Summary

As a result of investigations using these methods, the molecular details of many solution reactions are becoming apparent. However, these techniques have not yet been applied to many types of reactions. They promise to be of considerable further usefulness in revealing the mechanism of many chemical reactions.

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NEWS AND COMMENT

M.I.T.: New President Will Pursue Broadened Goals

Cambridge. The Massachusetts Institute of Technology has been evolving rapidly during the postwar years toward what its leaders call a "university polarized around science and technology." In July, M.I.T. will have a new president, one who promises to continue in the path of his predecessors and make "no right angle turns." The presidency of M.I.T. is, most would agree, a position of unusual significance because of the Institute's leadership in technology and its major role in government-sponsored "big science."

As one Massachusetts newspaper has observed, a computer assigned to the screening of candidates for the presidency might have passed over Howard W. Johnson, the 43-year-old president-elect. Johnson is neither scientist nor engineer, but an economist whose reputation rests chiefly on his work as dean of M.I.T.'s Alfred P. Sloan School of Management. He will succeed President Julius A. Stratton, a physicist who did outstanding work in electromagnetic theory during the 1930's and 1940's.

However, it is not unprecedented for M.I.T. to choose its president from outside the ranks of scientists and engineers. The Institute's third president, Francis Amasa Walker, who served from 1881 to 1897, was a political economist. Stratton's predecessor, James R. Killian, Jr., now chairman of the Corporation of M.I.T., came to the presidency from a career primarily as an academic administrator. Moreover, the selection of a social scientist as president does not seem inappropriate for an institution which, though emphasizing science and technology, is concerned with the "totality of the human experience."

The New York *Times*, in a lead editorial on Johnson's election shortly after it was announced in December, observed that Sir Charles Snow, in taking a second look at his "two cultures" hypothesis, has perceived that the social scientists might lead in bridging the gap between humanists and physical scientists. The *Times* suggested that Johnson could be expected to continue the cultural bridge building already well under way at M.I.T.

Lord Snow's "two cultures" may be, as some believe, a moribund and scarcely accurate cliché. But there is no gainsaying the fact that at M.I.T., or any other institution, establishing a measure of common understanding between various fields of specialization is an endless task for which a social scientist may be as well fited as anyone. According to Killian, Johnson caught the attention of the M.I.T. Corporation and its selection committee because of exceptional personal qualities, not because of his professional identity as dean of the School of Management. Or, as Stratton put it, "It was not a choice based on the theology, but on a man."

The search for a new president began last November after it had been announced that Stratton would depart at the end of the current academic year. (Nearing M.I.T.'s retirement age of 65, Stratton will leave the Institute and devote himself to the chairmanship of the Ford Foundation board of trustees, a post which he assumed on 1 January.) The M.I.T. Corporation appointed a Committee on Succession, whose members were James B. Fisk, president of Bell Telephone Laboratories, Inc., chairman; Vannevar Bush, former vice president and dean of engineering of M.I.T. and former president of the Carnegie Institution; Crawford H. Greenwalt, chairman of E. I. du Pont de Nemours and Company, Inc.; Robert C. Gunness, executive vice president of Standard Oil Company (Indiana); and Edward J. Hanley, chairman and president of Allegheny Ludlum Steel Corporation. It was on this group's recommendation that the Corporation elected Johnson.

According to Killian, the committee assumed that, whoever became the new president, M.I.T. would not be making any radical shifts of direction or basic policy. All else being equal, the committee would favor someone from inside the Institute who understood M.I.T.'s complexities and whose selection would spare the Institute a long interregnum. There was no disposition to pass over the scientists and engineers. "It would be natural to think that the head of the Institute would come from engineering or science," Killian said. "This was the assumption at the beginning." But, he added, the most important quality sought was a gift for leadership, regardless of academic specialty.

