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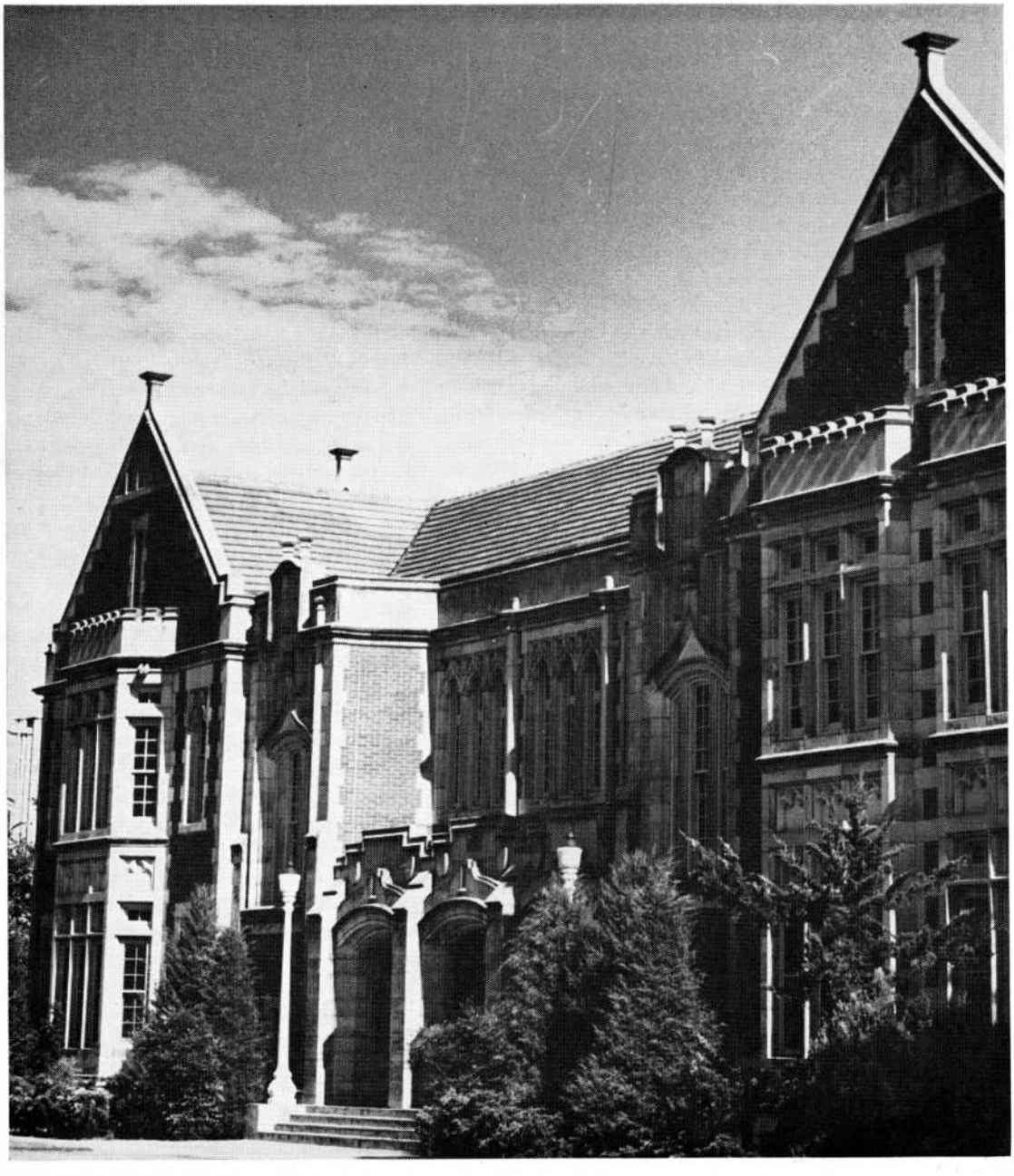


JACOBSON HALL, one of the most beautiful buildings on the O.U. campus, seems serene under winter skies.

Education in Egypt

By JOHN PAUL DUNCAN

Initial experience with Egyptian higher education led me to "expect anything." Soon after my arrival in Cairo as Fulbright Lecturer at Ibrahim University, the administrator of the Foundation took me to visit one of my deans. The latter was temporarily located in an old villa surrounded by an ornate iron fence. Uniformed guards were at the gates. A large crowd of students appeared to be trying to force its way past the guards and gates. They were vociferously demonstrative in their efforts. Indeed, at first glance I wondered if this was one of the famous student political mobs I had read about which at least once during the previous year had marched out of the classrooms and helped set the town afire not only figuratively but literally. It turned out that such was not the case.

This was the beginning of the school year and the students were simply trying to see the dean about admission. Somewhere, somehow, despite thousands of years of foreign rule by autocrats, Egyptians have been thoroughly indoctrinated with the belief, often claimed by the West, in "the value and worth of the individual." In fact, each Egyptian not only seems to believe he is worth as much as the next one but demonstrates the fact at every opportunity. On this occasion, not one student was willing to "queue up." Likewise, Western regimenting administrative devices such as "time cards" had not been instituted. One got to see the dean in this instance by fighting his way to the front, battling steadily to remain there, and then wriggling through the gate and the guards when the gate opened a crack to permit someone to leave. A great deal of noise accompanied this whole procedure.

Although I wondered whether this system might not be a bit unsystematic I merely thought about it at the time in terms of its incidence upon administrators. Since I was not an administrator my interest was mainly "academic."

A few weeks later, however, I met my first class. I knew it was scheduled to contain a thousand enrollees, but I assumed that to handle this number there would be a system for peace and order.

I found the class with ease; one could not very well miss it. There appeared, however, to be considerably more than a thousand students present. They had not only filled all of the seats, but scores, if not hundreds, were standing jammed about the room and even among the seats or clustered about the many windows looking in. After considerable effort to get the "class" started, I found that large numbers of students would come in and stand around for a while or sit down and later get up and leave for a period, only to return again if they felt like it. Shutting the doors aided imperceptibly because those who left temporarily, left the doors open and the crowd outside, previously prevented from entering, would pour into the room. Doorkeepers gave little assistance because if they attempted to keep a student out there would be a repetition of the demonstration I had seen at the dean's gates. To make the situation really difficult many people who came to the lecture were not members of the class, not even members of the Faculty of Law, but Engineers in whose building we were temporarily housed. The engineers and lawyers appeared to have the same traditional rivalry at Ibrahim University that they have at certain American schools. However, instead of "stealing" a school "queen," Egyptian students "steal" a professor by "stacking" the class with students from the rival faculty. I never discovered whether this was really intentional or because they love learning for the sake of learning and have a desire to broaden themselves. I have my suspicions.

If a reader receives the impression that the above situation is bad pedagogically and makes for bedlam it is a correct one. There is much too much of this type of disorder both in the relation of the undergraduate students with administrators and with teachers. In fact, there are times when the native-born Egyptian professor himself becomes so irritated with a noisy class that he slams his books and notes into his brief case and stomps to his office, usually with a large portion of the class hurrying after him, apologetically pleading with him to return.

On the other hand, these impressions I first received of Egyptian higher education are not, I believe, a fair estimate of the total situation. They were merely indications of certain weak aspects, partially inherited from the past.

In fact, even this kind of "initiation" for the new teacher has its value. For if you cannot handle the situation, bring order out of chaos, and force discipline by displaying a command of your subject plus the ability to explain it clearly and interestingly you are forced to give up and turn to another pursuit than teaching. The Egyptian universities retain professors only of both recognized scholarly attainments and teaching capacity. To be selected, the doctorate is usually a necessity. Publication of scholarly writing is required for promotion. But it is the students who particularly add their own requirement that a scholar be verbal and able to express himself orally in a first-rate manner. Actually, every Egyptian member of the staff with whom I was associated was a first-rate speaker and usually in more than one language.

Immediately, some of the trouble with education at the university level is due to the educational system at lower levels. But basically, as I have indicated, the difficulties are inherited from the past and are due to certain social, economic, and political facts of life. The British, who took control in 1882, not only did not push higher education, except to secure civil servants, but did not develop education for the masses at the lower levels. It has been since the British began to leave after the First World War that a broader system has been developed. Even since then progress has been slow because of the continued bad government and feudal economic situation in which there has been a small, extremely wealthy, landed class at the top, not always too public-spirited, and a mass of peasants living in poverty and forming the base. Until recently the extremely small middle classes were mainly composed of foreigners.

The wealthy sent their children to excellent foreign private schools at home or abroad; the middle classes often did the same. The masses simply received no education. Since the bulk of the population lived in great poverty, it provided no tax base from which revenue could be secured by which to develop a real public school system. However, with independence the Egyptian people and especially the upper classes have developed an increasing sense of responsibility. A broadly based educa-

tional system is considered now to be a "must." The requisite economic and social reforms have also been increasingly pressed. The land reform program of the Naguib government is an instance of this effort.

As a result of this awakening to social needs and the importance of widespread learning, Egypt now has compulsory education through the elementary schools or until fourteen years. The situation is still critical. Of three million children who should be in school only about one million are actually kept there regularly. The government has simply not been able thus far to provide enough buildings or teachers to care for all. Also the poverty of rural people often forces them to keep their children at home to work with them.

Officially, education begins at six years when a child enters either a kindergarten or elementary school. Those who go to kindergarten may transfer to a so-called primary school at eight years. These schools stress another language in addition to Arabic and are for those who wish to go further with their education later on. At twelve years children may take a general examination and those who pass may go on to a secondary education; if they do not pass, they must stay another year or until they are fourteen.

Secondary schools are technical or academic. At the end of two years, in addition to having attended 80% of the sessions and having passed at least 50% of the exams, students must pass a general preparatory exam before continuing their education. If they do meet this test successfully, they still remain two more years in secondary school, possibly transferring from one type to another. At the end of this latter period in the academic schools they take a final general examination. If they pass this test and desire to go to the university they must remain a fifth year. All of this actually means that Egyptian students take an additional year or two years of secondary school work above that of American students before going on to the university.

