teaching physics in JAVA

The following impressions are those of an American physicist who has devoted nearly three years to the task of organizing a modern physics department at the University of Indonesia.

By ***W. C. Dickinson***

IT was more than two years ago, the summer of 1954, over after-dinner coffee at the home of friends in Los Alamos, New Mexico. Our host sighed with obvious relief, "I pictured you, Bill, going to Indonesia to teach physics in a grass hut to students dressed in loin cloths. Now I feel much better!"

I had described something of our expected life in Bandung as had been gathered from correspondence with a future colleague at the University of Indonesia. At that time few of our friends had heard of Bandung and in fact, some were in doubt as to the difference between Indonesia and Indochina! Because of the significant role that Indonesia now plays in world affairs and also the recent visit to the United States of President Sukarno, perhaps this new Asian democracy is now more familiar to Americans. It is the fabled land of Java, Bali, and the Spice Islands. Tigers constitute a serious menace to the village people and farmers of Sumatra. That island is also noted as the land of the world's largest flower—the Rafflesia, sometimes more than one yard in diameter. Borneo, about the size of France, is a largely unexplored land of tropical forests, high mountains, diamond mines, and few but not always friendly inhabitants. In Java, the cultural, economic, and political center of this 3000 island archipelago, 52 million people live in an area equal to that of New York State. With an average population density of over 1000 per square mile, this island is home to one-fourth the population of the Southern Hemisphere. A chain of volcanic mountains, heavily wooded with teak, palms, and banyan, extends the length of the island. Several areas are dangerous to enter because of occasional wild buffaloes, boars, panthers, and prehistoric one-horned rhinoceros—not to mention the bandit gangs which infest the western mountains. On motor trips to Djakarta we pass through groves of heavily laden coconut palms, banana and rubber plantations, and everywhere the clusters of bamboo cottages almost hidden by dense vegetation. Birds of brilliant plumage swoop in front of the car and friendly spider monkeys wait patiently along the roadside for a possible handout.

Our mountain city of Bandung is the third largest in Indonesia and, since the Asian-African conference held here in 1955, perhaps the best known to the world. It is situated in the province of West Java on a plateau 2400 feet above sea level and is surrounded by lush green mountains. A few miles to the north the landscape is dominated by the active volcano, Tangkubanprahu. It has not erupted for many years but clouds of sulfureous steam emerge from the three craters. This city of almost one million was intensively built up after World War I by the East Indies Dutch as a resort haven for sweltering civil servants from the steaming capital city of Batavia (now Djakarta) 100 miles to the northwest. Even today, almost ten years after Indonesia won its bitter struggle for independence, hundreds of retired Dutch nationals live here. Indonesia is home to them.

The climate is uniformly mild and a blanket is needed at night. We have only two seasons. The monsoon begins in October and ends in April or May. Then comes the dry season. During the monsoon there is a driving rain almost every afternoon and evening but the mornings are delightfully warm and sunny. The high humidity causes mildew to grow on books and shoes. Even in the dry season there is a rain almost every week. The annual rainfall in Bandung averages 70 inches and in some parts of the island the average reaches 280 inches. It is this together with the black and fertile

Javanese scene near Bandung: coconut palms, water buffaloes, and rice paddies.

volcanic soil that provides sustenance to so many millions. Two crops of rice are harvested each year.

Compared to Tokyo, Hong Kong, Bangkok, and Singapore, we find Bandung a most un-Asian city. It is called the Paris of Indonesia because of its beautiful, colorfully dressed Sundanese women. Its residential sections have broad tree-lined streets and comfortable homes, all with steep red-tiled roofs. Flowers and flowering trees abound. But there is another side to Bandung that the casual visitor seldom sees. Interspersed among the "Europeanized" districts are small bamboo villages, each with an unbelievably large population. Although the inhabitants are almost always clean and neatly dressed they are very poor. Almost their only food is rice. Between three and five percent have tuberculosis; yaws and glaucoma incapacitate many.