Campus speculation on the chief contenders for the presidency pointed to Charles H. Townes, M.I.T.'s provost, and Jerome B. Wiesner, dean of the School of Science. Townes, co-winner of the 1964 Nobel prize in physics for

View of two additions to the M.I.T. campus———Kresage Auditorium (left) and the recently opened Stratton Building, which houses the Student Center. These facilities reflect the administration's concern for improving the quality of student life.

his part in the invention of the maser and laser, had been brought to M.I.T. in 1961 from Columbia—as Stratton's heir apparent, some believed. Wiesner was named dean of the School of Science in 1964 after 3 years in Washington as the President's science adviser; before joining the Kennedy administration Wiesner had been director of M.I.T.'s Research Laboratory of Electronics.

Townes' and Wiesner's names were, in fact, on a "short list" which the Committee on Succession discussed with the chairman of the faculty, with several ex-chairmen, and perhaps with a number of other senior faculty members. The whole story of how such committees arrive at their selections never is publicly revealed. Indeed, the psychological processes involved are complex and perhaps not fully understood even by those participating. Though a case for either Townes or Wiesner is easily made by their partisans, both men were passed by when the committee widened its search. Johnson—not even a dark horse in the speculation—then came to be seriously considered.

Vannevar Bush was one of the first committee members to become interested in Johnson. Bush, Hanley, and Gunness knew Johnson; Fisk and Greenwalt did not. Killian and Stratton, who met frequently with the committee, of course knew Johnson well. As dean of the School of Management, Johnson had been an active and influential member of Stratton's Academic Council, which is M.I.T.'s most important policy-making body except for the Corporation itself.

According to Killian, the Committee on Succession found in Johnson just what it was looking for. "He had a mix of qualities that seemed to be particularly fortunate and right for the person to become President of the Institute," Killian has told *Science*. These included a gift for acute and decisive academic leadership and a "personality that inspires respect and confidence and that works to build a harmonious organization," Killian said.

The committee was impressed by Johnson's record at M.I.T., which began in 1955 with his appointment as associate professor of industrial management and director of the Executive Development programs. Johnson had come to M.I.T. from the University of Chicago, where he had been director of management programs at the Industrial Relations Center. (Johnson, who does not hold a doctorate, received a master of arts degree in economics from Chicago in 1947. He did his undergraduate work at Central College in Chicago, and studied afterward at the University of Glascow, Scotland.) He was promoted to associate dean in 1958 and to dean in 1959.

Under Johnson's leadership, a doctoral program was established in 1960, and, among the 300 graduate students now enrolled, 50 are Ph.D. candidates. The faculty was strengthened, and some major research programs were inaugurated—in finance, organization, information and control systems, industrial dynamics, and the management of large-scale technology-based enterprises.

In addition, the Institute expanded its programs for business executives and instituted several international programs. For example, an advanced management program was begun in India, and "M.I.T. Fellows" have been sent to serve in management positions in new African nations. Altogether, it is a record which has impressed not only the Committee on Succession but also Johnson's professional colleagues at Harvard's School of Business Administration. "Johnson has kept the Sloan School in the forefront," one of the Harvard deans remarks.

The M.I.T. faculty's surprise at Johnson's election to the presidency was all the greater because he had recently acquired a new home in Cincinnati, where, on 1 January, he was to have become executive vice president of Federated Department Stores, Inc. (Johnson is now serving Federated temporarily as a consultant, dividing his time between Cincinnati and Cambridge; he returns to M.I.T. this spring for a transitional period before taking office.) Though startling, the announcement was well received.

In part, this seems to have been because Johnson had made a favorable impression on faculty members who

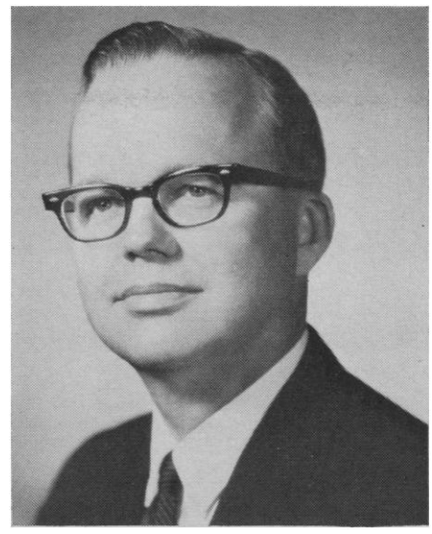
knew him; also, the M.I.T. faculty trusts the Institute's administration, and in most instances is willing to have the administrators administer, leaving them, the members of the faculty, undisturbed in their teaching and their scholarly pursuits.