In the Egyptian public schools the situation as to poor or good instruction varies considerably from locality to locality, school to school, and of course class to class. The general impression seems to be that the instruction is not very good either at the elementary or secondary levels. This contrasts strikingly with the university situation. Also, a lack of discipline is one of the worst and most persistent conditions at the lower levels. This paves the way for the disorderly habits of students at the university level.

Besides the regular state schools there are the many private schools established by foreign groups, such as the French, British, and Americans. These schools are obligated to meet government standards, etc., but actually the standards may be higher and the instruction better. Indeed, students matriculating from these schools are probably well in advance of students in American public schools, aside from the additional year or more of education required prior to college entrance.

Returning to university education, there are four great Egyptian universities in the land and several foreign universities and colleges. The oldest is the Moslem university, Al Azhar. It was founded in 970 A.D. and is said to be the oldest university in the world. It was established to give both Moslem theological and secular education. It is still the center of Islamic culture. Education here is free and students are even given much help for maintenance. They come to it from all over the world. The institution was recently re-organized on more modern lines. It now consists of three faculties: one for Theology, one for Moslem jurisprudence, and one for the Arabic language. Many of the greatest thinkers and statesmen of the Middle East have come from this school; a number have gone on from here to European and other foreign schools.

The oldest state university is the University of Cairo, formerly Fouad I University. It was founded in 1925 after the British had largely withdrawn. In 1942 Alexandria University was also started; it has at least 8,000 students. Finally, in 1950 when Cairo University had reached an enrollment of 20,000 another university in that city was deemed necessary. Thus Ibrahim University was organized around a number of already existing higher institutes such as the Higher Institute of Engineering. By 1952 when I arrived to join the Faculty of Law at Ibrahim University it already had 12,000 students enrolled.

In addition to these Egyptian universities, the Americans have established the American University at Cairo, the American College for Boys at Assiut, and the American School for Girls at Cairo. These schools have an excellent reputation, meeting all of the Egyptian government requirements relative to language teaching, and the usual American standards as well. A very large number of the young women from the Egyptian upper-class families have been educated at the American School for Girls in Cairo and several outstanding Egyptian men leaders have had at least some of their education at one of the other American schools.

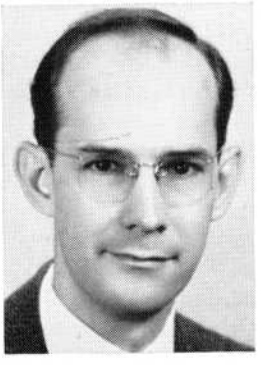
Besides attending the universities existing in Egypt, a very large number of Egyptians have gone abroad for further education. In an earlier day they went mainly to Germany, France, and Britain. Today many are also coming to America. Most of these return to university teaching, to work in business, or to serve the government.

Each Egyptian university consists of seven faculties and a number of certified institutes. The basic curriculum consists of four years with five years for engineering and six and one-half for medicine. Organization has been fundamentally along British and French lines. The classes open in October and continue in any given course straight through the year with a short vacation period in February until the time for the final general examinations covering all courses. These usually take place in June. There is no quarter or semester basis. If one fails the final general exam, he may take a second exam in the fall before the October term opens. If he fails, he must repeat the entire previous year's course.

Attendance at classes on the university level does not generally seem to be compulsory. Indeed, I am not sure that it could be with the mass classes in some schools. Of course not all schools or classes have as large a number of students as that of the Faculty of Law.

The libraries and laboratories are not yet up to American standards but they are rapidly improving. The choice of books is often good. For example, I found a small

ABOUT THE AUTHOR



Dr. John Paul Duncan, Associate Professor of Government, who joined the faculty in 1946 *and who in* 1951 *received one of the $500 awards given by the University of Oklahoma Foundation for the excellence of his teaching, spent* 1952–53 *as Fulbright Lecturer attached to the Faculty of Law at Ibrahim University, Cairo. His lectures were published in Cairo,* 1952, *as* Constitutional Government With Special Reference to the United States and Great Britain. *But this very interesting paper on Egyptian students, teachers, and universities is evidence that Dr. Duncan did not spend his time in any sort of professorial ivory tower.*

but excellent selection of political science books concerning American government already available in the library of the practically new Ibrahim University. Strangely, however, these books did not seem to be available yet for the students but were considered reservoirs of knowledge limited to the faculty.

If this latter fact seems surprising it is still true that the undergraduate students have a great deal to read and to do. Every Egyptian professor seems required to write his own textbook for his own class and these sometimes run more than a thousand pages. The students must learn this material almost literally as well as be able to explain it. Besides this, the taking of detailed lecture notes is another must. These, too, must be really learned and be explainable in essay or discussion, both oral and written. At the close of the year, undergraduate students are often brought before the teacher in small groups and examined orally much as we do in our "degree" exams. Then they are given the comprehensive written examinations. Proficient outside examiners often help grade the papers in the larger classes. These graders are not graduate students or general assistants but are persons of advanced professional standing. Thus, in the Faculty of Law judges and outstanding lawyers from all over Cairo were used in reading the papers of the law students.

Student life in Egypt has certain similarities to the American. Students enjoy attending athletic contests, working on the school paper, organizing clubs, and sitting over coffee and cokes in "bull" sessions. One striking difference is that university student social life is definitely not co-educational. Co-education does not exist academically until the university period begins. Dating even then is practically nonexistent. Indeed, for the most part women still sit by themselves in the classrooms and generally the two sexes do not "chit-chat" with one another in the halls or on the campus. There is a tendency for the Coptic Christian students to engage more and more in this Western practice but Moslem students apparently do not do it. Usually their marriages will be arranged.

On the other hand, I was unable to discover that this difference in social customs has any real effect academically. My Egyptian men students, for example, seemed to find just as much time to devote to entertainment detracting from serious study as is true in America where they spend time on dates. The women, too, seemed no more and no less serious than young women in America who are sometimes accused of coming to college to find husbands and spending much of their energy in this pursuit.

Formerly, political activity took much of the students' time. The students were often marshalled into groups which were adjuncts of the major political parties and were easily "pulled" out of the classroom for demonstrations. In fact, I was told that in the year prior to my lectureship the students were out of the classroom parading around Cairo more than they were in the classroom. Some of this parading culminated in violence. The Naguib government with its ban on political parties and its emphasis on each Egyptian engaging in "industry" and "living for Egypt," has put a stop to this. Where appeals to patriotism have not worked, the government simply puts the student ring-leaders of political demonstrations in the army for a month or so. Thus, not one of my law classes failed to appear during the year.

Administration in Egyptian universities seems nonexistent compared with that in America. There are Rectors, Presidents, and Deans. There are also a few male secretaries and doorkeepers. But the mass of secretarial workers and various administrative officialdom we use simply do not appear. I do not know how they get along without them; perhaps the universities fail to perform many of the services which we supply in America. However, I always had a classroom, and the students and I met each other regularly, and they finally were examined and they passed or failed. Also, the school managed to publish a book of lectures for me during the year. It was a somewhat arduous process getting this latter job done, partly because of the language difficulties in dealing with printers and bookstore men and more administrative help would have been welcome, but it did get finished even in a country where *bookra* (tomorrow) and *ma'lesh* (never mind) are notoriously customary statements given philosophically to excuse inefficiency and procrastination.

Parenthetically, deans conduct their business somewhat differently than they do in America. They sit behind their desks in large rooms in which there are enough sofas and comfortable chairs to seat a score or more of faculty members. At least a dozen of the latter may almost always be found visiting here while the dean conducts his business quite openly, filling in his time between visits chatting amiably with his teaching colleagues. It recalls the oriental court where the potentate held forth. It might break the nerve of an American dean very soon but it does create real "camaraderie."

I must close with a reference as positive as the one with which I began was negative. Not only were two of my classes at the Faculty of Law the largest, noisiest, and toughest assignments I ever have had, but a third class there was the pleasantest, the most exciting, and most stimulating. This class was as large as the others. It was composed of members of the army and the government ministries plus young men and women from business and the professions. These were mature students, quiet, serious, and well-behaved. The military men ranked from officers bedecked with ribbons and "brass" to privates, and ranged through the various services, including the Camel Corps composed of giant Sudanese in their khaki kilts, colorful sashes, and twisted turbans.

As in my other classes, I appeared in my "uniform" too, since it was the custom for the Law faculty to wear academic robes for lecture meetings. As I would enter this large hall it was the habit for the class to stand and applaud and as I concluded there was another round. No matter how sophisticated and "mature" intellectually a teacher believes himself to be, I think he will find there is at least a slight emotional stimulus in this type of class behaviour. It sharpens his intellectual activity and puts him on his mettle. It is something like the custom existing formerly, at least, in some British schools where the "school will please be standed" when the schoolmaster enters. It would seem odd perhaps to the casual Westerner in his living-room round-table conference discussion groups with their "Hi, Doc," but it has its place just as the latter does. I hope that Egyptian intellectuals and professionals do not drop this pleasant and courteous habit of sending the lecturer on his way with a kind of cheer as he begins and ends. In that "ideal" university of our own devising which most of us blow away in smoke clouds I might even encourage this practice for certain classes, at least experimentally.

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LOGOS

Chanticleer is dead. No dawn today.
The deed is undefined.
Reticence restricts the bloom of light,
Silence is the sustenance of night.
Without the Word, no whirl
Of spectrum into space.

Aurora sleeps. No herald to arouse.
Only the shadow of the taciturn.
And inarticulate, the sky grows cold and dumb.
St. John! St. John! How did you know
There is no fact without a name,
A nameless truth is never true at all?

