to a very small number of undergraduates. Meanwhile, the regular engineering programs at the universities in Myanmar remained closed for three years. Students who completed several years of study when the universities closed in 1996 had to wait three years to continue their studies. In 1999, universities and colleges reopened, but not in the usual locations—the regular students had to attend classes on remote campuses far from the cities (where they would not be able to demonstrate against the government). The students from the Yangon Institute of Technology took classes on a campus in Pyay, a remote location 250 km from Yangon. These students were still referred to as YTU students, and were taught by YTU faculty, but at a location far from Yangon. The YTU faculty had to travel between Yangon and Pyay—spending about a week at a time at each—in order to teach both the graduate students in Yangon and the undergraduate students in Pyay. But these initiatives didn’t last long. The special program at YTU closed in 1999, and all students were transferred to the special program

at Mandalay Technological University (MTU), which in turn stopped accepting new students in 2001. The regular undergraduate program at YTU (which was really situated in Pyay) closed in 2001.

To replace the closed undergraduate programs at YTU and MTU, the Ministry of Science and Technology converted the diploma-level government technical institutes for training technicians into bachelor’s-level government technical universities for training engineers. The same faculty who had been teaching the diploma courses in fields like plastics technology and food technology, and who held only bachelor’s degrees, were now teaching the undergraduate chemical engineering students. In addition, some new universities were established, including two that had chemical engineering programs.

In the middle of 2012, the situation for chemical engineering education in Myanmar was as follows. There were five undergraduate chemical engineering programs in Myanmar—three at former government technical institutes and two at new universities formed in 2005—and the quality of the education in these programs was not very high. YTU had essentially been closed since 1996, although it maintained a small graduate program during this time. Almost the entire YTU faculty had left the university—a few went to the new universities, but most went to industry or retired. And for the previous 15 years very few chemical engineers in Myanmar had graduated from strong educational programs.

NORMALIZING RELATIONS

But the situation in Myanmar has begun to change, and the country is undergoing a transition from military rule to democracy. Aung San Suu Kyi was released from house arrest in 2010. Free and peaceful elections were held in 2012, and Aung San Suu Kyi and the NLD party won 43 of 45 open seats. The United States began normalizing relations with Myanmar in 2012—most sanctions were lifted, an ambassador was appointed, and President Obama visited the country.

The undergraduate program at YTU re-opened in December 2012. This process is slow and difficult, and will take six years to complete—*e.g.*, there were only first-year students in 2012-2013, first- and second-year students in 2013-2014, and so on. Almost all of faculty members at YTU are new hires, because almost all of the previous faculty members had left. The strongest faculty candidates in 2012 were graduates from the “special program” at MTU in the early 2000s that stayed on at MTU for their Ph.D.s—this is the reason that seven of the nine faculty members in the chemical engineering department are younger than 35 and have their Ph.D.s from MTU.

Currently, the Chemical Engineering Department has nine permanent faculty members. Five have Ph.D.s in chemical engineering, two have Ph.D.s in biotechnology, one has an M.E. in chemical engineering, and one has a bachelor’s in industrial chemistry. There are also five visiting professors



The faculty of the YTU Chemical Engineering Department. Left to right: U Zaw Lay Win, Dr. Myo Min Win, Dr. Kaung Kyaw, Dr. Lat Lat Tun, Daw Khin Than New, Dr. Su Su Hlaing, Dr. Nwaynay Hlaing, Dr. April Nway Nway Htet, Dr. Zin Mar Lin.

and one visiting lecturer who help with teaching. Although retired, former department heads Dr. Maung Maung Win and Dr. Mya Mya Oo still give advice and guidance to the faculty.

ACADEMIC PROGRAMS

Undergraduate program

The undergraduate program reopened at YTU in 2012 with a new six-year curriculum. Currently there are 26 students in the undergraduate degree program, but by 2018, when all six years of the program become populated, there will be more than 100 undergraduate chemical engineering students (based on the planned enrollment of 20 new students per year).

The first year of the program is at a level similar to high school courses in the United States, which is necessary due to the poor secondary schools in much of Myanmar. The second year is similar to the first year of a college engineering program in the United States, and the students take mathematics, English, and basic science and engineering courses.

In the third to fifth years, students take a fairly typical chemical engineering course of study, including the usual chemical engineering courses, as well as more mathematics, science, and core engineering courses. Students also take humanities courses and English courses. Students are required to take an elective course in chemical technology each semester— topics include food, polymer, pulp and paper, petroleum and petrochemical, renewable energy, nano-technology, and environmental technology. Students also complete industrial practical training at a company site for two weeks during the academic-year breaks; the company that a student is matched with depends on the technical elective courses taken by the student.