William W. Buechner, chairman of the physics department, thinks many faculty members accepted Johnson's appointment on faith, knowing little about him other than that he was dean of a school. Charles P. Kindleberger, professor of economics and recently elected chairman of the faculty, says that the only faculty member who complained to him about the appointment was an engineer. The engineer proposed that the faculty be represented in the Corporation membership, but then let the matter drop.

Outside of the Sloan School, Johnson was perhaps best known in the School of Humanities and Social Science. Robert L. Bishop, dean of that school, regards Johnson as particularly sensitive to the requirements of good scholarship and to the aspirations of the faculty for the various departments. This quality, it would seem, is particularly relevant to the future development of Bishop's school, especially its humanities department, and of the School of Science.

Johnson will assume the presidency at a time when M.I.T.'s evolution toward university status of a unique kind is already far advanced. M.I.T. has professed lofty educational aims from its very beginning in the 1860's, but, according to Stratton, for many years the emphasis was on vocationalism. Recalling his own undergraduate years at M.I.T., Stratton (class of 1923) has said the Institute's concern with basic science and original research was minimal. The undergraduate curriculum represented the best of engineering education in the United States, but the science courses served largely a "service" function for the instruction of freshmen and sophomores.

Science at M.I.T. was strengthened during the 1930's and 1940's under the leadership of President Karl Compton. "Out of his own experience as an experimental physicist, he [Compton] foresaw great developments looming upon the horizon," Stratton has said. Compton maintained that, if engineering education were to continue to prosper, it must build upon a firm foundation of chemistry, physics, and mathematics. To this end he insisted that the departments of mathematics and science be vigorous and respected in their own right, Stratton said.



Howard W. Johnson

The new interest in research and the scientific component of engineering gained momentum from work in the laboratories established for military research and development during World War II. In view of the breadth, diversity, and quality of its program, M.I.T. now regards itself—and many qualified outsiders probably would agree—as preeminent among schools of technology.

The School of Humanities and Social Science, established during the early postwar years, represented a further broadening of the Institute's perspective and educational program. In recent years, social science and those areas of the humanities with the closest affinity to science—that is, those lending themselves to quantitative analysis—have begun to flourish at M.I.T.

The economics department, with Paul Samuelson as its brightest star, usually is rated superb. The department of political science and the Center for International Studies (staffed by economists and political scientists) are adjudged excellent. New Ph.D. programs in linguistics and psychology are directed by distinguished professors such as Noam A. Chomsky (linguistics) and Hans-Lukas Teuber (psychology). A Ph.D. program in philosophy (chiefly analytic), established in 1964, suffered a blow last year when Hilary Putnam, professor of the philosophy of science, moved to Harvard. Efforts are being made to strengthen the quality of both the faculty and graduate students in philosophy.

In short, when M.I.T.'s leaders say that the Institute is a university in fact if not in name, there is much to support the assertion. In addition to the progress in curriculum development, other evidence supports M.I.T.'s claim to a high rank in American education. In a poll of 120,000 National Merit Scholarship candidates, M.I.T. was the first choice of more students than any other institution—picked ahead of even its neighbor Harvard.

M.I.T.'s enrollment of 7000 students is not large, compared to that of the giant state institutions, but half of the 7000 are graduate students. (The undergraduate enrollment will remain at about 3500; the graduate enrollment is growing, and will continue to grow, by several percent each year.) The productiveness of the graduate programs has made M.I.T.'s influence felt throughout the United States and abroad. This has been particularly true in engineering, a field in which, between 1920 and 1962, the Institute awarded nearly twice as many doctorates as its nearest rival (the University of Michigan).