The hardest thing for me to become accustomed to in this beautiful country is the intense poverty, the malnutrition and disease, and the short life expectancy of the people. After only a few weeks in Bandung my secretary asked if I might wish to donate to a fund for one of the janitor-errand boys who works in the Physics Department. I asked if the fund was for some sort of celebration. "Oh no," she casually replied, "one of his children died last night and it is the custom to help with the funeral expenses." Only the day before, Ojo had been at work with no hint of sickness at home. Penicillin given in time would almost surely have saved the child. But there is no money for expensive drugs—a contribution is only asked for the funeral.

IN 1950 the University of Indonesia was created from the colonial Dutch university. Now more than 10 000 students attend its several faculties. These faculties are similar to the colleges of an American university except that each faculty is a self-contained unit almost entirely independent of the others. This stems in part from Dutch traditions and in part from geography. In Djakarta reside the Faculties of Medicine, Law and So-

William C. Dickinson (left front) with other members of the Physics Department staff at the University of Indonesia. A graduate of the University of California, Dr. Dickinson received his PhD in physics at the Massachusetts Institute of Technology. Before going with his family to Bandung in 1954, he was a member of the Physics Division staff at the Los Alamos Scientific Laboratory. Also shown in the photograph are: Go Pok Oen (right front) who is now spending a year of advanced study at Texas A & M College; Sumantri (left rear) who will soon come to the US to gain experience as an industrial physicist; Prof. Ong Ping Hok (center rear), Indonesia's lone PhD physicist, who obtained his doctorate in Holland; and Lim Tek Giauw (right rear) who is now working on his PhD thesis in Holland.

Street scene in downtown Bandung, the "Paris" of Indonesia. A city with a population of nearly one million, Bandung is the home of the science and engineering schools of the University of Indonesia.

cial Studies, Economics, and Arts and Letters while in Bandung are the Faculties of Engineering and of Mathematics and Natural Science. Halfway between, in the town of Bogor, are the Faculties of Agriculture, Forestry, and Veterinary Science.

The two faculties of Science and Engineering make Bandung the center of Indonesian higher technical education. Over 3000 students flock here from all parts of the archipelago each September. Although the Science Faculty was only recently established, the Engineering Faculty is the outgrowth of a Dutch civil engineering school founded in 1920. President Sukarno is numbered among the eighty Indonesian graduates in that school's twenty-year existence. Now the Faculty includes Departments of Mining, Electrical, Civil, Mechanical, and Chemical Engineering as well as Geodetics, Architecture, and Fine Arts (American engineering schools take note!).

Problems faced by the University would make those of a typical university in the United States seem insignificant. The most serious problem is shortage of teachers. Less than half of the senior staff are Indonesians; most of the others are imported from Europe. Many more are needed. It will be at least another five years before enough young Indonesians are trained to take over completely. The International Cooperation Administration of the US Government is now helping to solve this problem. In a tripartite agreement between the University of California, ICA, and the Faculty of Medicine, several professors from California now teach in Djakarta. Recently a similar contract was signed with the University of Kentucky to send some ten science and engineering professors to Bandung. An important feature of these affiliations is that Indonesian graduate students are sent to the sister institutions in the US to finish their professional studies and return to a teaching career. Also, books, periodicals, and technical equipment are provided.

Another problem is the difficulty that students encounter in obtaining textbooks. Because of the red tape of import regulations and foreign exchange allotments, books from abroad take at least nine months to arrive. Most students cannot afford to buy more than one or at most two textbooks each year. Some work is now being done in translating good foreign texts into reasonably priced Indonesian editions. A few engineering texts have been written by Indonesian professors. Drawing sets and slide rules are luxuries that only a few can afford. Most of our students laboriously calculate out their final answers in problem sets and examinations with an abundance of wrong answers resulting.

Laboratory space is scarce and lecture rooms are crowded. In the basic physics lectures students lean on the demonstration table, sit on the floor, and crowd around the doors. Recently an old opium factory was requisitioned by the Faculty of Economics in Djakarta to serve as a lecture room.

