airborne hologram radar was used by the Aero-Service Corporation to "photograph" (extremely clearly, in spite of an extensive cloud cover that would have blocked ordinary photography) 3 million square miles of the Amazon River basin in South America. Another example of the myriad uses of holography now being explored involves attempts to understand more fully extremely small objects. Holographic techniques have been used, for example, to clear up electron photomicrographs of molecular structures.

Optics is not the only field of specialization for Gabor. His papers on communication theory, written in the 1930's and 1940's, are now considered classics in the field. These contributions to information theory (the information content in wave fields) were noted in the Academy's announcement. In addition, he has written numerous papers on cathode-ray oscillographs, electron devices, and gas discharges.

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NEWS AND COMMENT

The Open University: Breakthrough for Britain?

Britain's Open University (OU), perhaps the most ambitious venture in extramural higher education ever undertaken, is completing its first academic year. Politically, the future of the OU is something of an open question. Educationally, a lot of issues will remain unsettled, even after the results of current final examinations are in. But in terms of momentum and morale, the OU can fairly claim a successful first year.

Called "the university of the second chance" by its partisans, the OU now offers part-time students 21 years of age and older the opportunity to work for bachelor of arts degrees. In the first year, the faculties of arts (the American equivalent is humanities), social science, science, and mathematics offered first-level courses; two new faculties, technology and educational studies, will offer first courses, starting in January. Second-level courses have been readied for the new academic year, and third- and fourth-level courses are in the works. Advanced courses, including "postexperience" courses and programs leading to graduate degrees, are being contemplated.

Instruction at OU is based on a mix of media, and although the heart of the curriculum is a big package of course material requiring written assignments from students, the OU appears to have beaten the stereotype of a "correspondence college." Not only is teaching by television and radio an integral part of all OU courses, but students have regular access to tutors and counselors through some 280 local study centers scattered around Britain. Students also are required to attend 1-week summer school sessions that are held at universities.

Along with its unique characteristics, the OU has many attributes of a traditional university—a royal charter, the right to grant degrees, administrators and professors of its own, a campus. It even has a crest, which on close examination proves to be a mod heraldic combination of the initials OU. The campus, near Bletchley in Buckinghamshire, lies an hour's train journey from London and near Britain's main north-south motorway, the M1. The OU buildings are going up on a 70-acre site on a country estate, Walton Hall, on the edge of the village of Walton. The campus is in an area which before too long will be part of the projected new city of Milton Keynes (named for the poet and the economist), which is to provide a new population center in crowded southern England.

The campus is, as one professor describes it, "an educational factory," where computers are used to process written assignments and handle complex academic and administrative dealings with students. Senior faculty is headquartered there, and Walton Hall is the center for curriculum development. If plans materialize, the campus is expected ultimately to accommodate everything from comprehensive educational publishing facilities to advanced research. At present, work goes on in the first new brick university buildings—in functional but not unattractive style—and in rows of one-story temporary buildings. A common misconception is that the OU is run by the BBC (British Broadcasting Corporation). The OU-BBC partnership is actually based on an understanding under which the BBC is reimbursed for production of television and radio programs.

The idea of the OU evolved in the mid-1960's while the Labour Party was in office. The then Prime Minister, Harold Wilson labeled the idea "University of the Air", which its backers feel gave it an erroneous and unfortunate image. The project was launched in 1969 and last year survived, if narrowly, the change in government. The Conservative government has remained skeptical of the OU, but has given it a 3-year grace period to prove itself. An observer wryly noted that one thing which recommends the OU to the government is its cost effectiveness. It is estimated that, even if only 20 percent of those enrolled in the first year earn degrees, the investment per graduate will be about half that for graduates of conventional universities. (About $12 million will have been spent on plant and equipment by 1973, and the operating budget for 1971 was about $15

million, including $3.75 million for the BBC.)

In its first year, the OU enrolled 25,000 students out of 42,000 applicants. The pressure was heaviest in social science, with 34.7 percent of the applicants, and in arts, with 27.3 percent. Science and mathematics each drew under 20 percent of the applicants. A decision was made to adjust the balance in the actual number of places provided, however, and admissions to social science and arts courses were limited to 8000 each, while 7000 students were accepted in both science and mathematics courses.

Admissions were influenced not only by quotas for courses, but also by considerations of applicants' occupations and regions. A manual laborer from Yorkshire who wished to study science was almost sure of acceptance, for example, while a teacher from the London area who was interested in arts would face strong competition for a place.