During the 5-year period that ended last June, M.I.T. awarded 1296 doctorates—103 in social science and humanities; 543 in science; 630 in engineering; and a small number in planning and in industrial management. In 1964 M.I.T. ranked fifth—behind California (Berkeley), Illinois, Wisconsin, and Harvard—in the total number of doctorates conferred in science and engineering.

It is axiomatic that any institution's academic quality depends partly on its financial resources. M.I.T.'s resources are large, even though surpassed by Harvard's and those of some other universities. Its budget for the 1964–1965 academic year (the last to be made public) totaled more than $165 million, of which about $35 million was for the general academic program and about $130 million was for research. Most of the research money came, of course, from the government. Nearly $60 million in federal funds went to Lincoln Laboratory, operated by M.I.T. for the Air Force and the Advanced Research Projects Agency.

No more tangible evidence can be found of the pervasiveness of M.I.T.'s influence, as well as of the wealth of its alumni, than the $98 million raised during the Institute's 3-year Second Century fund drive. The total value of M.I.T.'s invested funds last year exceeded $340 million.

Impressive as its accomplishments have been, however, the Institute has not yet achieved the all-round excel-

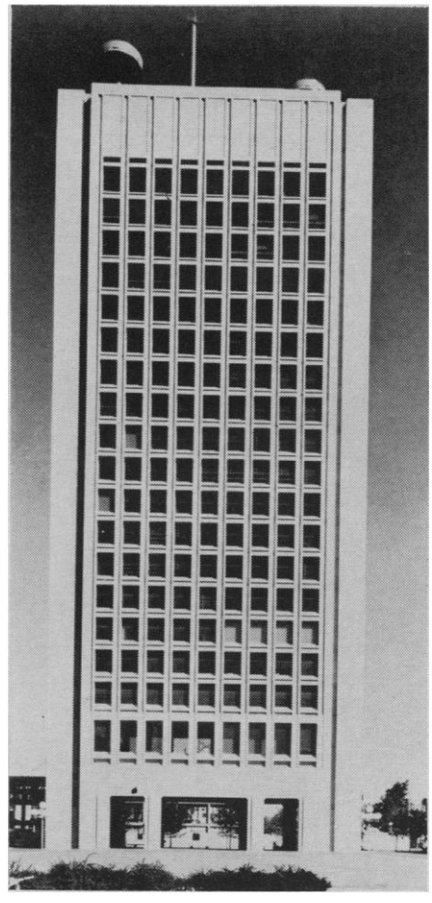
lence to which it aspires. The humanities program, though good, has somewhat the same "service" status which the science program had in the pre-Compton era. The School of Science, while considered strong, has not—to judge from Nobel prize awards—produced the kind of highly creative work that has been done at certain other institutions. The only Nobel laureate at M.I.T. is Townes, who was honored for work done at Columbia. One notes that the University of California at Berkeley alone has nine Nobel laureates.

On the other hand, the School of Science is looking to the future and attracting distinguished younger scientists such as Frank Press, who recently left Caltech to head M.I.T.'s geology department. Johnson, whom Killian credits with some effective recruiting as dean of the School of Management, is expected to see that the search for potential stars receives continued emphasis, in science and in other academic areas.

M.I.T. may not be the community of scholars that it aspires to be, but probably no institution has labored harder and more introspectively at defining for itself a mission in which all disciplines can claim an important part. President Stratton believes that the next step in M.I.T.'s evolution should be the strengthening of the humanities program. But the problem of giving such a program first-class status in an institute of science and technoloy is inherently difficult.