Winston Weathers

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A Look at Egypt

By BERNICE GILTNER DUNCAN

Sometimes when I close my eyes and imagine that I am again walking along the Nile in lovely Zamalek where we lived in Cairo, or that I am window-shopping along Soliman Pasha or Kasr El Nil streets, or that I am bargaining in Mosky (the bazaars), I confess to a feeling of nostalgia for that fascinating city. For, after having lived there nine months I acquired a "taste" for it and an appreciation of its "local color." Not that I do not feel more comfortable in Norman, but now and then on rainy days I remember that in those nine months it rained about twenty minutes one day. It is truly a land of sunshine—not an unmixed blessing, of course, since the desert encroaches upon the towns and irrigation is a constant necessity. But the blue skies and sunny days were a real pleasure.

One of the sharpest impressions one gets of Egypt is that it is a land of extreme contrasts. There are buildings which look centuries old and new apartment buildings as modern as day after tomorrow; areas that are quite clean and areas where the rubble of centuries has accumulated and does not bother anybody; Cadillacs by the dozen and ostentatious wealth side by side with miserable, disease-ridden poverty; traditions, customs, dress as Eastern as the Orient itself and shops, buildings, movies as Western as Coca-Cola and washing machines. It seems like a big pot in which the Eastern and Western ways are boiling furiously; sometimes one bubbles over, sometimes the other.

Ferment and activity are the key words characterizing both the people and the country. There is a feeling of new "aliveness" in the political temper of the country. Of course, nationalism is strong, as it is in many places in the world today. After a long, long period of living under various forms of foreign control Egypt is like a young woman who has slept agelessly through the years and now has awakened to control her own destiny. There is a great hurry to get things done and there is an amazing amount of energy and vitality. The people are mercurial, affectionate and quarrelsome, alert of intelligence and enterprising, quick in thought and action. I found them very likeable, never dull and stodgy.

Certainly traffic is never dull or unexciting. Nowhere have I seen such mad driving as in Cairo. The idea seems to be to miss the pedestrian by a hair's breadth because it would not be any fun to miss him by several inches or a foot, even when the space is available. Pedestrians themselves seem slightly mad. They walk leisurely in the middle of the streets (except the principal ones in the central business area), cross at any angle they choose, and pursue their own course, arrogantly unmindful of vehicular traffic.

Streets are very crowded and the variety of traffic is amazing: numerous automobiles (Continental, British, and American), bicycles, trucks, trams, buses, horses, donkeys being ridden and donkeys pulling carts, men pulling carts, blackclad women driving herds of goats before them, motor scooters, and camels, each proceeding at his or its own pace, which usually is at great variance with every other. You may start across the street, thinking that nothing is approaching within a safe distance, only to turn around suddenly at a slight noise and find a quietly moving camel breathing down your neck. These creatures appear awkward but they move with an astonishing lumbering grace. Perhaps they give the impression of grace by the rhythm and fluidity of their movements. The camel is the only traffic hazard which is not noisy. The din of motor horns, tram bells, and whistles was such bedlam that one week while we were in Cairo they tried a traffic reform program into which everyone entered with as much zeal and enthusiasm as was usually put into jay-walking, horn-honking, brake-screeching, and speed. It was an earnest effort and although I suspect that it was a little trying on most people's nerves, it probably did some good, even if the benefits were not permanent. My own opinion was that it might work to try one or two reforms until they became a habit, add another one or two, etc., but they didn't ask me.

The sheer number of people alone is enough to complicate traffic. Egypt is the most densely populated country in the world from the standpoint of the relation between population and amount of cultivable land. Only 3.5% (between 6 and 8 million acres) of the country's area is cultivable. The population is around twenty millions and the density ratio is 2,000 persons per square mile of arable land. If you crave solitude, Australia or Bolivia would be a better choice because in Egypt there is always someone at your elbow, it seems, and in the parts of the city where foreigners do not live people appear to be falling over each other. The rate of reproduction, I have been told, is at the biological maximum. So there is less room to breathe and stretch out than in America.

The American convenience I missed most was our super-markets. Most of my buying of groceries was done by going to small shops which sold vegetables, others which sold fruits, small butcher shops for the meats (pork was usually not available), to other stores for canned goods and dry groceries, to the bakery for bread, etc. There were a few stores, usually operated by Greeks, which compared fairly well with our markets in the variety of merchandise, and also a large central market, but they

ABOUT THE AUTHOR

As this article shows, Mrs. Bernice Giltner Duncan spent as entertaining and profitable a year as an American housewife in Egypt as did her husband in lecturing at Ibrahim University. She has written a second article, "The Status of Women in Egypt," *which the* Quarterly *will publish in its next issue. Mrs. Duncan is an Instructor in Spanish and Assistant Editor of* Books Abroad.

were not close enough to be reached easily and quickly from the residential district in which we lived, so I usually bought in the many small shops rather than in a large one.

Relative to food preparation, foreigners, particularly Americans, are urged by medical units such as N.A.M.R.U. to wash all fruits and vegetables in a potassium permanganate or acetic acid solution; milk needs always to be boiled and then used only for cooking (you can't be sure whether it is cow's milk or gamoose), and we did not eat lettuce or strawberries on account of the methods of fertilizing. However, we enjoyed a variety of fine vegetables: carrots, peas, green beans, cauliflower, artichokes, okra, tomatoes, beets, cucumbers, asparagus; and fruits: mangoes, dates, figs, grapes, oranges, bananas, apricots, kumquats, guavas, pomegranates. Egypt produces two or even three crops a year and the fruits and vegetables are very good. But since there is more uniformity in climate than in our country, and a less controlled storage and distribution system, foods are more seasonal. When a crop is ready for the market there is an abundance of it but when it is gone, it is really gone, and is not obtainable until another crop of that fruit or vegetable has matured.

Flowers are also plentiful, wonderful and cheap. A "flower boy" used to bring bunches of flowers to our back door nearly every day and for the first time in my life I could have flowers in the house whenever I chose. For instance, a bunch of two dozen Talisman roses would cost about thirty cents or a large bouquet of gladioli or snapdragons about fifty cents. Most of the villas in the neighborhood had beautiful large gardens with flowers always in bloom, and there were several kinds of blooming trees along the streets which by turns made a lovely avenue of red, purple, yellow, or blue.

The most elaborate gardens were those of the Winter Palace Hotel at Luxor which were a riot of color when we stayed there a few days during the latter part of January. The trip to Luxor (formerly Thebes) was one of the most interesting experiences of the year. Here the ruins of the old temples and palaces are impressive memorials to a glorious past, while in the Valley of the Kings, across the Nile to the west, the tombs of Egypt's ancient rulers are also marvels of engineering ingenuity and skill as well as lasting evidences of the country's former grandeur and power. We entered five or six of the tombs, of which there are known to be 64, two of which have not yet been located. The most famous one we visited was that of King Tutankhamen. His

Continued page 29

The Modern Meaning of a Liberal Education

By DUANE ROLLER

So much has been written about the meaning of a liberal education—from the time of the Greeks onward, and by so many people of distinction—that it could seem fruitless for one to try to do more than merely to reiterate a few of the countless things said—emphasizing those that appeal personally to one as being especially useful. However, we know that it is often fruitful to approach a question of this kind by tracing a particular historical thread of development, especially if account is taken of any recently acquired knowledge that may throw light on the question. The thread to be followed here is one that lies close to significant scientific trends, including some that have been clarified by comparatively recent researches in the history of science.

Some two thousand years ago, the Greek philosophers expressed their views on the meaning of a liberal education with what would seem to be the deepest insight possible within the limitations of the knowledge of nature, man, and society available to them at the time. In the Hellenic civilization, the purpose of a liberal education was conceived to be education for *citizenship,* as well as for general culture, using "culture" here in the sense that the Greeks understood it—in the everyday, nonanthropological sense. Thus the Greek curriculum was, for its day, a *modern* curriculum, in that it was intended to prepare a citizen to live *in his own generation.* Its aim was to know one's self, in relation to one's society —Greek society.

With the decline of the Hellenic civilization and the further development of the great Hebraic-Christian tradition, the interests of scholars and schoolmen naturally turned from mundane affairs to the problems of man coming to know himself in relation to his God and to the afterlife. This early medieval period, the so-called Dark Ages of the West, has fashionably been regarded, ever since about the sixteenth century, as a period, not just of stagnation, but of retrogression. Yet for the early Church Fathers to have retrogressed would have meant deliberately to have ignored or destroyed everything that the Greeks had gained. Instead, they were unaware of the existence of much of this knowledge. Much of it had been lost to Western Europe. In this connection, it seems of considerable significance that parts that were not lost—the logic of Aristotle, Plato's *Timaeus,* certain traits and attitudes from the Greek and Roman cultures—were preserved and fostered by the scholars of medieval Western Christendom. For instance, employing the Aristotelian logic, many of them became expert dialecticians. But having little secular knowledge on which to build, they found that the pursuit of it in comparison with matters religious and moral held for them little that was of interest or commendable.

After the middle of the eleventh century, when Greek knowledge, especially Greek science, was recovered to Western Europe, we witness the beginnings of several major trends, which grew out of Scholasticism and on the part of a few scholars, chiefly Albertus Magnus and Thomas Aquinas, to bring together and synthesize the recovered Greek science and the Christian teachings. A second trend, which really grew out of the first one and eventually led to the Scientific Revolution of the sixteenth and seventeenth centuries, consisted of a critical examination of Greek science, and the beginnings of a new formulation of physical science, especially mechanics and astronomy. However, from the point of view of educational thought, this scientific trend was, at the time, not significant, for the Scientific Revolution occurred slowly and quietly, and, until about the eighteenth century, had almost no effect on people in general—nothing, for instance, compared with the immediate and drastic effects on them of the Protestant Reformation.

It was still a third trend that was of immediate importance educationally. This trend, which grew out of scholasticism and was at the opposite extreme from the scientific trend, consisted essentially in a wholesale and uncritical adoption of Greek learning and, along with it, what seemed

to be a revival of the Greek conception of an education.