Salaries of University employees are sadly inadequate. Even the dean cannot afford a car and a secretary or librarian earns less than one-tenth the income of a professor. We lose our best young teachers, laboratory assistants, and librarians to foreign-owned industries which pay salaries 4 or 5 times higher.

Ganesa, or Ganesh, the elephant-headed, four-handed Hindu god of wisdom, learning, and prudence, stands guard at the entrance to the University's Engineering Faculty. Hinduism flourished in Indonesia before the 13th Century Invasion of Islam.

ONE of the first questions asked me by American visitors is, "How do you find the Indonesian students?" Shortly comes another sure one, "But if your lectures are in English, how can they understand you?"

Students here are in many ways like students everywhere. They heartily enjoy a corny classroom joke, crowd into the canteen between classes for an orange crush or a cup of Java, know all about the newest Hollywood stars and their latest films, and always put off till the morrow any work not absolutely necessary for today. The standard mode of transportation is the bicycle. I never tire of watching the tight formations, handle bar to handle bar, flow with perfect precision round a corner at the bottom of a campus hill, the riders laughing and chattering all the while. A few upperclassmen sport motor-bikes and the mark of the BMOC is a brightly painted motorcycle *sans* muffler.

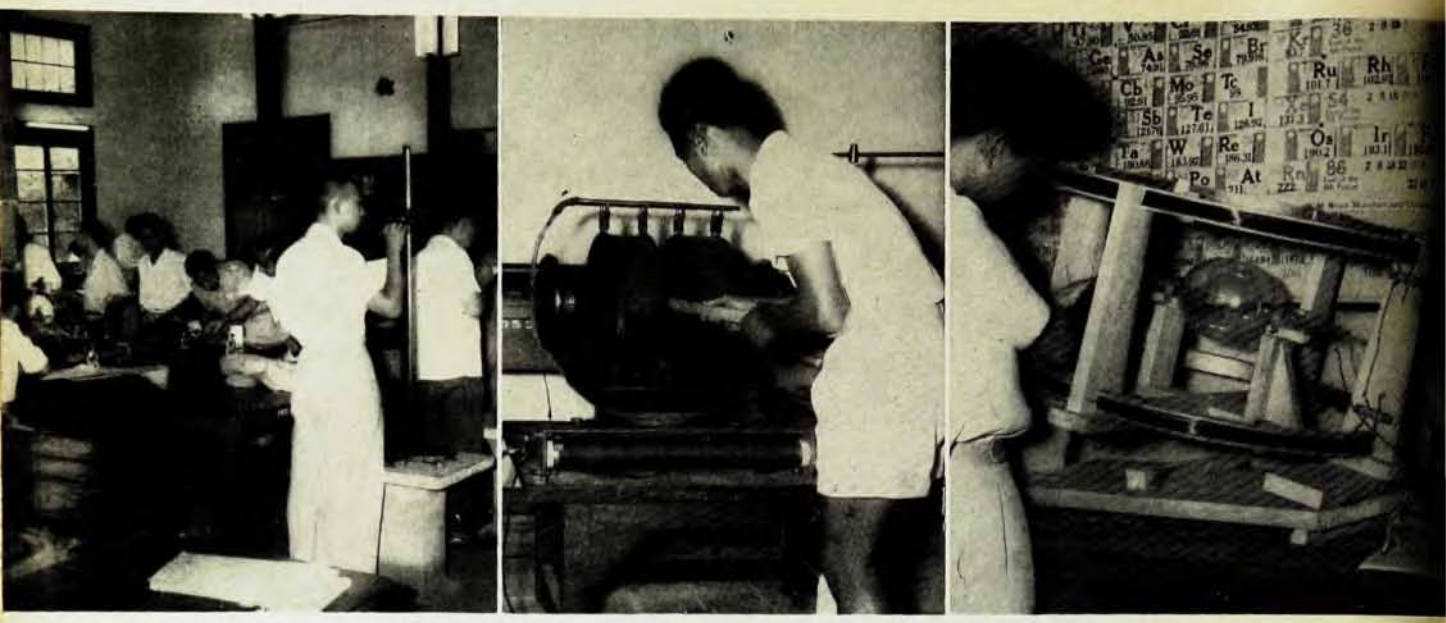
Campus dress for the boys is usually an open-collared white shirt and white duck slacks. The girls often wear sleeveless batik dresses with full skirts. The *adat* (customary or traditional) dress usually worn by the men and women of the villages is never seen on the campus except on ceremonial occasions.