Foundation Courses

In the first year, all OU students took so-called "foundation courses." These foundation courses are intended to accomplish several objectives. Students at OU are not expected to offer the usual academic qualifications for university admission. They represent a wide diversity in age, background, and level of sophistication in the subject they are studying. The foundation courses are meant to provide a broad introduction to a field and to give all students a grasp of essentials, although not all students are expected to go on to second- or third-level courses in the subject.

In the context of Britain's highly selective higher education system, the numbers enrolled in the OU are enormous. In science, for example, the OU's first-year enrollment virtually doubled the number of first-year science students in British universities.

If the OU departs from the precedent of selectivity, it shatters the equally strong precedent of specialization. Under the Oxbridge tradition, an undergraduate's education focuses on a single field, often a single subject, and culminates in all-or-nothing written and oral final examinations. The newer universities have modified the pattern, but specialization remains strong. The OU's requirements for a degree are deliberately designed to deter narrow specialization and to encourage multidisciplinary study. Students accumulate credits, American style, toward graduation. Two types of B.A.'s are offered—the ordinary degree, which requires the student to complete successfully the equivalent of six full-year courses, and the honors degree, which requires the completion of eight. In either case, the student must include two of the foundation courses in his studies.

For the ordinary degree, it is necessary to pass four other courses at the second level or above. For the honors degree, credit for six other courses—at least two of them at third or fourth levels—is required. A student may take no more than two courses at a time; thus the minimum time required to earn a degree, if all work is taken under the OU's aegis, is 3 years for an ordinary degree and 4 for an honors degree. Most students are expected to take one course at a time.

Because the OU is regarded by some as an upstart in higher education, those involved with it have been particularly concerned with establishing its academic bona fides. To insure quality control, the curriculum was systematically exposed to criticism from outside academics during the development period. As a result, there has been little criticism of the contents of courses. In fact, one observer says that standards for the science foundation course were set so high that the course makers have underestimated the time required to work through course units. An estimate of 10 hours a week as the average was aimed for, but many, perhaps most, students apparently put in more time.

The quality of the courses obviously depended on the faculty. In recruiting, a special criterion was a candidate's commitment to teaching the student the OU was created for—the late bloomer, those educationally disadvantaged by poor schools, bad health, or family circumstances. Otherwise, the qualifications were the same as for any other university appointment, including accomplishment in research. The dean and director of studies in science, for example, is physicist Michael Pentz, who came to OU after a decade of work at CERN (European Organization for Nuclear Research), where he was a group leader. The OU's professor of biology is Stephen Rose. A biochemist, Rose is a founder of the British Society for Social Responsibility in Science, and his appointment in his early 30's to the OU chair made him the youngest professor in Britain.

Despite the burden of work carried by faculty members for the past 2 years—70-hour weeks are routine— the 15 members of the science faculty have in most cases managed to keep up their research, most of them at their former institutions or at nearby universities. Rose heads a research group, funded by a Medical Research Council grant, that works in temporary quarters on the Walton campus. A science building, scheduled to be completed in 1974, will provide lab space for research and make graduate education possible on the premises.

To develop its curriculum, the OU relies on the "course team." In the case of the foundation course in science, the team comprised 26 people—15 academics, eight people from the BBC staff, two editors, and an educational technologist. An Institute of Educational Technology (IET) is part of the structure of the OU. The IET's role is to perform research on behalf of the OU program, monitor its progress, and in general act as critic and technical adviser.

For the foundation course in science, the course team produced 36 specially written units, equal to five 300-page textbooks, an ingenious home experiment kit and plans for 30 experiments, 36 half-hour television programs and the same number of half-hour radio programs, plus a variety of supplementary material. Most of this was done, incidentally, in a period of 15 months.

The team was collectively responsible for the course, not just in a formal way, but in the sense of reviewing each input at each step of the process. Typically, an individual academic would produce a draft unit in his special field. This would be reviewed and criticized by the whole team, subjected to criticism from outside experts, and then revised and reworked to mesh with the rest of the course.

Teaching on TV

From the beginning, the television portion of instruction in science was regarded as so essential that a student not having access to BBC-2 at his home or study center was discouraged from taking the course. Strong efforts were made to eschew the potted television lecture. The OU academic staff appeared on camera in most of the pro-

grams. "Teaching on TV is a skill," says Pentz, "and we're a little less amateur than others. We try to exploit the fact that both TV and science have to do with things that move, processes. It seemed crazy to project on a TV screen something that could be shown in a still photo or diagram. Still more useless to have some bod gassing. So we went after demonstrations, time-lapse photos, electron microscope pictures."