"The major difficulty is scarce time," says Richard M. Douglas, chairman of the department of humanities. Requirements in science and engineering are such that a student concentrating in either of those fields devotes slightly less than 20 percent of his time to work in the humanities and social science. Fifty-seven seniors this year are completing M.I.T.'s "Course XXI," a program in which a student combines a major in humanities with a major in science or engineering. But this is less than 6 percent of all M.I.T. seniors.

A pending question on the science and engineering requirement appropriate for juniors and seniors enrolled in Course XXI illustrates the dilemma in which the humanities are caught in a school of technology. The humanities faculty next year will propose that the requirement be reduced. Course XXI students now must take almost twice the work in science and engineering required of an economics or political science major. However, the humanities faculty itself is divided on whether or not the junior- and senior-year requirement in science and engineering should be reduced to zero. One important group of professors would reduce the requirement by only half. "They feel that the uniqueness of M.I.T. is that it combines science and the humanities," Douglas says. "They feel, to put it grandly, that the country needs people with both kinds of literacy." Douglas by no means disagrees with this assessment, but believes that the freshman- and sophomore-year requirements provide a base in science adequate for the humanist or generalist.



New 20-story Cecil and Ida Green Building for the Center for Earth Sciences, one of several new interdisciplinary centers which are playing an increasingly important role in education and research at M.I.T.

Douglas observes that one of the most common limitations of the humanistic tradition is "its refusal of the present—in almost all historical eras—as harsh, unstable or vulgar." Modern education, he adds, must urgently seek means to enable college students to create an intelligible present. The modern scientist and engineer lives and thinks, perhaps too much, in the future. However, any attempt to restrict him to a study of the past will be resisted. But his interest can be engaged by studies that impart a sense of past and present in conjunction—that treat the fractures in tradition as well as tradition itself.

"We do not propose to 'modernize' the study of humanities to the exclusion of all that traditionally belongs to the humanities," Douglas says. "But we do intend to develop a series of new courses for upperclassmen which will more expressly direct the humanities into modern experience, and into resources of analysis and imagination which attempt to make such experience intelligible."

Accordingly, the humanities department has been developing a series of interdisciplinary courses which are central to M.I.T.'s primary concerns. These courses develop such themes as the moral issues raised in the pursuit of scientific understanding; the biological bases of perception and knowledge; and the culture of cities.

This is the kind of effort M.I.T.'s leaders have been trying to promote, to make students and faculty less likely to develop the tunnel vision that is the bane of specialists of all descriptions. Johnson, sensitive to the need for this effort, feels that he and his colleagues in social science are often credited with a greater gift than they actually possess for seeing the forest as well as the trees.

When M.I.T. goes after a gifted young Ph.D. in the humanities, it finds it hard to compete with even money against, say, Harvard or Yale. The explanation lies, in part, in its lack of graduate programs in humanistic fields other than linguistics and philosophy. The question of whether additional Ph.D. programs should be established in the humanities goes to the heart of the M.I.T. philosophy that the Institute should remain basically oriented to science and technology. Johnson and the M.I.T. faculty will have this question to answer.

Bishop, dean of humanities and social science, foresees the possibility of new Ph.D. programs in the history of science and technology, in history in general, and in literature. The literature program would be more oriented to linguistics than a literature program in the liberal arts tradition would be.

"I think it's an open question," Johnson says. "We must consider whether we should follow the same route taken in the social sciences, where we did

find it necessary to establish graduate programs in order to build strength. It would be relatively simple to follow that route in history. If you go beyond that and do the same in literature, then you're building a university."

From the standpoint of the faculty's opportunity for scholarly pursuits, the lack of graduate programs at the Institute can be partly offset by summer research grants and the like. Some support of this kind has been provided the humanities faculty, and Johnson hopes it can be expanded.

"Tech is hell" is a traditional undergraduate expression, and there is some feeling on the part of the faculty that perhaps the temperature of hell should be lowered. A British Broadcasting Corporation film entitled *How To Be First* has depicted M.I.T. as a place of unrelenting pressure and little humanity. More of an essay than a documentary, the film overstates the case but does present recognizable features of M.I.T. life. The Institute has been making efforts to relieve the campus' physical austerity by such improvements as construction of a handsome new student center.