But there are sharp limits to all this western modernity. The rules of Islam are manifest. Western dancing is strictly forbidden in any university building. Each Friday classes are suspended at eleven so that male students may go to the mosque for mass prayers. During the holy month of Ramadan the Islamic students must totally abstain from food and drink between sunup and sundown. On the other hand, with broad-minded impartiality, Indonesia celebrates all Christian as well as Islamic holidays, with Chinese New Year thrown in for good measure.

Favorite sports are soccer, tennis, and badminton. There is an active student organization but little official encouragement of extracurricular activities. The Asia Foundation of the United States recently made the Bandung student organization a sizable grant to be spent for musical instruments, sports equipment, and leisure-reading books. (No liberal arts courses are included in the engineering or science curricula.) Efforts are now being made to raise funds for a small student union building with library and cafeteria.

Once or twice each year the students stage a gala evening performance consisting of a splendid mélange of dances from the different islands. This is a unique opportunity to compare the various cultures coexisting in Indonesia. Dances of Bali are the most enchanting for us, accompanied by the dramatic percussion music of the Balinese gamelan orchestra. There are the highly sophisticated dances of central Java and the primitive war dances of the Celebes and Moluccas. The acrobatic Sumatran candle dance is performed on a darkened stage by two dancers. Balanced on each hand is a saucer holding a lighted candle. A good dancer will never allow the candle to flicker out as he traces intricate patterns of light. A short time after we had arrived in Indonesia we attended one of these entertainments. The next morning a student entered my office. Despite his neatly pressed white shirt and trousers I suddenly recognized him as one of the best Balinese

Bicycles and open-collared white shirts are the rule on the Bandung campus. The photograph at right shows first-year University students leaving the Physics Department after a basic physics lecture.



Physics laboratory scenes. Graduate student (center) is using water-cooled electromagnet for Stern-Gerlach atomic beam deflection experiment. At right, graduate students make final adjustments on home-made e/m apparatus to be used in atomic structure laboratory soon to be opened for third-year physics majors.

