balancing the need to hire enthusiastic people with the semi-anonymity that SIPRI imposes. No staff member is permitted to make statements or appear in any way as a SIPRI spokesman—something which, Barnaby says, does not cause problems. "We recruit very, very carefully, people of high enough quality for it not to be a problem," he says. "We would avoid recruiting an overcommitted person—nobody could *use* SIPRI to get his ideas across."

What matters more is whether SIPRI is getting its own ideas across. Like the Pugwash movement, it may now be faced with the dilemma of deciding whether to direct its information and propaganda at decision-making elites or at the public at large. So far, to judge by the sales of its publications, it has chosen the first of these. The popular version of the arms trade book now being prepared implies a recognition that this is not enough. "Our success depends on our being comprehensible in foreign offices," says Barnaby. But also, perhaps, it may depend on being comprehensible to the man in the street as well. If war is too important to be left to the generals, peace certainly cannot be left to the bureaucrats.—NIGEL HAWKES

*Nigel Hawkes recently joined the London* Observer *as science correspondent.*

# Medicine at Michigan State (III): Conditioning for Innovation

The use of community health facilities for clinical teaching of medical students has become at least a modest trend in American medical education. In some cases, a reliance on existing facilities has been forced by the increasing difficulties of raising funds for medical center construction. But the positive aspects of going outside the walls of the university medical center are being given much greater weight these days.

The new alternative permits the kind of involvement in community health problems that activist students and faculty members have demanded. The medical school can exercise more direct influence to improve patient care in the medical territory it dominates. And, perhaps most important, experience in the community may overcome the alleged inhibitions of medical students and residents whose training is limited to university teaching hospitals and who are said to feel secure ever after only in such a setting.

At Michigan State University (MSU), multiple motives have led to the use of existing community facilities as the base for clinical education. MSU has no university hospital, and most clinical teaching is being done in community hospitals, clinics, and doctors' offices as far afield as Grand Rapids and Flint.

Novelty does not end there. MSU has not one, but two schools of medicine on its campus, and one of these a College of Osteopathic Medicine, the first such school to receive the full panoply of state support. Osteopathic medicine has a strong tradition of clinical training in physicians' offices and community hospitals, and this has reinforced the new MSU pattern. In a way, MSU is making use of existing facilities for preclinical instruction as well. Medical education at MSU does not take place in separate basic science departments within the medical school, but in departments that serve the university as a whole.

To some extent at MSU, necessity has bred innovation. The state legislature, which has supported a major expansion of medical education, began to look critically at medical school plans and programs (*Science*, 22 September). Legislators have resisted the replication of expensive clinical teaching facilities, partly because they felt, as house appropriations committee chairman William Copeland put it, "We were not getting the return on the money we were told we'd get."

Innovation at MSU, however, must be partly attributed to some dominant institutional traits. In 1855 the state of Michigan established an agricultural college that served as a prototype for the land-grant institutions created in the following decade. That agricultural college is today's Michigan State. For most of a century, however, it was a "cow college" overshadowed by the University of Michigan. Even after World War II, MSU was referred to superciliously at Ann Arbor as "Moo U," or "the udder university." MSU always took the land-grant principle of public service seriously, and in the postwar regime of president John A. Hannah it provided a remarkable display of successful growthmanship. Sometimes MSU's devotion to the solution of practical problems looked uncritical to outsiders, as, for example, with the creation of a School of Packaging. And sometimes the legitimacy of the uses to which the university was put was questioned, as with some AID contracts in behalf of the South Vietnamese government which earned MSU the cover story that brought *Ramparts* magazine national attention in the early 1960's. At the same time, however, the university was growing prodigiously in size—enrollment is now well over 40,000—and in quality. The same MSU that defined itself in the early 1950's by bulldozing its way to a No. 1 rating nationally in football, stressed in the 1960's that it was recruiting more National Merit Scholars than any other university.