But actually it was a different conception; for the purpose now was less one of a person coming to know himself in his own generation as it was "to know the Greeks." This we recognize as the conception held by those scholars of the Renaissance who came to be known as the Humanists. In their eyes, it has been said, nothing was so precious as the whole of antiquity. Indeed, this point of view made sense, for most scholars of the day were oblivious or had little concern for the rather impressive store of knowledge of nature, chiefly physical knowledge, that had been accumulating up through medieval times in the hands of artisans and craftsmen, of workmen-experimenters. So, to these scholars, the Greek writing exhibited a range of knowledge, especially about nature, that far transcended anything of the kind previously known to them.

But in this emphasis on "knowing the Greeks," the Humanists overlooked something well known to many of the Greeks themselves; it is illustrated by a saying of the Greek philosopher, Heraclitus: *one cannot step twice in the same river.* The late medieval West itself had been undergoing vast changes—economic, social, political, and technologic. And the scholars, skillful in logic, accustomed to dealing with general ideas and broad issues, were the ones who could have attacked the current problems.

There were a few—the scientist-scholars—who were beginning to bridge the gap between the scholar and the workman-experimenter. Some of the universities for a time were invigorating centers of this new learning—for instance, Padua, where men of the caliber of Versalius, Copernicus, Cardan, Galileo, Harvey had either studied or taught. But by about 1600 the Humanists were in control, political interferences were evident, and the universities were becoming sterile. And with this there came into being the scientific societies, which had no formal connections with the universities.

This necessary divorcement of the societies from the universities was a tragedy. For one thing, it meant that, as time passed, new blood in the sciences often had to come in solely through apprentice training, and often these new men were of the artisan and craftsman type, quite skilled in experimentation, but lacking in the intellectual tools and broad background afforded by a university education. There were tendencies and attitudes fostered at that time which persisted long after the sciences went back into the universities, and which persist to the present day. For instance, the sciences often went back into separate compartments, and in many cases this situation still exists. There developed class consciousness and antagonisms between the creative artists and writers, on the one hand, and the scientist, on the other, which still exist. Even though some of these tendencies may seem to be disappearing, they are among our greatest obstacles in trying to develop in our colleges a liberal arts curriculum suitable for our present culture.

However, even in the eighteenth century, a few universities showed evidence of getting immediately back onto the right track. Glasgow was a notable example. Here was a small, but fine faculty of young men—men of the caliber of Joseph Black, the founder of the science of calorimetry; Adam Smith, the political economist; John Robison, the physicist—who associated closely, and learned much from one another. And they took in as a social equal, who learned much from them, a frail young artisan of little formal schooling who had never seen the inside of a university until he got a job repairing scientific apparatus at Glasgow, incidentally thus starting what was probably the first scientific instrument shop in any university. This lad, because of his natural talents and interests, but also through his close associations with a democratic faculty, eventually became the prototype of the modern research engineer, and in doing so played a considerable role in helping to bring about the first industrial revolution. He was, of course, James Watt.

The University of Edinburgh later on showed liberal tendencies, and it may be of some significance that Black and Robison had moved to Edinburgh by that time. Then in this country eventually there was the University of Virginia, established by Thomas Jefferson.

But, by and large, well up into the nineteenth century, most of the universities were still controlled by the Humanists.

Even today, despite the almost inconceivable accumulation of knowledge since the Renaissance, there persists in several influential quarters a philosophy of education differing little in its essence from that of the Renaissance Humanists. For instance, one of the most prominent and influential members of this contemporary school has asserted that it is unnecessary to study the twentieth century at all, that "not one single new idea has appeared in any book published during the twentieth century." Those who hold to such a point of view have been aptly characterized as "sterile humanists"; and their educational philosophy has been summed up in this way, that, "within college walls it does not matter whether you live in Egypt or Athens or in the eighteenth or twentieth century, for the world of ideas is timeless."

Those who subscribe to this doctrine of timeless ideas will say that you can select any important current idea and they will show you the germ of it among the ideas of the past. This is usually correct; it is what we mean when we say that the world of ideas is evolutionary, or dynamic. But what seems to be overlooked is that the germ becomes recognizable and acquires significance only after the more fully developed modern idea has brought attention to it. The history of science affords hundreds of examples. One that illustrates the point, concerns the discovery of the planet Pluto: it was photographed sixteen years before it was discovered; the germ of the discovery was on the photographic plate, but nobody recognized its significance.

This doctrine of timeless ideas is of course completely static, rather than dynamic and evolutionary. It is entirely in-

ABOUT THE AUTHOR

Dr. Duane Roller received his B. A. from Oklahoma in 1923, *his M. S. in* 1925, *and his Ph. D. from California Institute of Technology in* 1929. *He was an Instructor in Mathematics at the University,* 1924–25, *in Physics,* 1925–26. *He resigned to carry on graduate work but returned to our faculty in* 1928. *He was a Research Associate at Columbia,* 1936–37, *on leave, and resigned in* 1937 *to become Professor of Physics at Hunter College, later at Wabash. For some years he was in the research department of the Hughes Aircraft Company. At present he is chairman of the editorial board, American Association for the Advancement of Science, and editor of the Association's two publications,* Science *and* Science Monthly.

Since 1936 *Dr. Roller has been interested in the place of science in a program of general education. This article is based on the lecture which Dr. Roller delivered in* 1953, *as one of the DeGolyer Lectures.*

adequate for explaining the major revolutions in scientific thought. As for the political and social revolutions up through history, have not the major ones been revolts against the majority of so-called educated people who cling to the illusion of timeless ideas and are resistant to change? Bertrand Russell recently made the pertinent observation that even those people who insist that there must be freedom in the economic sphere—freedom of material production—are often the ones who believe that "thinking should be confined within the limits of some authorized orthodoxy."

To return now to the Greek ideal, there are of course different degrees to which different people are capable of knowing themselves in relation to their culture. Our interest here, I take it, lies in those who need to achieve understanding that will equip them to assume *leadership* in the law, government, the ministry, creative literature and other fine arts, the sciences, industry, and so on. And for such able people the dynamic as opposed to the static conception of ideas seems to carry with itself the implication that deep understanding of current ideas and institutions involves also a knowledge of how these ideas and institutions have come into their present forms; moreover, how these components of our own culture compare with those of other cultures, past and present. I venture to say that the American people are beginning to understand our civilization better than they did in earlier days simply because it is being thrown into contrast with other existing cultures and ideologies.

Thus it would seem that for the education of these future leaders in society we should take a middle position between those who advocate an education solely in terms of ideas and institutions as they exist today and those who insist that ideas are timeless, and that the same set can be studied in any century. We could not get much of an education—following the Greek ideal—by confining our studies solely to the germs of ideas; we cannot learn about men solely by studying children. But to understand men fully, we must also know about children, something that is well known to all who have reared them.

The remainder of this paper is devoted to the description of a type of college course designed in the light of the educational objectives mentioned. This particular course is in physical science—astronomy, physics, and chemistry; but courses of the same general type can be, and indeed have been, developed in other branches of natural science, in mathematics, in the social fields, and in the humanities.

If we are to talk about how a science might best contribute to a liberal education, we must first settle on what we are to mean by "science," since it means different things to different people. To some people, a science means little more than technology. To others, it is merely a collection of facts, organized in some fashion or other. To still others, it is a particular universe of discourse—botany or astronomy—a closed universe of discourse with its own methods and jargon, having little to do with other fields of knowledge or manners of living in general. To some it is a method, or, more accurately, many methods, that have been found useful in attempting to settle any question of fact.

These different interpretations apply to

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CELLINI WOULD HAVE DONE THIS NIGHT IN GOLD

Who would have thought the Florentine to know,
There from the gates to Padua or to Rome,
The same soft rarity of fading light,
The rush of the wind and the bird's last haunting call?

And which of us shall strive for beauty's sake,
Now that the moment holds us fleetingly,
Which one, remembering Cellini's art,
Shall forge in the passing night some permanence?

Cellini would have done this night in gold,
Would have wrought such moonlight into foil,
That hence, a century or two, one might
Reach out and touch again the loveliness.

O, Cellini would have done this night with care,
Such as truth demands, that one might guess
Florence not too distant, nor the quest
So new—for renaissance and elegance.

Winston Weathers

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more or less important but nevertheless fragmentary aspects of natural science. But for a conception of science that will fit into a comprehensive and integrated scheme of liberal education, there is still another interpretation which is not only more fundamental but encompasses all the others: *natural science is the history of our ideas about nature, together with the history of the methods and conditions under which these ideas have been and are being reached.* This is the interpretation of most cultural significance—that will afford deepest insight, so far as the sciences can contribute to such insight, into the character of our present and past cultures, and how we as individuals are related to them.

The objection may be raised that what is advocated here is not so much science for liberal education, as the *history* of it. But to make such a distinction would seem to encourage much too narrow a conception of the meaning of a science. Surely every creative scientist, or, for that matter, creative person in any fundamental field, has *of necessity* a good knowledge of the history of his own particular area of specialization, whether this be spectroscopy, genetics, linguistics, or musicology. Goethe summed it up when he said that the history of science is science itself.

Evidently there are many different ways of outlining the sort of course envisaged and of selecting material. Here we will follow an outline for a one-year course that I have taught for a number of years. Although much of the physical information and history covered will be familiar to many readers, it may serve to impart a "feel" for what the students actually experience in taking the course.

The story starts with knowledge that began to accumulate thousands of years ago, in the hands of the ancient priests and of craftsmen such as the carpenters and metal workers. One may trace in some detail the development of such very old and primitive concepts as length, area, volume, time, and weight, as each of these passed from the qualitative, to the semi-quantitative, and then to the quantitative stage; and how, along with this, there was a shift from the most primitive type of physical definition—the denotative, or mere pointing-out type—to *operational definitions*. These operational definitions, which have received so much emphasis in physics during the present century, and also in certain social fields, such as the law, actually were employed, at least implicitly, hundreds of years before the Christian era, for they simply are an elaboration of the primitive, denotative type of definition.