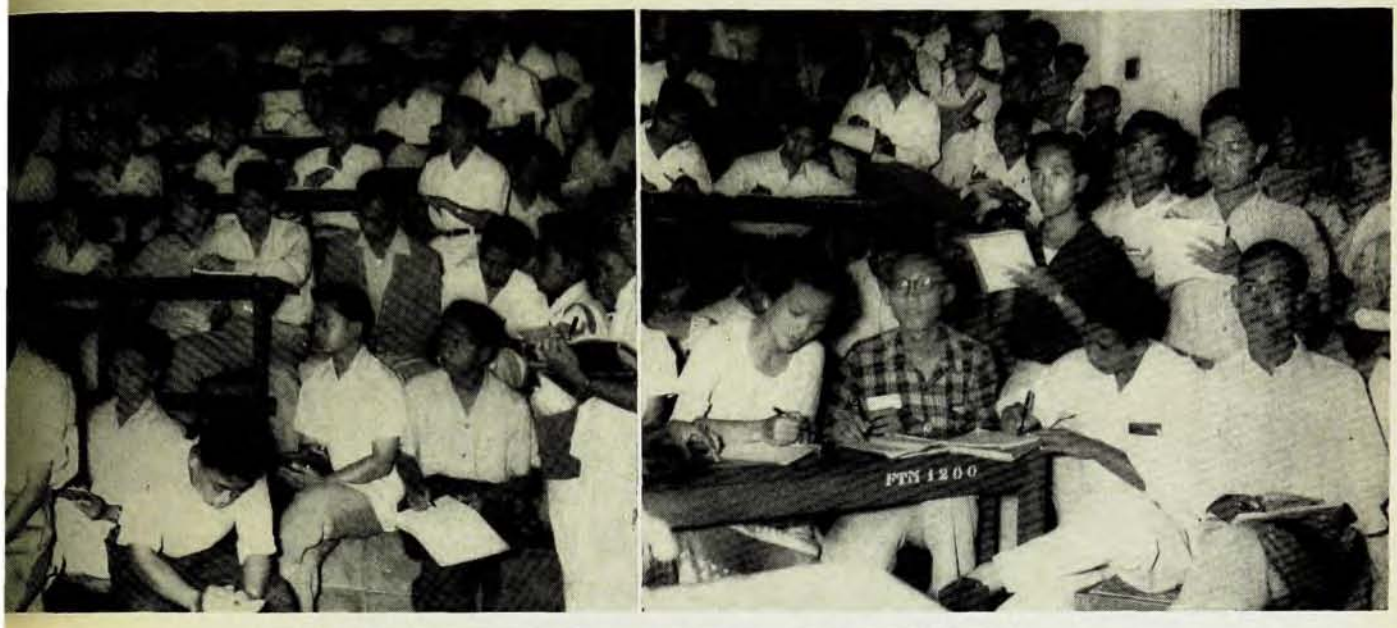
dancers we had seen the night before. In passable English he described his difficulty in understanding my last lecture on electrostatic image theory. And not a sign of schizophrenia!

In any serious comparison between the intellectual capabilities of American and Indonesian university students, a fair allowance must be made for the past environment and experiences of the latter group. They have grown up in the midst of war and revolution. One of my students only entered elementary school at the age of eleven. He was seven when the Japanese occupied Indonesia and put him in a child labor corps to scour the countryside in search of a wild fruit from which an oil was extracted for Japanese war planes. His schooling was further interrupted by the Dutch assaults in the period after the Japanese defeat. Most Indonesian students have risen from poor and illiterate families. Books were not to be found in their homes and there was no tradition of learning on which to build. Their high school preparation in science and mathematics was usually inadequate. Another of my students had only studied mechanics and electricity in his high school physics course because his teacher did not feel qualified to go further. Only a few high schools in the large cities are equipped with physics or chemistry laboratories. Finally there is the language problem. There are 200 separate languages (not dialects) used today in the various regions of this archipelago. A typical student from Central Java would have used only Javanese in his early childhood. In the fourth grade he would first begin lessons in Bahasa Indonesia—the national language based on Malay and still in the process of development. In high school he began lessons in English. (In colonial days he had to master the Dutch language before applying for admission to a high school.) When the student arrives in Bandung most of his lectures will be in English, often spoken with a heavy accent.

With such difficulties to overcome, coupled with an unnecessarily difficult and complicated Dutch curriculum, it is not surprising that the failure rate has been high. The fact that many students make excellent records in their studies can only be attributed to their enthusiasm and their unusual eagerness for learning.

Returning to the question of language, although I have studied Indonesian for the past two years I still do not feel able to lecture in it. Most of the students cannot speak English with any degree of fluency but their understanding of simple English spoken slowly usually seems adequate—at least for scientific lectures in which much is written on the blackboard. Surprisingly I found in answer to an unsigned questionnaire that nearly half of my students preferred lectures in "good English" to those in "good Bahasa Indonesia". Perhaps this is because of the limited scientific vocabulary of the latter language. It also might be due to the students' desire to learn English!

The problem of adequate and satisfying communication I can best illustrate by a recent incident. The Indonesian manager of a Djakarta book importing firm, with which the Physics Department had placed a large order for textbooks, came to my office one morning to unravel an error in his accounting. With my secretary, who had sold the books to the students, we walked over



Students at Bandung must sit on the steps and stand around the door at the basic physics lectures. More than 300 students crowd into the University's physics lecture room which seats only 175. The shaved heads belong to freshmen who have just endured initiation ceremonies.

to the Central Library to speak with the Dutch librarian who keeps a complete record of these transactions. Since his English is almost as poor as my Dutch, he and I spoke with each other in elementary Indonesian. The two Indonesians spoke with the librarian in Dutch which they know as well as their own language. They spoke with each other in Indonesian and with me in a fair English. At the end of the protracted conversation I believe there was some doubt in all our minds as to just what we had accomplished.