Medical education obviously requires a strong foundation in the sciences, and it is here that MSU has indisputably moved up rapidly in the academic pecking order. President of MSU Clifford R. Wharton, Jr., points to two American Council on Education (ACE) rating reports, published in 1966 and 1971, which show that MSU did particularly well in the sciences. The reports reflected the evaluation of departments in major institutions by faculty members rating departments in their own disciplines. In the 1966 report, which ranked 12 scientific departments, all but one MSU department (botany) were unranked. In the second study, for which evaluations were done in 1969, 9 of 12 MSU departments were put in the top, or "distinguished," category. The MSU biochemistry depart-

ment, for example, went from unranked to 28th among biochemistry departments in major American universities in quality of graduate faculty, and to 21st in effectiveness of graduate programs.

Back in the days when MSU enrolled mostly agriculture students and teacher trainees, science departments primarily taught "service" courses to undergraduates. Research was done in the agricultural experiment station, if at all. Engineering had firm roots, but even in this area MSU was known as an "applied school." Then in the later 1950's came the effort to build a research and graduate education capability. Science departments were strengthened, but they still did the teaching for everyone at the university—and this practice persists. Departmental baronies did not develop in the way they have at other universities, and it has therefore been easier to initiate interdisciplinary research and to accommodate the schools of medicine. Needless to say, the all-university department approach was used as a selling point with the legislature when the time came to discuss medical education. The argument could be made that MSU had the people it needed in the basic sciences and would not have to hire many more.

Medical education was being seriously contemplated at MSU in the early 1960's, but it was not until 1962, for example, that there was a biochemistry department. Most biochemists had worked in the chemistry department. The new department included the nucleus from chemistry, biochemists who had been associated with the College of Agriculture, and some new recruits to the university. MSU, of course, is not exempt from the collision of egos or the clash of priorities. One biochemistry professor recalls that when the department set up on its own, "the chemistry people felt association with the agriculture school would turn students off. And we did lose contact with other Big Ten chemistry departments." There also seems to have been an assimilation problem with some elements of the new department. But, says the professor, "After a few years of coexistence it evolved into an integrated biochemistry department." The ACE survey seems to support this view. The administrative arrangements under which the biochemistry department now operates indicate how the MSU system works. The department is jointly administered by the College of Human Medicine, the College of Osteopathic Medicine, the College of Natural Science, and the College of Agriculture and Natural Resources. Under the original agreement, Natural Science is mainly responsible for the undergraduate program and Agriculture for the graduate study. But it is generally agreed that the system works not so much because of formal arrangements as because of personalities and the habit of cooperation.

The department now teaches biochemistry courses to students of the College of Human Medicine and the College of Osteopathic Medicine separately. Biochemistry Professor James L. Fairley explains that "the osteopathic school had a going curriculum which they had worked hard to set up and we were willing to go along with it." The first biochemistry course for osteopathic students, says Fairley, is heavy on systems biology. They get 30 lectures in basic biochemistry at the outset. Over the next five terms, biochemistry is taught mainly in "minicourses" on special subjects.

For M.D. students, there was a two-term course in biochemistry. The College of Human Medicine curriculum has been changed substantially this year, and biochemistry will be taught in an initial 30-lecture cycle, with another 15 lectures at the end of the year. But the new curriculum stresses small-group learning, in a format called the "focal problem." Eight or ten students meet with preceptors representing the basic and clinical sciences and often the behavioral sciences; as the name implies, the group concentrates on a specific medical problem. Biochemists will be called on frequently to share the preceptors' role.

It would be simpler in many ways, of course, if the two schools of medicine had their students study biochemistry in the same way. Everyone involved agrees that there is no early prospect

# Briefing

## First Nonmedical Chinese Scientists to Visit U.S.

The Committee on Scholarly Communication with the People's Republic of China of the National Academy of Sciences in cooperation with the Federation of American Scientists (FAS) will be hosts for seven prominent Chinese scientists when they arrive on 20 November for a tour of the United States. The group will tour American research institutions and universities, probably including stops in Washington, D.C., Princeton, New Haven, New York, Boston, and San Francisco. The actual itinerary and length of stay of the Chinese, however, is yet undecided.