The television programs always refer back to the text and the experiments, and vice versa. In the unit on high energy physics, for example, the television program followed an experiment at CERN, and then students were sent photos of bubble chamber tracks and asked to analyze them.

Radio is used essentially as enrichment, or, as Pentz puts it, to add "relevance, unity, coherence." For example, when a unit on biology dealt with the Krebs cycle, the radio program was devoted to reminiscences by Hans Krebs on the development of his idea of the cycle.

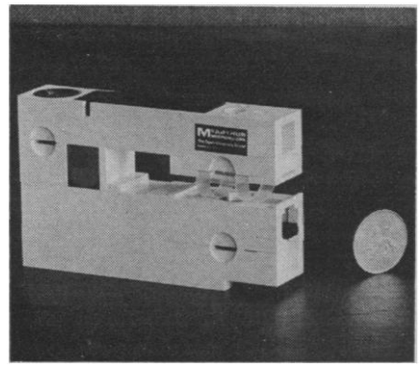
The BBC has had a lot of experience with educational programming. It has operated programs for schools since its earlier days, as well as a further education department, which produces programs and related instructional publications on a wide variety of subjects, notably foreign languages. For the OU effort, the BBC decided to add science graduates to its staff and teach them television rather than vice versa. And it seems to have worked.

Television instruction does present a problem for the OU—one that will grow more acute as the number of courses multiply. Television and radio time are premium commodities. This year, OU programs have occupied early evening prime time on BBC-2, making it possible for students with regular jobs to watch then or when the programs are repeated on the weekends. An extremely high percentage of students do—an average of better than 95 percent. The difficulties will arise when new courses compete for time. There is no immediate prospect that the problem will be solved with new technology—closed circuit or cable television, for example, or cassette technology. Even now, although radio tapes and facilities to play them seem adequate at the centers, television playback equipment is in limited supply. This is an area in which the OU's limited resources hurt. And oddly, there seems to be little general discussion on how to come to terms with smaller groups of students taking many more courses.

Open University's home experimental kit. [Fox Photos]

It should be noted that, although probably held by a minority, there exists the opinion that the television part of the science course has been a disappointment, not because of quality, but because a half hour a week is not enough to permit television to play its intended role.

If there has been no great leap forward in technology, almost everybody recognizes that the science course stands or falls on the quality of its instructional materials. The amount and variety of material makes it difficult to give more than a very general description of the science course, for example. Each course unit is published separately in a magazine-sized paperback of under 100 pages. The treatment falls between the modern textbook style and programmed instruction meant to communicate moderately difficult technical material. Objectives are clearly stated and restated, illustrations and diagrams are frequent and attractive, trail-marking questions and answers are interspersed through the text, and self-evaluation tests are included. The prose is clear and manages to be friendly and encouraging in tone without being patronizing.



Microscope specially adapted for OU foundation course in science. [Fox Photos]

To accommodate the differences in students' knowledge and interests, the science course has three "channels." The course units constitute the main channel. There is lower-channel material for those who need assistance and supplementary upper-channel material for those able to explore a subject in greater detail and depth.

The foundation course proceeds in order from physics to chemistry to biology to earth sciences. The logical progression, in general, is from the small to the large and the simple to the complex—from atoms and molecules to living cells and multicellular organisms, and thus, by way of evolution, to the environment and the study of the earth. The course is placed in the context of the interaction of science and society, and the final units close the circle with, for example, a case history of the CERN 300-Gev accelerator project. The science student tackles 36 units, each intended to provide a week's work during a term that begins in January and runs for 42 weeks. There are provisions for time off in the summer, including the period of the Wimbledon championships, when the BBC is heavily committed to tennis.

Examinations are taken in the conventional way at exam centers under the eyes of proctors, whom the British call invigilators.

For the foundation course in science, each student was expected to complete one computer-marked assignment (CMA) each week, and a tutor-marked assignment each month. The latter could be, for example, a write-up of a home experiment, which the tutor would mark and comment upon.

Students who encounter problems with their work are expected to make contact with staff at one of the study centers. Most of these centers are located in existing institutions of higher education, such as polytechnics. They are conceived primarily as performing a remedial role, but many students visit them regularly, and in many cases they have become social centers for OU students.

This year, the study centers were open Monday through Thursday nights from 5:30 to 9, with sessions scheduled on Saturdays for different groups. Next year the centers will be open on Friday night as well, and the science faculty is seeking ways to give students in upper-level science courses more sophisticated group experience in laboratories.