THE Physics Department is part of the Science Faculty although it is located on the spacious campus of the Engineering Faculty nearby. In the new four-year curriculum adopted by both faculties at the beginning of this academic year, all engineering and physical science students in their first two years receive a common course in basic physics. This is divided into four semesters: mechanics; electricity and magnetism; mechanics of fluids, heat, and sound; optics and modern physics. (Electricity and magnetism was advanced from its customary place in the sequence in order to prepare the electrical engineers for their second-year engineering courses.) We have adopted the three-volume *Principles of Physics* series by Francis Sears. Plans have been completed for the translation and publication of these texts in the Indonesian language with the financial assistance of Franklin Publications of New York. However we are having difficulty in finding an Indonesian publishing firm which is equipped to handle the job.

Almost half of the 1000 Science Faculty students are studying to become pharmacists. Together with the zoologists, botanists, and geologists they take a one-year basic physics course in which stress is laid on heat and optics. Also we give a one-semester course in mechanics, heat, and sound to prepare the first-year architects for later courses in structural mechanics and building physics.

These three programs, in which almost 1500 students are enrolled for lectures, problem sessions, and laboratory, engage the efforts of the entire physics staff and student assistants. In addition our department presents each year about ten courses on the intermediate and graduate level. Engineers in the third and fourth years take the requisite courses in applied physics—heat transfer, wave propagation and antennae theory, etc. There are about 50 science students majoring in physics. The best of them in the third and fourth years assist in the Basic Physics Laboratory. Several teach high school physics and mathematics in the afternoon and evening.

Our fifteen graduate students working for the Doctorandus degree (similar to an American PhD minus dissertation) will constitute the first group of Indonesian physicists. They are following a two-year program of study consisting of lectures in experimental and theoretical physics and mathematics. Also they must help in the department teaching program—either teaching some of the many basic physics problem sessions or supervising in the laboratories. Each must successfully complete at least one experimental project. Presently this consists of building up experiments for the Atomic Structure and the Electrical Measurements Laboratories

At left is shown a portion of the basic physics laboratory, where every afternoon one hundred students do experiments in mechanics, heat, electricity, and optics. At right is a corner of the book room of the Physics Department library. Before a shortage of government funds two years ago resulted in cancellation of all subscriptions, the Department received 32 international physics journals.

which will accompany undergraduate lectures next year.

Unfortunately, because of equipment shortages and small staff, it has not been possible to begin a program of original research. There is a possibility that we may be able to participate in the "Cooperative Nuclear Emulsion Research" program recently organized by a group of small American universities. We will ask the ICA to send an Indonesian member of our staff to the United States to obtain instruction and experience with nuclear emulsion techniques. Upon his return he would guide our graduate students in a research project using nuclear plates previously exposed at US accelerators. This idea of cooperative nuclear emulsion research was originally designed to offer research opportunities to small physics departments in the US. However it seems ideally suited for extension beyond American shores, particularly to countries like Indonesia who have little money for investment in expensive research facilities.

A serious handicap in preparing our graduate students for a career in physics research is lack of modern laboratory equipment and facilities. Funds have been requested for the purchase of radioactive sources and electronic instrumentation for a small nuclear physics laboratory. This would introduce our students to the atmosphere of modern physics research and at the same time be a valuable supplement to our graduate nuclear physics lectures. Within the next few years Indonesia will undoubtedly wish to begin an active program for the utilization of atomic energy. Already nearby Burma is constructing a Nuclear Research Center in Rangoon and the Philippines hopes soon to have a US sponsored "Asian Nuclear Center" in Manila. We visualize our projected laboratory as providing a starting point for a future Indonesian program. Initially it would be used for the training of physicists, technicians, and medical doctors in the use and handling of radioisotopes. At some later time the laboratory could be transformed into a nuclear research center and be equipped with a research reactor. But all this is now only a hope for the future.