Then one can trace the development of *standards of measurement*—for instance, standards of length, taking the story up to a development of the last decade, that of the single isotope-of-mercury arc lamp, which provides a standard of length incomparably better than the meter bar in Paris. It is one of many constructively useful things that have come out of the Manhattan project arising from military necessity. This evolution of the various standards of measurement—of length, of time, and so on—is a fascinating story, and some study of it would seem indispensible for those who wish to try to develop standards of measurement and of comparisons in other fields—biology, psychology, and the social studies. Note in passing that efforts to obtain inter-

national agreement concerning these basic standards did not bear fruit until after the middle of the nineteenth century; and if agreements on such matters are so recent, perhaps we should not be too impatient if, say, the United Nations is unable to settle in a decade or so problems that involve conflicts of cultures, of vested national interests.

Familiarity with the early history of such concepts as length, area, and volume places one in a good position to gain a real understanding of how geometry was developed by Euclid and those who went before him. Euclid's problem, to put it briefly, was to take the rules that the ancient artisans had developed empirically, by trial and error methods—such rules as those for computing the area of a rectangle, or a circle, or for the volumes of various regular objects—and in the light of them, to frame a set of axioms from which the rules can be deduced as theorems and, what is more important, from which new rules, new theorems, are deducible.

Every important characteristic of the postulational-deductive stage of inquiry, which is employed so powerfully in physical science, can be illustrated through Euclidian geometry, provided it is so presented as to bring out these characteristics —and fortunately students already have a certain familiarity with this geometry from school. Although not always pointed out, Euclidian geometry really is a branch of theoretical physics, and the simplest branch, since it involves nothing but spatial concepts—no concepts of time, momentum, energy, and so on, to confuse matters.

Thus it can be easily used to elucidate the three important characteristics of any axiom, or postulate, of a natural science: (1) it is always framed in the light of experience (it is not a self-evident truth); (2) it always involves an extrapolation beyond experience to an idealized situation and hence can be tested experimentally only by deducing theorems from the axioms that can be applied to specific situations; (3) it is always a definition. Then one can go one to demonstrate how the theorems are deduced by combining the axioms in various ways, using the rules of mathematics, which play the same role here that the rules of logic do in logic; and in this connection it becomes clear that any deductive theory is a tautological scheme; the theorems involve nothing not already contained in the axioms and the rules for manipulating them.

Next to be shown, is how a theorem is tested experimentally. To do this, one must first re-state the theorem in operational language. For instance, if the phrase "straight line" appears in a theorem, it must be converted to the phrase, "edge of a ruler," or perhaps "beam of light." All the abstract concepts in the theorem must be converted to specific concepts applying to some particular physical situation. As has been said, the theorem must be reworded in "kitchen language" before it can be tested experimentally. This requires practice. Many people who can recite the golden rule are unable to put it into kitchen language.

Then, finally, there can be brought out the important principle that if one theorem fails to check experimentally, then one or more of the axioms will have to be modified. On the other hand, if the theorems correctly predict what we find in nature, this merely increases the probability that the axioms are satisfactory.

Some of these things, of course, could be taught in school geometry, although most students of school age are still rather factually minded, and, understandably, are not much interested in methodological considerations. Such considerations and what might be called the "grammar of science" are better studied in college; and my experience is that this can be done effectively even in a beginning college course. Yet, strangely, it is seldom done to an extent sufficient to be effective. Even for science majors it usually is left to the graduate years, and sometimes comparatively little explicit attention is given to it even there.

To go on with the outline, a next section might well be devoted to early astronomy, beginning with primitive notions about the celestial bodies, some of which are closely connected with the time concept studied in the preceding section. Then come some of the really fascinating astronomical developments and calculations of the Greeks, including Ptolemy's picture of the universe, then the much later work of Copernicus, and finally the wonderful astronomical observations made by Tycho Brahe and, based on them, the three empirical laws of planetary motion developed by Kepler at the begining of the seventeenth century. These Keplerian laws involve only geometric concepts and the concept of time. Moreover, like the geometric rules of the ancient artisans, they are generalizations that Kepler reached inductively from raw data and from his analysis of Brahe's observations on the positions and motions of the planets. There was no set of postulates, or axioms, from which these laws could be derived as theorems. To develop such a postulational-deductive theory was Newton's problem; but discussion of it is better left until the students have acquired some background of knowledge of early mechanics.

So here begins a fourth sequence, which again takes us back to antiquity and, more especially, to Aristotelian physics. No respectable orthodox course in physics starts with Aristotle for, in truth, this would be studying a completely obsolete physics; it is ancient history. Instead, the usual course starts with Galileon-Newtonian mechanics, which was a part of the Scientific Revolution. Now this Scientific Revolution has a cultural role of the greatest significance. It has been characterized by Herbert Butterfield, the historian, as outshining everything else since the rise of Christianity, and reducing the Renaissance and the Reformation to the rank of mere episodes, mere internal displacements, within the system of medieval government. The Renaissance and the Reformation were acknowledged attempts to restore *old* outlooks, whereas the Scientific Revolution, as A. N. Whitehead has pointed out, was the most intimate *change* in outlook that the human race has encountered up to that time.

But revolution and change, of any important kind, cannot be comprehended without knowing conditions beforehand as well as afterwards. And the most influential physical development that came before the Revolution was Aristotelian physics. A fair knowledge of its essential characteristics can be gained in a few hours of reading if the material is carefully selected, and this material should include excerpts from Aristotle's book on *Physics* and the one on cosmology. Such recourse to primary sources seems needed if the student is to gain a "feel" for the period he is studying and, also, if he is to develop a sense for good scholarship.

Moreover, the presentation of Aristotelian physics must be a sympathetic one, emphasizing good points as well as defects. Indeed, one might well conclude with Aristotle's own remark: "I found no basis prepared; no models to copy. Mine is the first step, and therefore a small one, though worked out with much thought and hard labor. It must be looked upon as a first step and judged with indulgence." He was an humble man, but a tremendous figure. One may guess, as Wendell Johnson has said, that if Aristotle were living today he would be our leading non-Aristotelian.

Greek knowledge, especially Greek science, was lost to Western Europe, but was preserved by the Arabs, chiefly through the efforts of Jews and Christians who were among them and who translated the Greek writings into Arabic. The Arabs were intensely interested in natural phenomena, from both a factual and an aesthetic standpoint; and they added greatly to the store of physical knowledge, in astronomy and optics. But there are reasons for thinking that the natural sciences as we know them —involving the postulational-deductive

LIKE A CHILD

When all is done, Human Life is, at the greatest and the best, but like a froward Child, that must be Play'd with and Humor'd a little to keep it quiet till it falls asleep, and then the Care is over.

Sir William Temple: *Of Poetry,* 1690.

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stage of inquiry—would not have developed among the Arabs or, for that matter, among any of the Eastern peoples. If this is true, we should try to find out why, for it might throw additional light on the reasons why our Western civilization developed as it did.

Among the reasons given are the following. They are connected with activities in the monasteries of Western Europe from about the sixth century onward and especially in the church schools instituted by Charlemagne near the end of the eighth century. In them the teachers and scholars preserved and fostered, first of all, a conception of and respect for law and order in all things. This was a conception that the Greeks had highly developed; later it was exemplified in the Roman law; and then in the church it took the form of church law and the orderly development of religious teachings. The doctrine of the orderliness of nature and the notion that this order can be described in terms of laws and principles is of course indispensable for the development of the sciences.

Next, these schoolmen fostered the sense for what Whitehead has called "the remorseless working of things." Whitehead points out that this sense for the remorseless working of things was the very core of the great Greek tragic dramas. In the early medieval church it became a sense for moral law—not petty morals, but a great moral code which, if it were evaded, would invite self-destruction. As Whitehead goes on to say, after the Scientific Revolution, people began to look upon the laws of physics as also being decrees of fate; there are certain things in nature that are inevitable and we must adapt ourselves to them.

These early schoolmen, for another thing, preserved the habit of clear and orderly thinking. As was said earlier, the Aristotelian logic had not been lost to the West, and many of the schoolmen became expert dialecticians. They preserved a tradition for logical thinking and for intellectual honesty that was passed up to the Renaissance universities, where it became a part of the intellectual equipment of those scholars who eventually turned their attention to the study of nature.

Also fostered was the ability and willingness to think in general terms, as the Greeks had done. People have to learn to think in abstract terms, and we know of existing cultures in which the degree of abstraction employed is not very high. The sciences as we know them could not have developed without this ability and disposition to frame and deal with broad abstractions.

In the monasteries, especially, it came to be regarded as respectable and dignified for scholars to work with their hands. Practical agriculture was encouraged. Although the church scholars, being interested primarily in religious matters, did not turn their scholarly interests to these practical affairs, the idea that such activities were respectable was passed on, for example, to the medieval artists, who became skillful in depicting the nature they observed around them. The culmination of this was the marvelous sketches, technically perfect, of Leonardo da Vinci. The point is that observation of nature and the use of one's hands were being made respectable for secular scholars, not merely for artisans and craftsmen; and such an attitude among scholars was indispensable if they were to engage in experimentation, without which modern science is impossible.

As a last point, it is conceivably important for the later development of the sciences that these schoolmen emphasized, naturally, the concept of a God who is rational, intelligent, and intelligible, as compared with some Eastern conceptions of gods that are irrational, capricious, and whimsical. A science of nature having predictability would not even be conceivable in a world presumed to be ruled by a capricious being.

These are some of the attitudes, traits, and values that are thought to have prepared Western minds to capitalize on the Greek knowledge, once it was recovered in the West, and that eventually helped to bring about the Scientific Revolution. It is worth noting that they are characteristic not only of the Hellenic culture, but of the medieval church and of the scientific tradition. In brief, they ramify through the whole framework of our Western Civilization. I take it, then, that one may regard these ideals as providing a code that serves to define the character of our Western Civilization. And if we will examine the forces of destruction within our civilization today, I think that we will find that most of them represent the very antithesis of these ideals. They are alien forces.