As with the group of Chinese doctors now touring the United States, the Chinese will be dealing with the NAS throughout the visit—a turnaround from their earlier refusal to deal with the academy because of its other activities involving Nationalist Chinese. For several months, the FAS has been serving as a communications link between the American scientific community and the Chinese authorities. Hence, the forthcoming visit is largely the result of diligent FAS groundwork with the Chinese. The scientists, their affiliations, and fields are:

*Pei Shih-chang*, delegation head, member, standing committee of National People's Congress, member of Presidium of the Scientific and Technical Association of the People's Republic of China (PRC), and president of the Institute of Biophysics of the Chinese Academy of Sciences; biophysics.

*Pai Chieh-fu*, deputy head of the delegation, member of Presidium of the Scientific and Technical Association of the PRC, leading member, Peking municipal bureau of science and technology; science administration.

*Chang Wen-yu*, vice president, Institute of Atomic Energy of the Chinese Academy of Sciences; high polymer physics.

*Chien Wei-chang*, professor at Tsinghua University; mechanics.

*Chien Jen-yuan*, council member, Society of Chemistry, research fellow of the Institute of Chemistry of the Chinese Academy of Sciences; high polymer physical chemistry.

*Hu Shih-chuan*, scientist at the Shanghai Institute of Biochemistry of the Chinese Academy of Sciences; biochemistry.

*Li Fu-sheng*, deputy director, research office, Shenyang Institute of Computing Technology, Chinese Academy of Sciences; computing technology.

Also in the party will be two Chinese interpreters and a secretary.—D.S.

of this happening, and everyone seems willing to live with the fact.

There are other problems inherent in a jointly administered department. Faculty members, for example, have four curriculum committees to serve on. In addition, there can be difficulties as faculty members form stronger loyalties to one school than to another. Some biochemists wonder whether an all-university department will be able to give the medical schools all they think they need without slighting other departmental responsibilities.

At this point, it appears that the basic science departments will not soon be inundated with students from the medical schools seeking to do advanced work. "Some human medicine students come back to take advanced courses such as neurobiochemistry, but it's not going to be a high percentage," said a biochemist.

The emphasis in both schools of medicine is on family practice, and observers say this emphasis has been reflected in admissions policy. One biochemist says, "Top science men are not getting preference."

So far, the department has not had to increase the average teaching load for faculty members, but members of the biochemistry department acknowledge that the "inefficiency" of the use of faculty time in the focal problem format could cause trouble. In addition, the teaching of clinical sciences in the College of Human Medicine is still very much in the process of evolution, and the same faculty members observed that there are "still deficiencies in the correlation between basic sciences and clinical sciences people."

The all-university department approach may well have to be modified. A split has already occurred in pathology, with the College of Veterinary Medicine opting for a separate division within the department.

One factor at MSU that militates in favor of the freewheeling departmental approach should not be left out. Partisans of Michigan State frequently make the point that MSU is a "proletarian" school. What they seem to mean is that the land-grant tradition of public service has been balanced against traditional academic values and a finger sometimes put on the scale in favor of the former. What critics call opportunism, advocates call openness, vigor, and responsiveness. First-generation university students from farms, blue-collar backgrounds, and the ghetto were going to MSU in large numbers long before anybody talked about open admissions. In the legislature, this has meant that MSU rates well with the self-made businessmen and the legislators who identify with ethnic groups, just as the University of Michigan has the lawyers. Inside MSU, it means that people stand less on academic ceremony and the observance of forms and tend to stress getting the job done.

The reputation and inner adaptability of MSU have helped the College of Human Medicine with its program to provide clinical teaching mainly away from the campus. The strong emphasis on family and community medicine owes something to the legislators' penchant for seeing this kind of training stressed and to their refusal to finance the construction of what they viewed as more clinical Taj Mahals on campus. On the other hand, the use of community facilities for clinical training is a popular strategy these days, and MSU seems particularly well suited to following it.