Summer Sessions Succeed

The 1-week summer sessions for the foundation courses seem to have been generally successful, particularly perhaps, in giving students a sense of belonging to an extended academic community. Summer sessions for second-level courses will be 2 weeks long.

The key relationship for the OU student, however, is with the part-time faculty members with whom he has primary contact. These are his counselor, to whom he has regular access at a study center, and subject tutors. The student meets the counselor early and can turn to him for general guidance and help with particular problems. The subject tutor marks assignments and periodically gives tutorials, which are essentially seminars involving small groups of students, in his specialty.

The OU passion for self-criticism extends to the tutorial corps. The tutor and counselors—about 1000 of them in all—are part-timers, for the most part drawn from universities and polytechnics in a given area. Tutor-marked assignments go to Walton and are monitored by a sampling process. If a tutor's "scripts" are marked erratically or with excessive harshness, this is noted. The OU is decentralized in the sense that hiring and handling of the tutorial staff is delegated to full-time OU staff in 12 regions. If the monitoring system turns up a case of tutorial excess, or if a student complains, the matter is reviewed at the regional level. The appeal is handled regionally by a staff tutor in the subject, and his decision is the final word, although negotiation rather than arbitrary action is what all parties expect.

"Continuous assessment," in fact, is something of an OU fetish; in the case of computer-marked assignments, the computer is programmed to take note if a student does badly on successive assignents or if his work slumps seriously. Counselors and tutors are informed of each student's progress—each has about 20 students assigned—and are expected to take the action indicated.

Prodigious efforts at evaluation of the first year's operations have been made. Until the results of the examinations are analyzed and the details of enrollment for the second year are clearer, however, it will be impossible to draw up anything but the most tentative balance sheet. At the end of the summer, something over 19,000 of the original 25,000 students were still working at their courses. This is a substantial loss, but small in comparison to the wastage in good correspondence courses, which averages 50 percent or more.

The total number of applicants for first-year courses was down from 42,000 to 35,000 this year, and the number of places has been cut to just under 20,000. First-year places in science and mathematics have been cut from 7000 to about 4500 each, but 2200 new places for first-year students in technology have been added.

There was some disappointment within the OU and some reproaches from outside because the largest group of applicants and of those admitted for the first year were teachers. The implication was that the OU was catering to the middle-class rather than providing opportunities for higher education to groups who had been denied it by the traditional system. The fact was that teachers, many of whom earn less than skilled workers in Britain, are under heavy pressure to get university degrees to qualify for higher rank and pay. And to everybody's relief, the percentage of teachers will be lower and that of manual workers higher in the next first-year intake.

Some of those who stress the social mission of the OU mistrust the intentions of the present government. There is pressure being exerted on the OU to lower the age limit from 21 to, perhaps, 18. This is seen as an effort to take the pressure off the traditional universities. Some see a class bias behind such pressure, while others simply argue that accommodating large numbers of "school leavers" who have been turned away by other universities would convert the university of the second chance into the university of the second rate.

Strength in Idea

Partisans of the OU feel that there is real strength in the basic idea of providing higher education for mature, strongly motivated students. As Pentz puts it, "I think we're going to turn out a different kind of graduate, the kind that other universities will get around to producing in about 20 years, the kind who will develop slightly different skills —versatility, adaptability, the capacity to learn rapidly."

In addition to a sense of mission and confidence in its product, the OU is deliberately open about all its works. All textual material, even the home experiment kit, can be purchased by those not enrolled in courses. And the OU does not intend to play a passive role in the marketplace. A compact microscope specially developed for the OU is looked on as a likely source of royalties for the OU endowment. Several thousand copies of material on earth sciences has been sold to M.I.T.—surely a case of carrying coals to Newcastle—and a marketing director has just been named for Scandinavia. It is often noted that OU faculty members appearing on TV programs can be judged by their peers in other universities. It is equally true that students from other universities who see the programs can make comparisons with the instruction they are getting.

What about the future for the OU? Some optimists see an infinitely expanding horizon, with courses in law and preclinical medicine even in the cards. In the shorter run, the OU seems to be successfully working toward the solution of real problems of meeting professional society qualifications for its future graduates in technical fields. And conversations at Walton Hall and elsewhere made it clear that those committed to the OU are not merely concerned with the survival of the institution, but regard one measure of success as how the OU will influence higher education in Britain and elsewhere.

—JOHN WALSH