Johnson thinks it is also important that the undergraduate's intellectual regimen be improved. "Quiz pressure for quiz pressure's sake" he regards as undesirable. "Students of the quality we have at M.I.T. can bear heavy burdens. M.I.T. should remain a heavily demanding place, but all aspects of M.I.T. life should be meaningful," Johnson says.

Under the leadership of Compton, Killian, and Stratton, M.I.T. has built a tradition of major involvement with the pressing problems of the time. Under the new administration the tradition is not likely to wither. Stratton has identified a number of demanding public concerns, outside the ever-present one of defense, which M.I.T. and other institutions must pursue.

The transformation of the cities under the impact of technology, the crisis in transportation, automation and its impact on the labor force, environmental pollution—these are examples of problems which, according to Stratton, require the attention of institutions such as M.I.T. because government, industry, and research institutes all lack either the intellectual resources, the incentive, or the capacity for self-renewal that are essential. Johnson, in his 10 years at M.I.T., has grown up in the tradition of "engagement" with the outside world and, as dean of the Sloan School, has made his contribution to it.

In the past, M.I.T. has kept its leadership as a school of technology partly by the sheer weight of its output of highly trained engineers. In the future, as the production of engineering Ph.D.'s at other institutions continues to grow, M.I.T.'s influence will decline unless it maintains its place at the leading edge of technological change. For his part, Johnson has no doubt that the Institute will keep that place, through its selectivity in admitting students, its flexibility in using its resources, and its constant experimentation in program planning.—LUTHER J. CARTER

Animal Care: The Humane Movement Is Pulling Ahead

Warfare between the research community and the humane movement over the regulation of animals used in research has been carried on for some time, with researchers relatively confident that, while the "dog lobby" was something of a nuisance, it presented no immediate legislative threat. Until recently, that assessment was probably correct: the humane movement was concentrating on efforts to limit the number of animals used in painful experiments and on the amount of pain to which they were subjected, and Congress showed little inclination to make judgments so intimately affecting research. But in the past few months the humane movement found its thalidomide in sensational nationwide exposés of pet thievery and brutality among the animal dealers who supply research institutions.

The result was the creation of a kind of second front, focusing not on animal experimentation but on animal trading and handling. Public interest is at an incredibly high pitch: the House Agriculture Committee alone received over 20,000 letters following 2 days of hearings this month, and individual congressmen report mail from constituents running far higher than combined mail on Vietnam, inflation, poverty, and civil rights. As a consequence, there seems very little doubt that Congress will approve some form of regulatory legislation this session. The issue now at hand is whether the legislation to control animal suppliers will deflate the drive to regulate experimentation, as the scientific community rather openly hopes; whether it will be the first step in securing such regulation, as part of the humane movement wishes; or whether it will itself be broadened to include some authority over laboratories, as other segments of the humane movement intend. Behind each of these possibilities is an army of formidable lobbies fighting like cats and dogs as well as about them.

At this writing, prospects are best for the third possibility—a strong bill that would give the Secretary of Agriculture some authority over research laboratories as well as over animal dealers. A number of bills providing for lesser degrees of regulation were considered by the House Agriculture Committee's subcommittee on livestock and feed grains during its recent hearings. But the subcommittee, in action late last week, rejected the weaker proposals and approved the bill introduced by its chairman, W. R. Poage (D–Texas), the second-ranking member of the Agriculture Committee. The subcommittee's action has already won a favorable response from Harold Cooley (D–N.C.), chairman of the full committee, and Cooley has promised quick committee action.

In the Senate, hearings before the full Commerce Committee are scheduled, for 25 and 28 March, on two bills, one introduced by Hugh Scott (R–Pa.) and one cosponsored by Joseph Clark (D–Pa.) and Warren Magnuson (D–Wash.), the Commerce Committee chairman. The Clark-Magnuson bill is