One wonders whether such an analysis perhaps throws light on what is really behind the Humanist movement of today. In saying earlier that these modern Humanists are clinging to the illusion of timeless ideas,

NOT TOO FAR

We ought not to stretch either our legs or our hopes to a point they cannot reach.

The Enchiridion, or *Manual, of Epictetus.* LXXXV.

Translation by Elizabeth Carter.

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I realize that there is something presumptuous in making such a remark; for some of those who are pursuing this particular philsophy of education are first-rate people, many of them able scholars. But perhaps they need to change their terminology and some of the thinking that is bound to be influenced by faulty terminology. When one of them says that not a single new idea has appeared in any book of our time, that is nonsense and can be shown to be such. If he were to say that there is a set of broad attitudes, traits, and values that are common to all the centuries since the Greeks, that would make sense. It is not timeless ideas, but essentially timeless *values* that make our Western civilization what it is and that we must seek to protect.

If these values go by the board, Western civilization will soon degenerate, and so will Western science. So a discussion along the lines indicated here is not at all extraneous in a broad course on any natural science. Moreover, it gives an opportunity to correct a popular misconception, namely, the misconception that, in the training of a scientist, the fostering of strong character traits and attitudes of the kind we have been mentioning plays only an incidental role. The right aptitudes for creative work and a large stock of knowledge and skills are prime requisites; but equally so are these character traits and attitudes.

To return to our outline, when the Greek writings came back to the West, they were translated into Latin from the Arabic. They were not well received. Indeed, Aristotle's works were at first condemned by a Church Council in Paris, in 1209. However, they were soon re-translated, but now from the original Greek, which was much better, for translations of translations are likely to be unreliable.

Then as was said earlier, it became clear that these Greek writings exhibited a range of knowledge, especially of nature, that transcended anything previously known to scholars in the West; and to absorb this material into medieval Christian thought became essential. This was the task undertaken by Aquinas, with the help of his teacher, Magnus, who was well versed in the Greek science. Their task was one of Christianizing Aristotle, so to speak—of combining two systems which in various

respects were quite alien to each other. Now the American psychologist, William James, once said that there are two kinds of philosophers, tender-minded and tough-minded. Aquinas was tough-minded, a hard thinker who really got his teeth into a problem and tried to work it out rigorously in all its details. He recognized two sources of truth: *first,* the Christian faith as transmitted through the Scriptures, the teaching of the Church Fathers, and Church tradition; *second,* scientific truth, which to him meant truth reached by experience and human reason as set forth by Aristotle. A more general way to put this is to say that he accepted as legitimate both philosophic truths and scientific truths. Thus his resulting philosophy did not separate religion and science, but represented a fusion of the two. And he worked out this fusion with such consummate skill that any subsequent criticism of Aristotle's physics was for long interpreted as an attack on the Christian faith.

His great treatise, the *Summation of Theology,* was detailed, highly technical, and not understandable to any except trained scholars. Now, to get technical or highly unfamiliar knowledge to people in general is one of the functions of the creative arts, and this function for the technical work of Aquinas was performed by Dante in that great philosophical poem, the *Divine Comedy*. Some sixteen centuries earlier, the same function had been performed for the mechanistic philosophy of Epicurus by the Roman poet Lucretius. Much can be learned by students at this point about the philosophic, as contrasted with the esthetic function of creative writing and the creative arts, and how the use of emotive language, as contrasted with the referential language of science, makes it possible effectively to acquaint nonspecialists with highly technical or unfamiliar conceptions.

At the time when Aquinas was working, other men were beginning the new investigations of physical nature that led into the revolution in physical science associated with such names as Copernicus, Kepler, Gilbert, Galileo, and Newton. Of Galileo's work on the motions of objects through the air, much practical information was already available because of experience with artillery fire. Indeed, Galileo, in the first pages of his great book on mechanics, *Two New Sciences,* tells how he often visited an arsenal, which by that time was quite old and well developed, and how much he learned about practical mechanics from the skilled artisans working there and from the machines they had developed. Here is one of a number of places in this history where one may introduce a discussion of the Marxian point of view on the question of the origin of the sciences and stimulation of scientific activities.

This Marxian viewpoint, which was unknown to the majority of Western scientists until less than two decades ago, has considerably modified our thinking about the socio-economic and political aspects of scientific development. And for the better, for we had long been overboard on notions connected with the so-called "purity" and supposedly ivory-tower characteristics of the scientific endeavor. Indeed, some of the initial attempts in the West to attack the Marxian arguments were pretty feeble and often emotional; it had to be learned that the Marxians of today do not approach questions of importance to them in a half-hearted way. Only subsequently, by careful and objective analysis, coupled with sound historical research, has it been possible to show that the Marxians also have gone overboard, on the other, or larboard, side. The middle position on this question, which Western historians are now beginning to take, is without doubt the sound one.

Almost certainly Galileo's interest in mechanics was spurred on by military and practical considerations having political implications. But he also visited the local arsenal because it was the best possible place to get first-hand information about the strength of materials and the motions of objects; there were no laboratories or instruments available in the universities of the day. As for his initial interest in physical science and mathematics, this was aroused when he studied Aristotle, as an undergraduate at the University of Pisa, where everybody had to read Aristotle and where he had gone initially with the intention of studying medicine. Galileo really owed a great debt to the man whose system he helped to overthrow—for he owed to Aristotle his initial interest in physical science, he made capital use of Aristotle's logic, and the latter had furnished a conceptual scheme of the physical universe that could be used as a basis for criticism. Aristotle's physics was largely erroneous, but it was not chaotic. And as Galileo's contemporary, Francis Bacon, said: "truth will sooner come out from error than from confusion."

Some of Galileo's achievements beyond Aristotle were that, first, he confined his mechanical studies initially to very narrow and specific problems—for instance, the fall of a heavy body to the ground—whereas Aristotle had tried to develop, from the beginning, a comprehensive theory that would account for the motions of all bodies, both on the earth and in the heavens; and the human mind does not work that way; it must move gradually from the simple to the complex. A second achievement was that he moved almost immediately to the postulational-deductive stage of inquiry—the stage of theoretical physics—whereas Aristotle had stayed almost exclusively in the empirical-inductive, or natural history, stage. In the sciences, Aristotle was no armchair philosopher; he was an empiricist, in both physics and zoology. It was Galileo who was the theoretician, but he built his theory on a foundation of empirical knowledge.

The student can and perhaps should read the third and fourth chapters of Galileo's *Two New Sciences,* preferably in an edited and annotated form that leaves out most of the tedious geometric proofs of theorems and other material not needed to preserve the main thread of the story. Anyone going through these two chapters will find that Galileo's theory of projectile motion was not built by pulling timeless ideas out of the blue. It required the patient examination and rejection of wrong hypotheses as well as the ultimate acceptance of useful ones; it involved the use of many so-called *unconscious* hypotheses, as Poincaré later called them, and there are few things more rewarding than a study of and an awareness of the unconscious hypotheses that enter into all of our thinking.

In passing on to Newton, a first thing to be noted is that the student will gain little by trying to read the source literature, namely Newton's *Principia* (1687), for it is an advanced treatise. Newton had been dragged into many controversies by some of his contemporaries. One biographer of Newton has said that one of these, Robert Hooke, regarded Newton as a competitor, whereas Newton regarded Hooke as a nuisance. Thus Newton, when he finally agreed to summarize his mechanical discoveries in the *Principia,* made the treatment advanced so that only the very able could read it. Indeed, during the century following the first appearance of the *Principia,* some 75 books in various languages were written to "explain" its contents. Perhaps the most widely influential of these books on the part of a creative writer was Voltaire's. Voltaire was no scientist; but his mistress at the time he wrote the book was an accomplished mathematician and physicist, and the translator of the *Principia* into French.

One should come to see that Newton's essential task was somewhat analogous to that performed much earlier by Euclid for spatial description. Euclid's problem, we will remember, was essentially to frame a set of postulates from which the geometric rules obtained by the early artisans and

craftsmen could be deduced as theorems. Newton's problem, similarly, was to find a set of postulates (the basic ones are his "laws" of motion and "law" of gravitation) from which Kepler's empirical laws of planetary motion could be derived as theorems. Many new theorems resulted too, among them, a set providing a theory of ideal machines. There should also be some understanding of the important philosophic ideas which emerged from Newton's work —concepts of private and public time and space, of mechanism, and so on—because of the large part that these played in guiding future thought, including political and social thought.

Here we come to another parallel. As in the time of Aquinas, there now arose the possibility of formulating a new philosophy in the light, not of the Aristotelian physics, but of the discoveries coming out of the Scientific Revolution. This was the task undertaken, first by Bacon and Descartes, and then, for Newtonian mechanics, by John Locke and others. Moreover, just as Dante had interpreted the Thomist philosophy for the people, so did a number of the English poets of the eighteenth century, notably Pope, interpret the new philosophy growing out of the work of Galileo and Newton. In this connection, some attention might well be given to the relation between Locke's philosophy and the development, involving such figures as Adam Smith and, later, Jefferson, John Adams, and Franklin, of our classical Anglo-American economic and political systems. Similarly, then, is another thread of thought leading through the philosophy of Kant and Hegel to the Marxian doctrine.

When these connecting threads are pointed out, the question naturally arises as to the validity of the notion that value theories in the social fields and humanities can be developed and tested only in the light of the findings of the natural sciences. Possibly not enough is yet known to settle this question unconditionally, one way or the other. But at least it should be pointed out that this notion did not originate with scientists and never was pursued primarily by them. It can be traced back, for instance, to Plato's *Republic,* where it is asserted that only those who have passed through the hypotheses of the mathematical, physical sciences can arrive at the idea of the good that one has a right to say holds for everybody.