### Open-Ended Corporation

The concept devised at MSU to carry out medical education in the community is the open-ended corporation. The preferred model is one in which several hospitals and other health care facilities in a community agree to link themselves with the medical school. Corporations are operating in Grand Rapids, Flint, and Lansing now and are expected to function in Kalamazoo and Detroit later. The school also makes one-to-one arrangements with hospitals and other health care facilities in smaller communities. Typically, the overcoming of local hostility among competing hospitals is prerequisite to the scheme's working. A main point is that the corporation, not the university, administers the program, and medical school policy is "to lean over backwards so that the university will not dominate."

The College of Human Medicine's associate dean for clinical and community affairs, W. Donald Weston, has had a principal hand in developing the program. In the past, says Weston, in dealing with community health facilities medical schools have usually played a strong advisory role or taken responsibility for the development and actual operations of such facilities. "We've turned that around. We define the quality of education—then evaluate it. It's not a case of residents doing the teaching: 70 to 80 percent of teaching is done by local physicians." Under the affiliation agreements, the medical school has no control over patient care. The university pays the cost of education. The community puts up the money for institutional costs.

A student is assigned to a particular community as his primary base throughout the period of clinical training. Plans call for students to spend some time in a small-town community hospital to be taught fundamentals of patient care early in their clinical training, and some training will be obtained on the MSU campus; but the balance of the student's clinical training will be done in one community with a participating corporation.

The chances of keeping medical school graduates in the state after they complete training are thought to be enhanced by basing clinical training in the community. And it may be the off-duty as much as the on-duty experience that clinches it. One state official cited figures gathered by a practical sociologist showing that a medical graduate is most likely to practice in Michigan if he marries a Michigan girl (the data apparently did not extend to women graduates). So it might be said that the girls of Grand Rapids, Albion, and Kalamazoo are really part of the plan.

It is too soon to draw up a balance sheet on the MSU experiment. The first 4-year class of the College of Human Medicine was graduated only this year. Medical school administrators concede that the evaluation process for clinical education is not perfected and that the community corporations are still shaking down.

Some faculty members of the College of Human Medicine seem slightly apprehensive that their colleagues in academic medicine may regard innovation at MSU as eccentricity and the use of community facilities as an unseemly compromise. Prestige in medical education still accrues to the research oriented schools—the Stanfords and Harvards. But the MSU College of Human Medicine seems to be stressing research as heavily as education and is attracting able investigators to its faculty and there seems no real conflict between its present organization and high quality research in both the basic and clinical sciences.

The College of Osteopathic Medicine is using community facilities for clinical training in a way that does not depart drastically from past practice in osteopathic medicine. Individual D.O.'s in the community serve as preceptors for students, and the medical school makes affiliation arrangements

with osteopathic hospitals in surrounding cities for clinical education. (There are still many unresolved questions about the interactions between the two medical schools at MSU; these will be discussed in a final article.)

It should be noted that medical education at MSU will not necessarily prove less expensive than the more common big-university-medical-center model. Certainly the expense of a major teaching hospital will be saved at MSU, but the operating costs in a community-based system of administration, deployment of faculty, and student travel may well counterbalance the saving.

The ultimate question, of course, is what kind of doctors MSU will produce. So far, graduates have fared well in moving on to other medical schools (when MSU had a 2-year school) and in gaining acceptance in good internship and residency programs. But the question of whether or not MSU medical graduates will stay in Michigan and improve the condition of health care must await some years for an answer. At MSU, however, there seems to be a genuine feeling that the prognosis is good for both the partnership between the medical schools and the communities and, in the longer term, for MSU's alternative style of medical education.