Each week the physics staff and graduate students meet together for an informal discussion. A student may describe difficulties he has encountered in an experimental project—it usually comes down to the lack of a vital piece of equipment and the question of what to substitute. Another time a student may present a two-hour colloquium on a subject which has attracted his interest. (Each student must present two of these before the completion of his graduate work.) Recently a young Italian physicist visited our department and attended one of these talks. The subject was "The Detection and Measurement of the Anti-Proton". After a lively question session she confided to me that she had no idea there were Indonesian students on such an advanced level. She was being sent by Unesco to the Gadja Mada University in Central Java to help build up their Physics Department. In Europe she had been warned that Indonesian students probably would not yet have mastered the rudiments of the calculus!

IN an address to the 1956 graduating class at Baylor University, President Eisenhower suggested that American universities and their graduates help to establish educational institutions in the new nations of Asia and Africa. He said, "Many nations, though their cultures are ancient and rich in human values, do

The Bandung branch of the University of Indonesia annually offers technical training to more than 3000 students. The graduate students at right will constitute the first crop of Indonesian physicists. Besides laboratory work and teaching duties they attend lectures in quantum mechanics, nuclear physics, electromagnetic theory, cosmic rays, x-rays, and applied mathematics.

not possess resources to spread the needed education throughout their populations. But they can wisely use help that respects their traditions. For example, the whole free world would be stronger if there existed adequate institutions of modern techniques and sciences in (the lesser-developed) areas of the world. . . . Do we not find a worthy challenge to America's universities and to their graduates? I firmly believe that if some or all of our great universities, strongly supported by private foundations that exist throughout our land, sparked by the zeal and fire of educated Americans, would devote themselves to this task, the prospect for a peaceful and prosperous world would be mightily enhanced. . . . We would gain new knowledge and wisdom out of the priceless values of another people's traditions and cultural heritage. They would gain knowledge in the technical and scientific fields where we have had an earlier start."

From this on-the-spot location in one of Asia's most important new democracies, I can only hope that this proposal will receive serious consideration. Without exception these new nations must now undertake a job that was left undone for centuries—the education of their young people. When Indonesia won its sovereignty in 1949, less than one percent of the people could read and write. Under the colonial regime fewer than 200 Indonesians graduated from high school each year. After only seven years of freedom, literacy has risen to almost forty percent. New schools are going up in every corner of the archipelago and the shortage of teachers is being solved by two and even three shifts each day. But the problem of creating new universities is more serious. Money is appropriated and buildings are erected, complete with student dormitories. But no professors can be found and there is only the old colonial system of higher education to serve as a guide in planning curricula. Indonesian graduate students are often asked to interrupt their studies to help these new institutions get underway.

President Eisenhower has well expressed the need for American university people who wish to lend a hand in this part of the world. Living conditions will be less than ideal and research opportunities will be limited or nonexistent. Daily there will be frustrations and minor irritations. One must learn to adjust to the tempo and the mores of a foreign culture. But all this is more than balanced by the satisfaction that comes in doing the job. Opportunity for exerting personal initiative is unlimited. And there is the fun of becoming immersed in a nation's growth, learning a new language, making new friends, and having the broadening experience of seeing your own culture through the eyes of others.

One thing I know. Speaking as a pampered American physicist, I will never again take for granted the blessing of an air-conditioned laboratory with stabilized voltage at every outlet and a well-stocked supply room just down the hall!

I am happy to report that, after concluding this article, Professors F. L. Yost and Richard Hanau from the University of Kentucky and Professor Bernard G. Saunders from the Oak Ridge National Laboratory have joined the Physics Department staff. Also Mr. Hugh Reeves from Christ College, Tasmania has recently arrived as a lecturer.