In tracing these connections between the sciences and value theories, and also between the sciences and creative literature, I have disregarded another connecting thread between the sciences and society, the *technologic thread*. The tracing of it should include a several-weeks sequence on the de-

Continued page 29

Culture Is Where You Recognize It

By HARRISON KERR

The average American usually gives little thought to his state of cultural grace. Nor is he apt to be greatly concerned with the exact standing of his locality in respect to the creative arts. He remains unconcerned until made aware that he and his environment are being judged, not solely on the basis of the business enterprises of his community or upon its prowess in the field of sports, but are also being weighed for cultural accomplishment. Often, he begins to take stock when he discovers that hard-headed business men are asking, "What do they have in the way of music there? Is there a symphony orchestra? What about the art museums? Do they have writers and painters out that way?" Fortunately for their self-esteem, there are today few communities in the United States that must give entirely negative answers to these questions. But, after satisfying the interested inquirer that the locality does indeed contribute to cultural matters in proper proportion to its population and facilities, there is apt to be a further question to be faced: "To what extent does the public support these artistic enterprises?" Aye, there's the rub! This question should give pause to the citizens of many portions of this country and one of these portions is Oklahoma.

Before dwelling inordinately on this embarrassing query, perhaps it would be well to explore the local cultural terrain, paying special attention to the conditions of the creative arts in Oklahoma and especially on the campus of the University. In this category let us include architecture, music, painting, sculpture, literature, and the theatre, although the latter is primarily an interpretative art. It is an immediate relief, and a tonic for the ego, to discover that Oklahoma, in spite of its youth as a state, has contributed its full share of creative effort in all of these fields. This contribution is, by the nature of things, more evident in certain fields than it is in others. If we examine the situation closely, we will discover that the impression outside of the state, even as far away as the East and West Coasts, is somewhat at variance with the information available to those who are here on the scene. Probably Oklahoma's literary contributions are best known outside of the state; better known perhaps than here at home. Oklahoma has contributed novelists, playwrights, writers of short stories and of non-fiction in almost every field of human interest. Some of these writers have become so well known that no one remembers, sometimes including the author, that he is, or was, an Oklahoman. Of course, the vast majority of our local writers do not achieve a wide reputation as important literary figures, but the proportion who do is at least as great as elsewhere.

Mention has been made of play writing and this leads to the related subject of the professional theatre itself. There are many Oklahomans who have had notable success on the stage, in motion pictures, radio, television, and the dance. It is no accident that most of them were trained at the University of Oklahoma.

Anyone who is acquainted with other sections of the United States will find it easy to discern the fact that in architecture, Oklahoma is a leader. That this preëminence is due to a few strongly creative, progressive, and dedicated personalities is no reflection on the healthiness of Oklahoma in this field. In all the arts, in any place, a few individuals must furnish leadership. That, here, this is particularly marked in architecture is due to the strength of the leadership rather than to weakness on the part of those who are perhaps less influential but who nevertheless combine forces with the leaders to build a strong local school. That this development has centered at the University of Oklahoma is likewise no accident.

Perhaps it may be accepted without argument that both literary and architectural achievements in Oklahoma have become well-known throughout the United States. In a more limited sense, this is also true of painting and sculpture. Most museum directors and critics, and others whose personal interest in the arts leads them to keep

abreast of developments, are acquainted with the work of the more important painters and sculptors of this state. In some instances, the work of these artists is far better known outside of the state than it is locally. The reason for this, I shall try to make evident later.

Music, certainly one of the most widely practiced and appreciated of the arts, obtained an early foothold in Oklahoma and has, more than any of the other arts, established itself on a broad and firm basis. A number of well-known composers have either been born in this state or have taken up residence here. Several of these have international reputations, their names being known to the musically enlightened not only in this country but abroad. Yet, even more strikingly than in the case of painting and sculpture, their local reputation is limited in comparison to their national reputation. In the field of performance much the same is true. Many Oklahomans have become successful instrumentalists and singers but the state of their origin is overlooked, and at home their names and reputations are scarcely noted.

If, for the sake of discussion, the reader will accept the foregoing, perhaps he will then ask, "What are our future potentialities?" Here the judgment of people who have a wide acquaintance outside of the state should carry special weight. When an outsider becomes genuinely acquainted with the conditions in this state, one reaction that can be counted upon is amazement at the wealth of talent and the level of accomplishment both of students and professionals. There are still those who believe that all artistic talent is the exclusive property of the European. That unsound premise belongs to the last century and is accepted now only by the least informed. Yet, in spite of the realization that talent is embarrassingly plentiful throughout the United States, it is sometimes difficult to recognize it when it is found at home. That ailment has been frequently diagnosed within this state.* No certain cure has been found, but perhaps the acuteness of the symptoms will disappear for a person who finally comes to realize that Johnny Smith next door will indeed have the qualities required of a great painter and that Joe Brown, across the street, could hardly have won a national award for musical performance if his talents were not at least equal to those of contestants from the rest of the country. The writer of this article, being familiar with the state of the arts both here and abroad, believes that the leaders in almost all of them, in the immediate future, will come from this region. The first of the chosen have already journeyed forth and conquered. Unless Oklahoma criminally neglects its duty, it is safe to predict that the next generation will *stay at home* and win acclaim.

It is a regrettable fact that, like a potato plant or a football team, the artist, whatever his medium, must be nourished, cultivated, and given a proper place in which to grow. When a talent cannot find suitable conditions at home (part of his gift is the *wisdom* to *know* what he needs) he seeks the proper environment elsewhere. In turn, the place he vacates is filled by another seeker from a less favorable clime. This produces interchange of ideas and influences, but the man who comes here, to replace the man who has left, cannot carry on his creative activity without the support that the first man had found lacking. This type of stalemate bears a close resemblance to the situation that now exists in Oklahoma.

What are the chief requirements for a cultural environment suitable for the development of the arts? First and foremost, of course, is public support. That means an audience which demands the right to hear and to see the work of its own artists and thus bring about the publication, the exhibition, the sale or the performance of each artist's product. The belief that the artistic awareness of the general public decreases, the more remote the public is from the great European centers, is another false assumption. The potential audience, for any art, is about the same everywhere. The size of the audience depends more on the educational level than upon any variation in natural interest. The vast majority of people are born with the ability to appreciate one or all of the arts. However, appreciation depends on familiarity, on knowledge, and on opportunity. If these are denied to the population of a given area that area will be culturally backward. A certain number of hardy spirits will, by some supersensory perception, discover the meaning of artistic expression without the aid of formal education and without even average opportunity. This is demonstrated time and time again, for the very greatest artists frequently spring from backgrounds where little understanding of the arts exists. The ability to find one's way under such conditions implies not average but exceptional talent, and an audience cannot consist solely of geniuses.

For a moment I would like to examine each particular audience and attempt to discover what it has contributed to a creative art, first in this region and then specifically in outstanding cultural centers such as the University of Oklahoma. And, in relation to this area, there can be no question that the University has been just that. The obvious example is literature; including the factual works as well as products of the imagination. As stated, Oklahoma writers have received national support in many instances, but more important to us is the fact that they have had support at home. A mention of the University of Oklahoma Press to enlightened people in the United States and to many in Europe, will bring a gleam of recognition. That the Oklahoma writer has had this outlet at his door and, because of it, has had the means to reach his particular audience, has been of inestimable value to him.

The architect, while not the most unfortunate of the local artists, has had rather less opportunity at home than have the writers. Yet he has fared better in Oklahoma than in many of the older and supposedly more cultured and more advanced states. The number of buildings of contemporary design and artistic merit that have been erected in Oklahoma, is proportionately high. Yet Oklahoma's opportunities for leadership in this field have been far from realized. In this, she has much company, but this does not in itself excuse the partial waste of talent, or shall we say genius? The architects, though, have had their share of national recognition and this is not only helpful to them but to a degree helpful to the reputation of this state. A more active interest on

ABOUT THE AUTHOR

Harrison Kerr became Dean of the College of Fine Arts in 1949 after having served as Director of Music at Greenbrier College, Executive Secretary of the American Music Center, New York, and for two years as Chief of the Music, Art and Exhibit Section Reorientation Branch, Civil Affairs Division, Department of the Army. He is a member of the executive board of the National Music Council and of the Music Advisory Committee of UNESCO. His compositions include three symphonies and other orchestral works, chamber music, and many shorter pieces.

the part of our citizens would be even more to the point.

When we come to artists and sculptors we find a great reservoir of talent but a talent that must be content with a relatively small audience. As is the case with the architecture, but to an even greater extent, the local artists and sculptors must depend on recognition away from home. There are many reasons why this is so but the one that is easiest to understand is that the artist, in order to reach a public, must be in a position to make it possible for the public to see what he has wrought. The artist must have museums and galleries so operated that the public will be interested and so located as to be accessible to all who wish to visit them. Of all artistic facilities, these are the most neglected. There are several small museums in the state; one or two of them excellent within the limitations imposed upon them by the very meagre support that they receive. It is up to the citizens of Oklahoma to provide proper exhibition facilities for the artists of the state. It is not likely that anyone else will do it for them.

For some reason that is not at all apparent, the theatre is also rather shabbily treated in Oklahoma. There is an audience for the drama, as has been demonstrated many times, but if it were not for three or four interested groups and more especially the University of Oklahoma, there would be no theatre in this state.