The sixth year is all project-based. In the first semester,

students do either a research project in the department labs or work with a community in applying engineering to help the community. In the second semester, students do an internship in industry, where they practice processing and design as well as administration, planning, and marketing skills.

Graduate programs

The master's degree typically takes two years to complete—one year of coursework and one year for research. There are currently six students in the master's program.

The Ph.D. degree program takes three years after completion of the master's degree. Students take classes and write a research proposal in their first year, and do research in the next two years. The students present their research results every two months to the department, and then defend their thesis in front of the advisory board. There are currently three students in the Ph.D. program.

The Diploma in Food Technology (DFT) program is a one-year course of study after the bachelor's degree. This program attracts students from a variety of undergraduate majors, and provides the necessary knowledge and technical skill for food technology. Most students in this program are staff from food industries and medical doctors from the Myanmar Food and Drug Administration. There are currently eight students in the DFT program.

RESEARCH

The research in the Department of Chemical Engineering at YTU focuses on the unique energy, environmental, and food technology issues that have an impact on Myanmar.

A major YTU project has been to develop biogas facilities to provide electricity for rural villages in Myanmar. Less than 15% of the people in Myanmar have access to electricity, which is the lowest electrification rate of any country in the world outside of Africa^[2]; most of those without electricity live in small rural villages far from the electrical grid. The biogas facilities use cow dung as the source for energy (there are many cows in these rural villages). The cow dung is converted to methane in bioreactors, and the methane is used to power generators that provide electricity. Once built, the biogas facilities are operated communally by the villagers. The YTU-led team has built biogas facilities in 183 villages throughout Myanmar, which provide electricity for over 100,000 villagers who were previously without electricity. Prof. Myo Myo Oo has led the biogas project.

Another YTU project addresses providing electricity for villages, small industries, and agriculture sectors (especially rice mills) through gasification of biomass. A down-draft gasifier driving a 20 kw fuel engine was developed at YTU in 2004 with funding from the Ministry of Science and



Laboratories of the Department of Chemical Engineering: processing laboratory and unit operations laboratory.

Technology. The feedstock for this gasifier is wood chips, and more than 20 of these 20 kw gasifier facilities have been installed at rice mills throughout the country. Research is now being carried out to expand the process to use other feedstocks. In particular, rice husk is an abundant biomass in Myanmar. However, when gasification is carried out with rice husks, it is hard to attain a smooth-running condition because of the low heating value, the low bulk density of the rice husk, and ash and tar problems that occur during gasification. Currently, YTU faculty member Myo Min Win and his graduate student carry out research on the catalytic gasification from pelletized rice husk in order to gasify at lower temperatures. This system is intended to overcome the problems that have limited the use of gasification technology with the rice husk feedstock.

Myanmar is facing water pollution problems because there are no relevant environmental protection laws and most industries did not install wastewater treatment facilities (the Ministry of Environmental Conservation and Forestry is currently drafting laws to require such facilities in the near future). YTU faculty members, along with graduate students, are carrying out several research projects on wastewater treatment, with the goal of transferring technologies to industry. Faculty members Nwaynay Hlaing and Lat Lat Tun are conducting research on the anaerobic fermentation of industrial wastewater, and Su Su Hlaing is working on wastewater treatment by adsorption.

HOW YTU DIFFERS FROM U.S. UNIVERSITIES

Due to the isolation of Myanmar from the rest of the world and the long-standing control of the universities by the military government, as well as the unique culture of Myanmar that is closely tied to Buddhism, there are a number of aspects of YTU that are very different from universities in the United States.

Interactions with other countries

YTU has been very isolated from the world outside of Myanmar. As noted, all of the chemical engineering faculty members received their degrees from universities in Myanmar. As of mid-2013, none of the chemical engineering faculty had spent extended periods of time outside of Myanmar, and in their studies they had not interacted with faculty or students from outside of the country. This situation is very different from other places in the world, where significant international exchange in universities is common (in even the poorest countries in Africa many of the faculty have studied outside of their country).

But that's beginning to change. Visitors from other countries are now coming to YTU to interact with the faculty and students. In 2013, Prof. Daniel Lacks from Case Western Reserve University (CWRU) twice visited on a Fulbright program to work with the faculty at YTU. On his second visit, 13 students from the CWRU Masters of Engineering Management program came to YTU and joined 13 Myanmar participants for the course International Engineering Entrepreneurship—the first U.S. academic course in Myanmar in at least 25 years.