—JOHN WALSH

# APPOINTMENTS

**Charles A. Payne**, professor of chemistry, Morehead State University, to dean, School of Sciences and Mathematics at the university. . . . **Charles D. Michener**, professor of systematics, ecology, and entomology, University of Kansas, to chairman, entomology department at the university. . . . **Donald R. Progulske**, head, fisheries and wildlife department, South Dakota State University, to head, forestry and wildlife management department, University of Massachusetts. . . . **Cyrus Mayshark**, associate dean, College of Education, University of Tennessee, Knoxville, to dean, School of Education, University of Texas, El Paso. . . . **Louis S. Harris**, professor of pharmacology, University of North Carolina, to chairman, pharmacology department, Virginia Commonwealth University. . . . **Martin W. Donner**, acting director, radiology department, Johns Hopkins University School of Medicine, appointed director of the department. . . . **Kenneth J. Ryan**, chairman, obstetrics and gynecology department, University of California, San Diego, School of Medicine, to head, obstetrics and gynecology department, Harvard University. . . . **Raymond R. Walsh**, professor of physiology, Southern Illinois University at Edwardsville, School of Dental Medicine, to chairman, biology department, St. Louis University. . . . **Stephen E. Fienberg**, assistant professor of statistics and theoretical biology, University of Chicago, to chairman, applied statistics department, University of Minnesota. . . . **Lewis J. Sherman**, professor of psychology, University of Missouri, St. Louis, to chairman, psychology department at the university. . . . **Gordon E. Stone**, associate professor of anatomy, University of Colorado, to chairman of biological sciences, University of Denver. . . . **Orlando F. Gabriele**, professor of medicine, University of North Carolina, to chairman, radiology department, West Virginia University. . . . **Earl W. Collard**, associate professor of dentistry, University of California, Los Angeles, to chairman, operative dentistry department, University of Oklahoma. . . . **Maurice Bender**, former chief, research and training, grants branch, division of air pollution, Public Health Service, to director, Arctic Health Research Center, Alaska. . . . **Warren F. Jones**, dean of administration, University of Louisville, to dean, School of Arts and Sciences, Georgia Southern College.

**RESEARCH NEWS**

# Magnetic Containment Fusion: What Are the Prospects?


Very early in the atomic age it was realized that the reaction that produces the hydrogen bomb could be a great source of energy if it could only be controlled. At one time it was thought that the research on a fusion reactor might proceed so quickly that it would possibly be an alternative to the first generation of fission reactors of the breeder type, but the early projections were too optimstic. No one knew in the early 1950's how slow progress toward a fusion reactor would be because few scientists realized that it would be necessary to unravel and master the details of a whole new field of science—plasma physics—first. Scores of different shapes for magnetic systems have been tested to see how well they would contain a fusion reaction. But so far none has shown that net production of energy is feasible.

As a result of rather encouraging experiments in the last 4 years, many scientists now think that controlled fusion is probably attainable with magnetic containment systems, possibly about 1980. Some scientists have estimated that an alternate approach to fusion—with a laser to heat the fuel—might be feasible sooner (*Science*, 29 September 1972). If the scientific feasibility of either magnetic or laser fusion were demonstrated, commercial sales of fusion reactors would still not begin until after experimental reactors were extensively tested and a demonstration reactor proved successful. The specific studies necessary to begin to assess the size, cost, operating characteristics, radioactive hazards, and environmental effects of a fusion reactor are in a very early stage for laser fusion and are just becoming available for magnetic fusion. However, it is clear that fusion reactors would have two great advantages: virtually unlimited fuel resources and no conceivable danger of an explosive accident.

Two heavy isotopes of hydrogen are commonly considered as the likely fuels for fusion: deuterium and tritium. Deuterium is so plentiful in seawater that it would be an extremely cheap fuel (costing only 0.003 mill per kilowatt hour); but tritium would have to be bred in a fusion reactor, much like plutonium can be bred in a fission reactor. The temperature for burning a mixture of deuterium and tritium is so high that no material could contain the fuel without melting. But magnetic fields shaped like bottles can keep the hot fuel from touching any walls.