Reference was made above to the early acceptance of music as a part of the life of the Oklahoma pioneers. Early records show more than average activity in this field of expression. As all Oklahomans know, we have two symphony orchestras in the state, one of which has achieved a national reputation. There have been enough people who have recognized the profitable effect upon a community, caused by the mere existence of an orchestra, to make it seem worthwhile to them to propagandize for the orchestra both locally and nationally. Yet, for some reason, the support of musical enterprises within the state has never been entirely sound. There is always a reluctance to do the two things that are most needed: pay for the performance and turn out to hear it. Few of the arts are self supporting; music never has been and probably never can be. To cover the expenses of a symphonic concert, including rehearsals, the salaries of the performers, the maintenance or rental of a hall, and the purchase or rental of the music would mean that the audience would have to be impractically large or pay an unreasonable admission fee in order that expenses be covered. In short, if the public wishes to have music, whether it be the music of an orchestra or of a solo performer, it must be paid for. If the audience understands this fact and genuinely wishes to have music, there will be a sufficient number who will pay. When this support is lacking, one must, for want of evidence to the contrary, suspect that there is some basic fault in the audience itself.

If this article during its progress has seemed to turn more and more toward the negative, it is because the writer believes that the cultural strength of the community depends on the widespread understanding of both its strengths and its weaknesses. The strengths of this region, as I have tried to indicate, are comparatively very great. It is sometimes puzzling to find that there are equally great weaknesses. Yet some thought concerning this problem will reveal at least a few of the answers. Perhaps the major key is education. It is due to the fact that outstandingly good training in all of the arts can be obtained in a number of places in the state that the strengths exist. But there is a great disparity between the best in education and the poorest. We have both extremes in this state and until the poorer education, which more frequently should be said to be lack of education, disappears, the state's ultimate cultural possibilities, can not be attained. In a laudable, but perhaps not wise attempt to make the arts available to the population, a number of organizations and individuals have given too much art of too unprofessional a level to the public. A firm cultural foundation can only be built on the best that is available. Because money was lacking to obtain this best or at least to present it to the public, recourse was had to that that could be obtained at no cost. At one stage of progress this perhaps has its usefulness, but Oklahoma has passed far beyond that stage. But it has not, in doing so, come to realize its own responsibilities or the sacrifices it must make to develop its own culture. The public must learn to pay for its art and those who have the means to pay for more than what they themselves require must realize their duty towards the less affluent portion of the public. This portion has just as much human need for artistic expression as do the men of superior means. Many pages could be filled by examples of public demand for art and the sacrifices individual artists have made in order to meet in part that demand, only to find that the public apparently does not realize that the artist can only give to the limit of his endurance. We make it difficult for the artist, whatever his field, to earn a satisfactory living. Is it fair to ask him to give lavishly of his time and energy for little or no return? Being an artist, he does just that but it is an unhealthy attitude of the public, either to expect this or, when offered, to accept it, with very little thought as to what this does to the artist.

Perhaps some may question whether this whole matter is of any great importance; whether as a matter of fact any state, any community, or any university, to bring the matter as close to home as we can, has any genuine need for the arts. If the question is asked with a full knowledge of the facts and with a knowledge of the role that the arts have played since before the dawn of civilization, it is rather useless to try to answer it. If the question is asked because of a lack of knowledge of certain basic facts, then let me mention a few of these. Music is not only one of the most widespread of the arts, it is one of the basic economic factors in this country. Music, as a business, is the third largest in volume. Can any community ignore so important an activity or fail to give it full support? Professional baseball is a great business too. Try to visualize for a moment, the number of people that attend all professional games in any given year. When you have added them up mentally you will fall short of the number of people who visited the Metropolitan Museum of Art during that same year, and the Metropolitan Museum is only one of dozens of outstanding institutions of this type scattered throughout the country. There are no figures at hand to indicate the number of people that attend theatrical performances during the course of the year. But even in these times, when the theatre is, perhaps because of motion pictures and television, a little less popular than usual, the size of the total audience is astronomical. Certainly such facts indicate that the arts are almost as basic as food and shelter. Yet a community which would not think of permitting itself to be backward in sanitation, medical care and, in fact, in any tangible convenience of present day civilization, will turn a deaf ear to a plea for the recognition and support of the arts, possibly because the fundamental need for these has never been fully realized. Even though it may be recognized that the arts must be a part of any educational system, the financial support of this phase of education is generally insufficient and is sometimes downright miserly.

Regrettably, a substantial part of this whole question comes down to hard cash. Perhaps we need to ask ourselves if we are only willing to pay for bathtubs, refrigerators, and highways. If our answer is a contentious, or perhaps an apologetic, yes, then we must be prepared for a low cultural reputation among our neighbors. They have discovered, it must be remembered, that it is hard common sense to invest in culture. There are those who say that this is all very well, but the big foundations should, if they support cultural things at all, give their support where it is most

needed. However, we must realize that it just does not work that way. A foundation, just like an individual, is most apt to help the group that has demonstrated that it is interested in, and capable of, helping itself.

It is an observable fact that communities or states, which have achieved notable reputations as centers of artistic creativeness, have done so because some person or group has had the vision to support the local artists. Often one patron who is willing to invest generously in the cultural future of his region, has been the catalyst that touched off the re-action. In the history of the arts such patrons have shared the fame of the artists they encouraged. The faith of our neighbors must be evidenced before a foundation can be impressed.

What the arts need, in Oklahoma, is the whole hearted support of Oklahomans.

""It's hard to think of a man as a great artist when you have seen him in his underdrawers." Mary Doyle Curran in the Atlantic Monthly for July 1953.*

The Modern Meaning . . .

Continued from page 26

velopment of thermal science, beginning with thermometry and calorimetry, and the parallel development first of atmospheric and then of steam engines. By the eighteenth century, these engines were beginning to be somewhat efficient. Eventually, as we know, they were utterly to transform old methods of mining, manufacturing, and transportation, and were to play a major role in bringing about the Industrial Revolution, the revolution from a peasant to an industrial society. There is an anecdote about a poet and a member of the British government who were standing on a bridge over a railroad, watching an approaching train. The poet said: "It's an ugly thing"; and those early trains *were* ugly! The other man replied: "Yes, but it marks the end of feudalism." For the first time in history, man saw the opportunity to be freed from grueling manual labor, to have abundant production, and to achieve democracy for all the people.

But these changes also gave rise to perplexing problems. Urban communities sprang up more rapidly than effective ways to govern them could be devised, resulting in congested areas, hideous and squalid. In the factories no provisions were made to prevent bad working conditions and the exploitation of workers. Trade unions then developed. With mass production, industries became interdependent and problems of mass unemployment arose.

Thus, though means for increasing human welfare were abundant, they developed so rapidly that people did not know how to use them, and perplexing problems of poverty arose. It was in this period that Poe was moved to say about science:

Hast thou not torn from me
The summer dream beneath the tamarind tree?

Nevertheless, this was the period of the rise of the common man. For the first time in history there was the possibility of having a civilization in which all the people could be free from hunger and poverty, from superstition and fear, if only ways could be devised to utilize these opportunities.

Conditions did improve in the last half of the nineteenth century; optimism was again in the air, and we hear Walt Whitman visualizing democracy as now building a civilization of greater freedom, equality, and fellowship than the world had ever before known.

Then something new happened to bring about a second industrial revolution, the development of electric power and machinery—the transition from a steam to an electrical age—and again new and perplexing problems arose. Yet, as has been often pointed out, this development of electric power has been the single greatest factor in our country's material prosperity during the last half century.

Perhaps there will be another industrial revolution with the advent of automatic control devices, or even of nuclear power. If so, we can see what some of the new problems may be. If happiness consists in having important and interesting problems to solve, then the social scientist of today should be in a state of complete bliss. How is he going to solve these problems? An obvious possibility is to apply some of the hair of the dog—to approach these problems by methods similar to those that created them. Many will counter that scientific approaches have been tried and failed. Yet it may be that what has so often been tried and has failed is an oversimplified formula, going by the name of *"the* scientific method." There is no such thing. There are scientific *methods,* and almost as many of them as there are problems and people working on them. This would seem to present a hopeless situation so far as the opportunity for the nonscientist to understand such methods is concerned. But perhaps not. Much has been learned in the last couple of decades about teaching scientific methodology and attitudes, and it is, briefly, to make people acquainted with the history of ideas and the way in which a succession of selected scientists, up through the ages, have developed them.

These sequences which have been briefly skimmed over—on primitive concepts and measurements, on astronomy through Kepler, on mechanics through Newton, and on thermal science—can be covered conveniently in about a semester. The second semester, in the particular course which I have been describing, is devoted to the rise of chemical knowledge, basic developments in optics and electricity; and, finally, the sequence of developments beginning about 1890 and leading through the discoveries of the electron, X-rays, and radioactivity to quantum theory and work on atomic and nuclear structures, thus bringing the story up to events occurring within recent years.

Because so much of this paper has been devoted to material not ordinarily treated in an elementary course, it should be emphasized that, in the actual course, at least three-fourths of the whole time is given to what most people have come to regard as the only "real science"—the ordinary technical details and rigorous developments. Moreover, the course is only one part of a program that should include similar courses in general biology, in the social fields, and in the humanities. Such a program intended to provide a modern liberal education need be anything but superficial.

A Look at Egypt . . .

Continued from page 20

gold sarcophagus is still there, although the outer sarcophagi have been placed in the museum. Some excavating work is still going on and there are spots which are roped off because the piles of stones have been sorted and classified, probably in preparation for some re-assembling. The most active group of archaeologists and Egyptologists in the vicinity is apparently from the University of Chicago which has an excellent center with workrooms, a good library, an attractive physical plant, and pleasant living quarters for the staff.

Besides these ancient sites in or near Luxor, there are also Memphis and Sakkara or the pyramids and sphinx at Giza to interest the historian, while those concerned with present-day problems find plenty of material in the living conditions of the rural villages, the complex and cosmopolitan life of Cairo and Alexandria, or the current political activities, including those involving the Suez Canal and the Sudan disputes.

Here we are reminded again of the feeling of sharp contrast, the antiquity and weight of a rich civilization against the feverish activity of a dynamic present of which its participants are keenly aware. It arouses something more than the passing interest which charms a tourist. Would I like to go back again some day? Certainly; not to live, perhaps, because Egypt's exoticism is a little overpowering to a Westerner, but a visit is a stimulating experience.