The YTU chemical engineering faculty members are now also spending time at universities in other countries. In late 2013, Lat Lat Tun began a two-year stay at the Korea Institute of Science and Technology (KIST) in South Korea. Nwaynay Hlaing and April Htet spent the Fall 2014 semester as visiting professors at CWRU, where they have been involved in teaching and research. In 2015, four of the chemical engineering faculty members (Hlaing, Htet, Win, Kuang) began carrying out research at various universities in Japan.

Male to female ratio

When looking at the first photo in this article, there is something striking—17 of the 20 YTU members in the picture are women!

The picture shows the group of faculty and students from YTU that interacted with Lacks during his Fulbright program in Myanmar in 2013. This group was not selected to be mostly women, but rather reflects the high female/male ratio characteristic of YTU. This situation contrasts, of course, with the United States where engineering is predominantly male.

The female/male ratio for the chemical engineering faculty is 2:1, which is also the ratio of YTU faculty as a whole. Of the M.E. and Ph.D. students, seven of the nine current students are women. In the DFT program, about 70% of the students are women. One reason for the high female/male ratio relates to the job market. Male students tend to find jobs after their undergraduate degree more easily than female students, and thus more female students pursue graduate degrees (and thus academic careers). The DFT program is mainly populated by female medical and pharmacy students because it will help them obtain a job in the Myanmar Food and Drug Administration. A further reason for the high female/male ratio of faculty is that university faculty members earn low salaries compared with employment in industry, and more men than women feel that the university salary would not be sufficient to support their lifestyles.

In the case of undergraduate students, about 75% of the students in the chemical engineering department are female. YTU admits 50% male and 50% female students overall for the undergraduate program; even though more females than males pass the entrance exams with higher scores, YTU aims to maintain a balanced female/male ratio. However, most male students choose mechanical, mechatronic, or petroleum engineering, leaving chemical engineering to be mostly female.

Teaching system

Students at YTU take up to eight courses each semester, including some with labs. For this reason students need to attend classes from 8 a.m. to 4 p.m., with a break for lunch and 10-minute breaks between classes. The student learning occurs mainly in class, and students are not usually required to solve homework problems outside of class. The instruction is very traditional. Classes are lecture-based; students seldom ask questions in the class, and the class is usually silent except for the instructor lecturing. Problems are solved only with paper, pencil, and calculator—there are no computer-based solutions to problems (*e.g.*, using spreadsheets or software like Matlab), and process simulation software is never used because of its lack of availability. In regard to laboratories, teachers prepare lab instructions and students do experiments following these instructions, without many independent contributions. As Myanmar is opening up and the faculty are interacting with colleagues from other countries, the curriculum will become modernized, including the use of computers in solving problems and enriched lab experiences.

Campus life

The traditional culture, closely tied to Theravada Buddhism, plays an important role throughout life in Myanmar. The most easily recognized landmark of Myanmar is the Shwedagon Pagoda, the Buddhist holy site in the heart of Yangon. Also, most Myanmar people have spent time as Buddhist monks or nuns (these 1-4 week stints are akin to religious retreats). The unique Myanmar culture pervades campus life at YTU.

Dress code: The YTU faculty members are required to follow a dress code based on the traditional Myanmar style. Male faculty members must wear a white shirt and a longyi (a longyi is a wrap-around skirt). Female faculty members must wear a white blouse with a blue longyi (also called Hta-mein), where the longyi has white waves from the middle to the lower part of the longyi. Students must wear a white shirt, but with either a longyi or trousers.

Alms for monks: Every morning around 9 a.m. monks and novices come to the YTU campus and visit the houses on campus and the canteen to accept donations of food. People from each of the houses and from the canteen are waiting to offer food. Rice is placed into the monk's bowl and fruits and other items are placed into the inverted lid of the bowl. Curries and vegetables are given in separate containers.

Kadaw ceremonies: Myanmar Buddhists pay respect to parents, teachers, and elderly relatives in "Kadaw" ceremonies. In the morning, students wear traditional dress and bring small gifts to teachers. The students take off their shoes, kneel in front of the teachers, and bow with their faces touching the ground. Students not only pay respects as a gesture of gratitude, but also ask forgiveness for any wrongful action they might have done. The teachers, even as they accept the Kadaw from students, ask forgiveness in turn for any wrongful action or hurt they themselves might have been guilty of.

CONCLUSION

Myanmar's circumstances have caused its educational system to lag behind that of much of the world, including its neighbors in Southeast Asia. But Myanmar's recent political changes—in which the military government is transforming to a democratic government—is giving academics hope that the educational system will be reformed. The faculty of the YTU Department of Chemical Engineering is excited and active in renewing its undergraduate program and expanding its research. The department warmly welcomes you to become involved in its reforming process, as well as to enjoy Myanmar's culture.

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